Science & Engineering & Technology Careers

GET INSPIRED WITH
ROLE MODELS
STUDY PATHS

EXCITING NEW FEATURES
ROBOTICS & AI
NANOTECHNOLOGY
UNMANNED AERIAL VEHICLES

INFORMATION ON 73 CAREERS
HOW TO GET FINANCIAL AID

2nd Edition

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation
SAASTA South African Agency for Science and Technology Advancement

2030 NDP

This publication is an initiative of the Science Promotion Unit, of the Department of Science and Innovation. For any further information or to request a copy, please contact the Science Promotion Unit, Department of Science and Innovation, Private Bag X894, Pretoria, 0001, Tel: 012 843 6850.

FOREWORD

Greetings to all the readers of the Department of Science and Innovation's second edition of the science, engineering and technology (SET) careers publication, which profiles more than 70 careers that will be indispensable in the next decade and beyond.

We hope that the publication will spark young people's interest in SET opportunities and provide them and their parents and teachers with information that will support good study and career decisions.

The publication is produced as part of the Science Engagement Strategy, which seeks to develop a society that is knowledgeable about science and engages critically with science issues.

The strategy also intends to awaken interest in science careers that will contribute to achieving the goals of the National Development Plan (Vision 2030).

A feature of this publication is the graphic illustration of various SET career paths, from Grade 12 to undergraduate subject choices, and on through postgraduate options in each field up to PhD level.

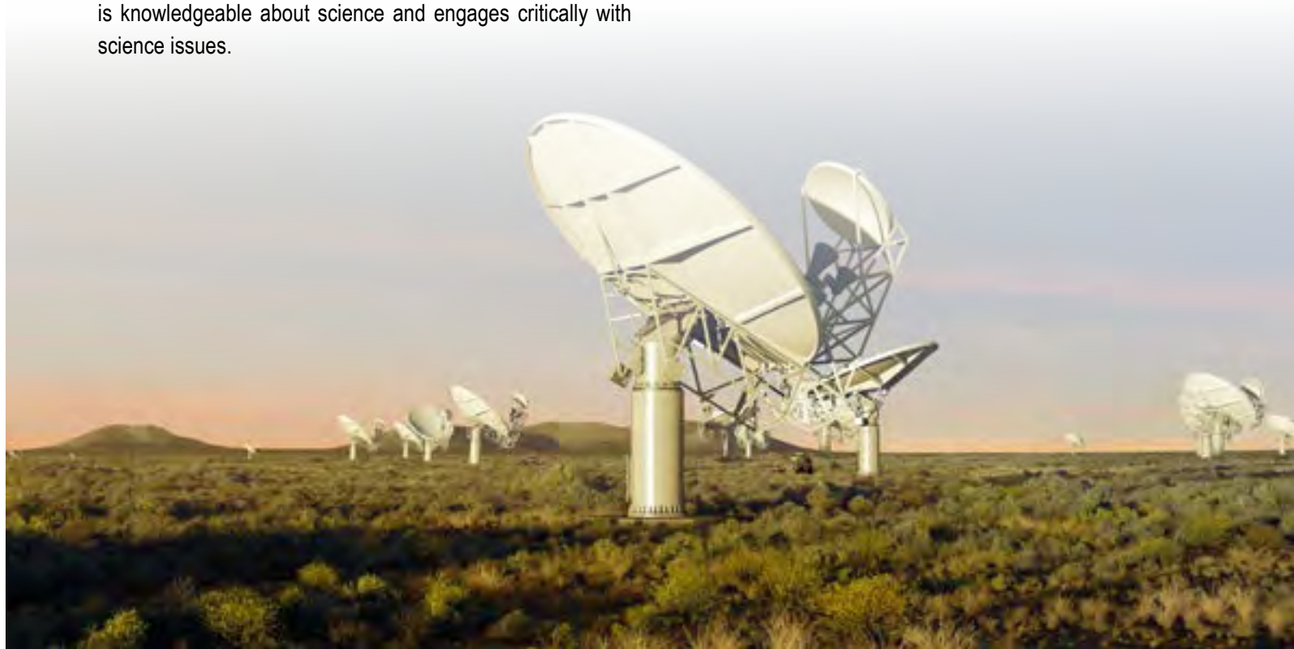
The pathway to a SET research career is emphasised, and research scientists are profiled to inspire more talented students to persevere in following this career path.

Several feature articles on robotics and artificial intelligence, unmanned aerial vehicles and nanoscience, among other topics, give readers a glimpse of the exciting world of the Fourth Industrial Revolution.

This publication is a sought-after resource for teachers, librarians and career advisors, and many of them are keenly awaiting this enhanced edition. As in the past, many thousands of learners and students will use it.

All the readers and users of this publication are requested to be generous and share the information with friends, family, colleagues and all other stakeholders with an interest in advancing SET careers.

Dr BE Nzimande, MP
Minister of Higher Education, Science and Innovation



INTRODUCTION

The Department of Science and Innovation is excited to be bringing out an updated edition of its career publication which is intended to inform and motivate learners, students, teachers and parents to follow careers in science, engineering and technology.

A valuable reference tool, this publication belongs in school, university and public libraries. It can be used by career counsellors and professionals at career centres and schools. Life Orientation teachers can also make use of it in class or at workshops.

This edition of the publication raises awareness about some comparatively new career fields, which are expected to grow in importance worldwide. Nanoscience, photonics engineering, space weather analysis and diagnostic medical sonography are some of these. Many traditional career options also remain relevant to the needs of society. As our country and the world increasingly embrace science and technology, more SET professionals and practitioners will be required, and readers need to be aware of the opportunities.

Career information should be widely accessible, and this publication will be available in print, on CD and online to bring potentially life-changing information to as many readers as possible.

The publication contains a brand new section to help readers choose an appropriate career, unpacking the paths to becoming a medical, engineering or natural science professional. Basic information and tools are provided to help students find funding for their studies. The information will also be made available in a separate booklet, which will be printed in large numbers and distributed at science awareness events.

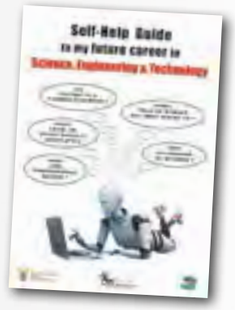
I am confident that the readers of this publication will find the time they spend exploring it rewarding, and hope that it will encourage many talented young people to study and eventually follow a career in a SET-related field.

Phil Mjwara
Director-General: Science and Innovation

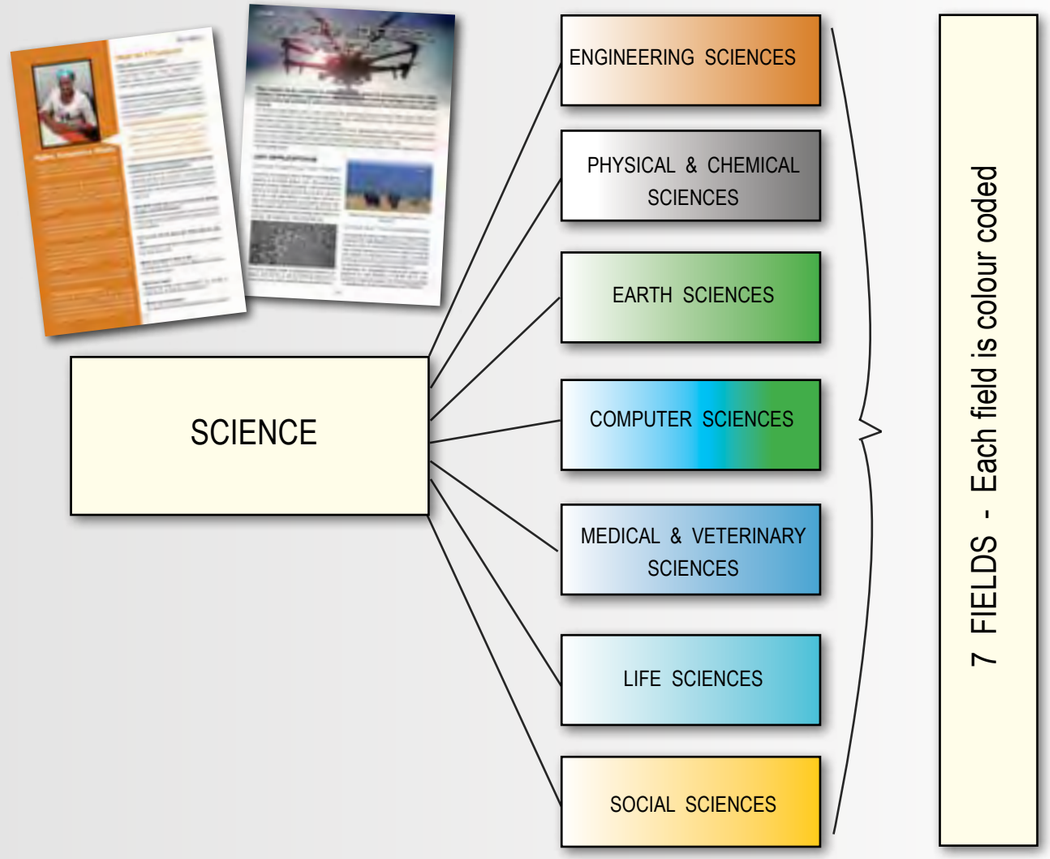
HOW TO USE THIS BOOK

Are you suited to a career in Science ? Which field of science are you suited to ?

If you are not sure, then this publication will help you answer these questions.



1. Do a Self Assessment Questionnaire “Who am I ?” (pg 194)
2. Identify a Field of Science suited to you (pg 196)
3. Research 3 Careers (pg 197-199)
4. Levels of study (pg 200)
5. What level of profession do you want to achieve (pg 201)
6. Look at how you will fund your studies (pg 202)
7. Draw up a Financial Plan (pg 204)
8. Draw up an Action Plan (pg 205)
9. Find your relavant careers in this book (Index pg 4-6)
10. Read the real stories of people in these careers (called Role Models)
11. Read fascinating articles on the trends in the field of science.



go study

This publication was compiled by Pace Career Centre.
www.gostudy.net | www.pacecareers.com

PACE Career Centre

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www.nmmu.ac.za
info@mandela.ac.za

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Gauteng
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www.vut.ac.za

ENGINEERING SCIENCES

The best way to understand engineering is to imagine a world without it. Engineering plays a role in every part of our daily lives, from riding a mountain bike to checking our Facebook status. From the beginning to the end of each day, engineering technologies improve the ways in which we live, communicate, travel, stay healthy and entertain ourselves.

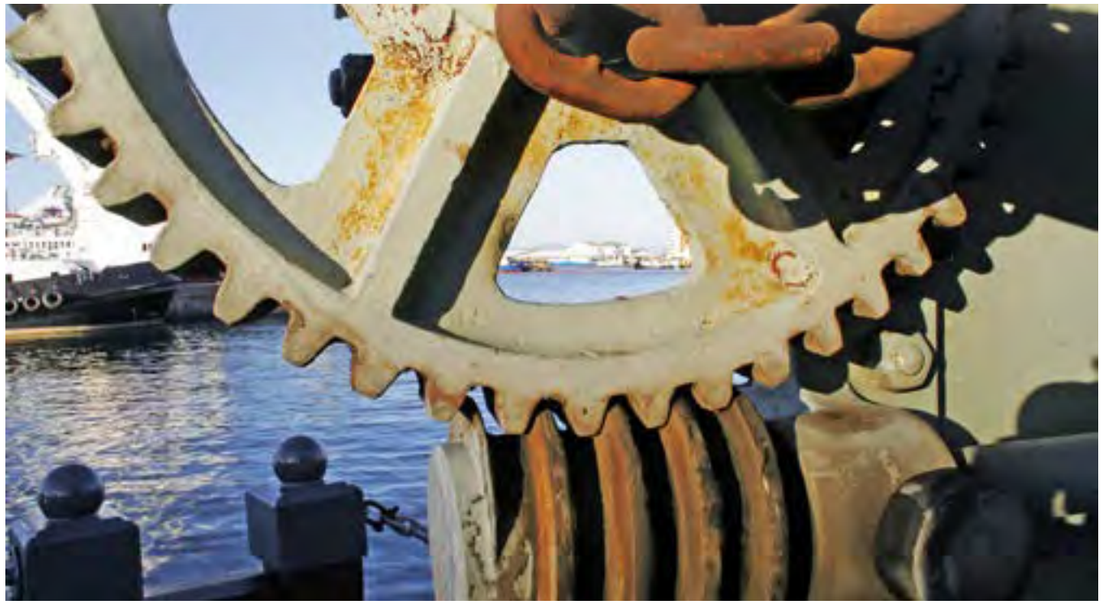
The field of engineering is as broad as science itself. Whilst science deals with the discovery of knowledge and the understanding of phenomena around us, engineering uses the discoveries of scientists to create useful products and to increase efficiency and reduce expense at every level. At an atomic level, a chemical engineer works on energy storage systems. At a molecular level, a bio-engineer develops new drugs. At an environmental level, an environmental engineer devises suitable methods to rehabilitate polluted seas. At a galactic level, an electronic engineer builds satellites for launching above earth's atmosphere, and on a personal level civil engineers help design and construct our homes, offices and stadiums, to name a few.

Engineering is at the forefront facing the environmental challenges relating to climate change, such as the development of renewable energy sources, as well as finding solutions for environmental disasters. Engineers are primarily concerned with finding solutions to problems and typically work as part of a project team.

Some solutions that would work may be too expensive to implement, other possible solutions might take too long to develop. Typically, a project has very specific time and financial constraints, which means that an engineer must often make difficult decisions.

In the workplace, engineering is an excellent outlet for the imagination: engineers may be involved in design, production, research or running businesses. Engineers are able to work in a variety of fields, such as marketing and sales, research, teaching, administration and supervision. Engineers can work for small or large businesses or even multi-national companies, anywhere in the world. A senior engineer will usually perform less technical work and focus instead on managing a project or a team of engineers.

Engineers typically follow a four-year undergraduate degree in a specific discipline such as chemical, civil, mechanical, electrical or electronic engineering. At undergraduate level students are given basic training in the sciences, including subjects such as mathematics, physics and chemistry. As students advance, they get to work in specialised areas, and many engineers work in multiple disciplines; for example electrical engineers may write software or design an electromechanical motor. Engineering is a financially rewarding field of study and can open up opportunities to enter into many careers.



ENGINEERING SCIENCES STUDY PATHS

National Senior Certificate:
With Mathematics
and Physical Science

Each education institution has its own unique entry requirements for each of its programmes. It is important to check the entry requirements for the programme with the institution of your choice before you apply.

University
Bachelor of Science Degree or Bachelor of Engineering Degree

Majors in:
Aeronautics
Chemical
Computer
Civil
Electrical
Geodetic
Industrial
Mechanical
Metallurgy
Mining
or any other related subject.

University of Technology
National Diploma

Diploma in:
Chemical
Civil
Electrical
Industrial
Mechanical
Mechatronics
Metallurgy
Refractories
or any other related qualification offered by the institution.

Internship / Workplace Experience

In order to register as a Professional Engineer at the Engineering Council of South Africa (ECSA), you first have to register as a Candidate Engineer and gain three years of work experience.

Professional Review
(Engineer)

After completion of the candidate phase ECSA conducts a professional review of the work experience. You can apply for registration as a Professional Engineer after the review has been completed.

Designation:
Professional Engineer

Only engineers registered with the ECSA may use the designation Professional Engineer. A designation is a title that a professional person may use (write behind her/his name) to indicate that she/he is fully qualified in a certain professional field and is a member of a professional body.

AERONAUTICAL AND AEROSPACE ENGINEER

Aeronautical engineering is one of the most challenging fields of engineering with a wide scope for growth. This career deals with the development of new technology in the field of aviation, space exploration and defence systems.

Aeronautical engineers design, plan, develop, manufacture and test aircraft, missiles, satellites and other relevant aeronautical products and systems. Aeronautical engineers usually work as part of a team with each team member representing a different area of specialisation.

British Aerospace EAP at the Aeronautical Engineering Department at Loughborough University
< http://en.wikipedia.org/wiki/Loughborough_University >

Aeronautical engineers may specialise in one of the following fields:

Structural analysis: the analysis of static and dynamic loads of the airframe and the choice of construction materials and production methods to be used.

Aerodynamics: the study of airflow over an aircraft to determine its configuration, stability, control and performance, and power requirements. This is often done with the aid of scale models, which are tested in a wind tunnel.

Propulsion: this involves flow mechanics, thermo-dynamics, gas dynamics and strength of materials. It entails the choice of appropriate vehicle engines. Engineers in this field of study occupy themselves with the design, development, production, assembly and testing of aircraft engines that must meet certain power and performance requirements.

Systems: this involves the definition, simulation, integration and evaluation of all subsystems of an aircraft / missile to ensure that the system meets all requirements and that it functions well. A systems engineer or project manager is responsible for integrating all these fields.

Manufacture and production: this field involves ensuring that the product is of a high quality, with the application of rigid standards and stringent control throughout the production process.

Avionics: this field involves aspects such as flight instrumentation, radar, computers, navigation equipment, communication systems and sensors (height and speed).
Servo and power systems: the use of hydraulic and electrical systems for the stability and control of aircraft and missiles.

Certification: this involves systematic flight tests to prove that an aircraft is airworthy and performs as required.

Aerospace engineers design and develop aircraft, spacecraft, missiles and aerospace systems and components. They develop and conduct tests and computer simulations of aerospace vehicles, systems and components, as well as prepare specifications for materials and processes to be used in aerospace manufacturing, maintenance, repair or modification. Aerospace engineers also supervise and coordinate the manufacturing, assembly modification, repair and overhaul of aircraft and spacecraft. They coordinate ground and flight tests of air and spacecraft, and they develop operational specifications, maintenance schedules and manuals for operators.

Aerospace engineers are required to develop the technical phases of logistical and operational support for aerospace vehicles and systems, investigate and report on structural or other component or system failures, accidents or incidents, and prepare recommendations for corrective action.

These engineers generally work indoors in offices or research laboratories. The actual work setting depends on the type, size, location and financial resources of the employer and the skill, experience and area of specialisation of the engineer.

Engineering graduates usually begin work under the supervision of experienced engineers and are gradually given more responsibilities as they gain experience. Some engineers with experience and additional education move into administration or management. Many high-level executives in industry began their careers in engineering.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Engineering Graphics and Design, Engineering and Technology.

Note: The engineering faculties of some universities offer a support programme to help students to become self-sufficient and capable of completing the very demanding engineering course. It is aimed at students from communities which lack proper educational facilities.

Further Training

Degree: BSc or BSc (Eng) with aeronautical subjects. Students can follow a four-year course in mechanical engineering, specialising in aeronautics.

A person who has obtained a recognised BSc (Eng) or BEng degree is eligible for registration as an Engineer in Training. After gaining at least three years of appropriate practical experience, an aeronautical engineer may register as a Professional Engineer under the auspices of the ECSA.

Postgraduate: Hons, MSc, MEng and PhD in this field are offered.

There are reseach opportunities available in aerodynamics, propulsion, avionics and structures.

Employment

- industries related to the aviation, aeronautical and aerospace fields
- Department of Transport - Civil Aviation Division
- commercial and private airlines
- Denel Aviation
- South African Airways
- South African Air and Defence Forces
- large organisations, e.g. Armscor, Kentron, CSIR
- self-employment - a qualified aeronautical or aerospace engineer, with the necessary experience can work as a consultant for one or more of the above-mentioned companies.

Further Information

Aeronautical Society of South Africa
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Aerospace Industry Education and Training Board
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Email: training.aafsa@aafsc.co.za
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SA Air Force
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Pretoria, 0001
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South African National Defence Force (SANDF)
Media Liaison Officer:
Department of Defence Information Centre
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Pretoria, 0001
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E-mail: info@mil.za
www.dod.mil.za

Some Related Careers

Agricultural Engineer, Chemical Engineer, Civil Engineer, Electrical Engineer, Electronics Engineer, Geological Engineer, Hydraulics Engineer, Mechanical Engineer, Metallurgical Engineer, Rubber Technologist.

AGRICULTURAL ENGINEER

Agricultural engineers, also sometimes known as natural resource engineers, apply engineering principles of science and technology, as well as knowledge of agricultural practices, to solve problems relating to sustainable agricultural production, the environmental impacts of intensive agriculture and the post-harvest handling of agricultural products. They manage living things and life-giving resources in such a way as to protect and preserve them by using mechanical, civil and electronic engineering skills.

They design equipment, buildings, and dams, which can utilise the environment and resources more effectively, while ensuring their renewability and sustainability. Some practise in areas such as forestry, food processing, urban and rural development, agricultural machinery design and manufacturing.

Agricultural engineers design agricultural machinery and equipment and develop methods to improve the production, processing and distribution of food and other agricultural products. They are involved in the conservation and management of energy, soil and water resources. These engineers design and use instruments to study the effects of light, humidity and temperature on plants and animals. They also design structures for crop storage and animal shelters. Some teach at universities and universities of technology.

Agricultural engineering provides challenging career opportunities in various fields such as research, consulting, development, testing, engineering surveys, management, planning, teaching and counselling.

Areas of specialisation

Water supply and irrigation: Effective utilisation of available resources is of primary importance. In this field the agricultural engineer is involved with hydrology and farm dam design; canal, pipeline and pump systems; sprinkler, drip and micro-irrigation systems; mechanised irrigation; surface irrigation and drainage.

Agricultural Mechanisation: Agricultural machinery plays an important role in the production of food. Agricultural engineers assist producers, contractors and farmers with: tractor and other engine tests; development of new machinery; design of agricultural equipment; planning and evaluation of mechanisation systems; agricultural energy research and consultation; and appropriate technology for developing areas.

Soil conservation: Agricultural engineers' civil engineering knowledge is essential for the planning and designing of: conservation and reclaiming structures; systems for the safe discharge of flood water; contour and other appropriate cultivation systems to safeguard vulnerable agricultural lands against erosion and specially adapted farming practices to enhance soil conservation.

Agricultural buildings and structures: This field includes the following: buildings for the intensive production of meat, dairy products, poultry and eggs; buildings with controlled environments such as green- and glass- houses, nurseries, and aquaculture; buildings for the storage and processing of products such as grain silos and dryers for maize, tobacco and fruit; and plastic sheeted tunnels for intensive cultivation of flowers and vegetables.

Food and fibre processing: Processing involves the preparation of commodities that are used by human beings or animals. Agricultural engineers guide entrepreneurs in the following: drying, milling, mixing, compacting, cooling, heating and liquidising of agricultural products; handling, storage, transportation and packing systems, for example, of fruit, vegetables and meat.

Work settings vary from indoors, in modern well-equipped laboratories and offices, to outdoors at farm sites. They may also vary according to the type, size, location and financial resources of the employer.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements
Compulsory Subjects: Mathematics, Physical Science.
Recommended Subjects: Agricultural Sciences, Life Sciences, Engineering and Technology.

Note: The engineering faculties of some universities offer support programmes to help students become self-sufficient and capable of completing very demanding engineering courses. These programmes are aimed at students from communities which lack proper education facilities.

Further Training

Degree: a four-year BSc (Eng) degree is available. As is the case with other fields in engineering, the completion of the degree and a minimum of three years' in-service training lead to registration as a professional engineer.

Diploma: For those who wish to qualify as technicians or technologists in an agricultural specialising field, the N.Dip. Agricultural Management or Agriculture, Science and Technology can be taken, followed by Agriculture MTech and DTech.

Postgraduate: various fields of research can be followed, e.g. Bioresources Engineering and Environmental Hydrology or an MEng in one of the following fields: environmental engineering, agricultural power and machinery systems, animal waste management, biomedical engineering, bioprocessing, computer applications, control systems, decision support systems, food process engineering, geographic information systems, ground and surface water management, irrigation system design, monitoring and controlling biological systems, plant environment, risk assessment, soil and water conservation and solid and hazardous waste management.

Employment

- Department of Agriculture
- manufacturers of agricultural remedies and food companies
- manufacturers of farm equipment and supplies
- government and private research institutes, such as SABS and CSIR
- universities, colleges and universities of technology
- consulting firms
- agricultural control boards and unions
- agricultural co-operatives
- large farming enterprises, such as estates
- self-employment - skilled and entrepreneurial agricultural engineers can start their own consulting or manufacturing businesses.

Further Information

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Engineering Council of South Africa (ECSA)
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Agricultural Research Council
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www.arc.agric.za

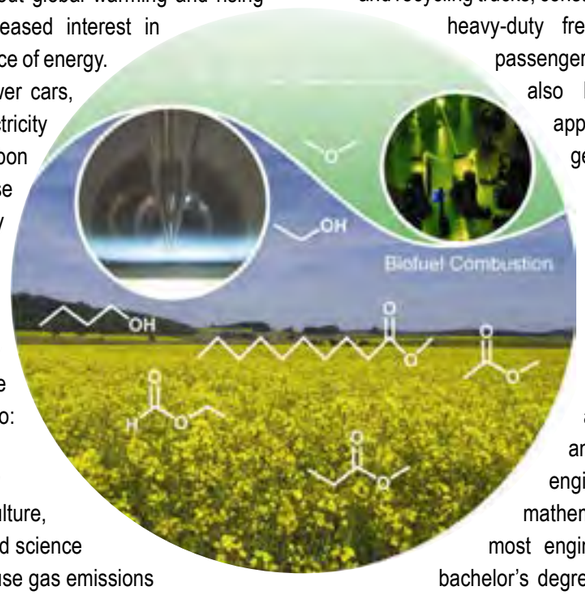
Some Related Careers

Agricultural Economist, Agricultural Extension Officer, Agricultural Scientist, Agricultural Inspector, Agricultural Technician, Animal Scientist, Environmental Scientist and Engineer, Food Technologist .

BIOFUELS RESEARCHER / SCIENTIST

Biofuels researchers or scientists develop and find uses for fuels derived from plant sources, so that our carbon footprint can be reduced.

Biofuel energy is a type of renewable energy that is made from organic matter. Traditionally, industrial society has been powered by fossil fuels such as gasoline and coal. However, in recent years, concerns about global warming and rising fuel costs have led to increased interest in biofuels as an alternative source of energy. Biofuel has the ability to power cars, heat homes and generate electricity with lower emissions of carbon into the atmosphere. These emissions can be taken up by plants that can be grown again (the process is renewable.)



Biofuels, as a complementary and alternative energy source to fossil fuels, can contribute to:

- increasing agricultural productivity, creating new job opportunities in agriculture, industry, infrastructure and science
- the reduction of greenhouse gas emissions and to improve environmental conditions for all people on our planet
- reduction in the use of crude oil-based products.

South Africa produces bioethanol from sugar and starch crops which are added to normal crude oil to form blends, to replace petrol. Biodiesel is a naturally oxygenated fuel produced from organic feed sources such as soya beans, cooking oil and animal fats. South Africa's biofuels strategy is mainly aimed at stimulating the production of suitable crops, such as sorghum, sugarcane, soya beans and canola, among others, in so-called "under-utilised agricultural areas" of the country, including the former homelands.

Biodiesel can also be produced from waste vegetable oil. An example is the Green Transport Programme, currently working with various stakeholders involved in the production of biodiesel from waste vegetable oil value chain. These stakeholders include: oil users, oil collectors, biodiesel producers, biodiesel users, and the SABS for writing standards for biodiesel.

Biodiesel can be used in its pure form or blended at any ratio with petroleum diesel to achieve cost efficiency and improve cold-weather performance. It is commonly used as a blend at 20% biodiesel and 80% petroleum diesel.

Biodiesel can be used in any diesel vehicle with little or no modification. It is used extensively in parts of Europe and is rapidly gaining support in the United States.

Applications include buses, delivery trucks, waste disposal and recycling trucks, construction and farm equipment, heavy-duty freight hauling, boats, and passenger vehicles. Biodiesel can also be utilised in stationary applications, such as diesel generators and boilers.

Although the biofuel product development career path is still fairly new, it is comparable to an engineering manager who would typically have a formal background and work experience in engineering, science or mathematics. Statistics show that most engineering managers have a bachelor's degree or higher, and that most specialise in a specific type of engineering, architecture or a related field.

Seven years after a government feasibility study showed that a biofuels industry in South Africa could create tens of thousands of new jobs.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting requirements for a degree course

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: Agricultural (bioresources) engineering. Mechanical or chemical engineering. Biochemical engineers can move into this field.

Postgraduate: **Master's and PhD programmes linked to biofuels are offered at various universities.**

Research opportunities have been identified in the development of additional feedstocks that could be used to make biofuels, along with research in making the production process safe for the environment.

Employment

- government departments, e.g. Agriculture and Energy
- biofuels industry
- renewable energy companies
- universities (faculties of science and agriculture).

Further Information

Technology Innovation Agency (TIA)
P O Box 172
Menlo Park, 0063
TIA House 83
Lois Ave, Menlyn
Tel: (012) 472-2700
www.tia.org.za

South African National Energy Association (SANEA)
SANEA SECRETARIAT,
PO Box 17306
Groenkloof, 0027
Tel: (012) 346-2152
sanea@sanea.org.za
www.sanea.org.za

Southern African Bioenergy / Biofuels Association (SABA)
P O Box 11666
Vorna Valley, 1686
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Midrand, 1686
Tel: (011) 655-7332 Fax: (011) 655-7011
www.saba.za.org

Biogreen
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Some Related Careers

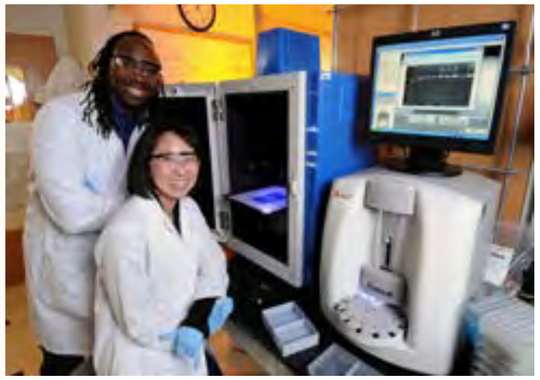
Agricultural Engineer, Biochemical Engineer, Chemical Engineer, Energy Engineer, Environmental Engineer.

An algae farm. Researchers at the University of Virginia say algae will produce significantly more biofuel per hectare planted than canola or switchgrass. Photo: Sapphire Energy. <http://news.virginia.edu/node/15719?id=15719>

Berkeley Lab's Christer Jansson and others hope to create a new recipe for biofuels by hydrocarbon-synthesizing genes from cyanobacteria (in the flask) and introducing them into tobacco plants. <http://newscenter.lbl.gov/feature-stories/2012/02/23/tobacco-biofuels/>

BIOMEDICAL ENGINEER

Biomedical engineers use engineering and scientific principles and techniques to solve medical and health-related problems in biology, medicine, dentistry and veterinary science.



Manu Platt (left), an assistant professor in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech & Emory University, & graduate student Keon-Young Park, produce high-quality images from the gels shown to quantify cathepsin activity. <http://www.gtresearchnews.gatech.edu/blood-testing-predicts-level-of-enzymes/>

Biomedical engineers design and develop medical instruments and devices such as heart-lung machines, iron lungs, artificial kidney machines, realistic artificial limbs and organs such as heart valves and hips, pacemakers and monitoring devices. They also adapt computers to be of service to medicine.

Research ranges from the study of the engineering aspects of human biological systems to the improvement of existing medical devices. Biomedical engineers design and develop equipment for medical imaging to display anatomical detail or physiological function. They may arrange testing to ensure the continuing safety of electronic, electrical and mechanical equipment used for diagnosis, treatment and monitoring of patients.

Some biomedical engineers advise and recommend the purchase of new equipment to administrators. They are also often involved with the training and supervision of technicians.

Biomedical engineers plan data processing services and the development of associated computing programs. They also analyse new medical procedures to forecast likely outcomes. They diagnose and interpret bioelectric data using signal processing techniques and provide computer analyses of patient-related data.

These engineers are concerned with the safety and effectiveness of instruments, and devices and they also advise on patient management. Engineers in this field often consult their medical and paramedical colleagues to find solutions to problems in the treatment of patients. This leads to the design, construction and development of instruments and devices that may help to relieve suffering and improve the quality of the patient's life. They analyse and design prosthetic and orthotic devices, particularly for those with disabilities.

Biomedical engineers must have a good theoretical and practical knowledge of engineering, a sound understanding of medical sciences and the ability to combine the two. They usually work in multidisciplinary teams with other professionals including nurses, surgeons, anaesthetists, other medical specialists, physiotherapists, and occupational and speech therapists.

Areas of specialisations

Bio-engineering: apply engineering principles to the study of biological systems and processes.

Clinical Engineers: research, develop and maintain instruments and equipment to aid clinical staff.

Rehabilitation Engineers: deal with systems and devices that improve the quality of life for people with disabilities.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for the degree.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: Some universities offer degrees in biomedical engineering. The Department of Biomedical Engineering forms part of the Groote Schuur group of teaching hospitals.

Postgraduate: **Since undergraduate training in mathematical science, computer science, engineering (electrical or electronic), medical or physical science is an entry requirement, couses in biomedical engineering consist of postgraduate programmes leading to the following degrees:**

- **BSc (Med) (Hons) Biomedical Science**
- **MSc (Med) Biomedical Engineering or Biomedical Science**
- **MPhil and PhD**

A biomedical engineer who wants to practise in a clinical setting must register with the Health Professionals Council of South Africa (HPCSA) as a Biomedical Engineer. A MSc (Med) degree in biomedical engineering is recognised by the Engineering Council of South Africa and by the Health Professionals Council of South Africa (HPCSA) as partial credit towards registration as a Professional Engineer and a Biomedical Engineer, respectively.

Two Ryerson Univesity biomedical engineering students Michal Prywata and Thiago Caires created a prosthetic arm which is controlled by brain signals, which is a first in medical prosthetics. <http://www.ryerson.ca/news/media/General_Public/20110329_RN_CairesPr.html>

Employment

- the Centre for Engineering and Health Care, University of Cape Town
- hospitals and other health care facilities
- medical research institutes
- universities
- medical electronics industry
- self-employment, with the necessary experience, through setting up a private firm to develop, design, manufacture and market medical instruments and devices, as well as to offer consulting services.

Further Information

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Associate professor Garrett Stanley (standing) and research scientist Qi Wang, both from the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University, are examining how different parts of the brain simultaneously communicate with each other. Photo Credit: Gary Meek < http://www.gtresearchnews.gatech.edu/biology-of-the-brain/>

Some Related Careers

Biomedical Technologist, Computer Engineer, Electronics Engineer, Industrial Designer, Life Scientist, Materials Engineer, Medical Physicist, Medical Orthotist Prosthetist, Radiation Therapist, Radiological Technologist, Systems Analyst.

CHEMICAL ENGINEER

Chemical engineers are involved in all phases of chemical products and chemical production. Some chemical engineers work in research, designing and performing experiments and then analysing the results. Others help to design and construct manufacturing facilities, occasionally having to first design a pilot plant (or a miniature version) then follow through to supervising the workers constructing the actual plant, as the final step.

Some engineers help to solve the problems involved in producing high-quality products at lowest cost. Safety and protection of the environment are key areas.

Chemical engineers design and operate processes for the production of chemicals, plastics, minerals and other raw materials. They may work in crude oil refineries, coal and gas industries and metallurgical industries, as well as in industries involved in the production of food, textiles, plastics, explosives, cement, etc.

Thomas Epps, UD assistant professor of chemical engineering, is developing nanoscale membranes for the next generation of materials.
< http://www.udel.edu/PR/UDaily/2007/apr/nsf041307.html >

Areas of specialisations

Research and development: The chemical manufacturing industry is based on processes discovered and developed in the research laboratory.

Economic evaluation: The economic viability of a production process must be determined by chemical engineers in cooperation with financial and marketing specialists.

Plant and equipment design: The manufacturing process entails: selecting the process and type of equipment; compiling mass and energy balances; calculating the capacity and dimensions of the equipment required for the operation of units such as reactors, heating and cooling systems, filters and pipelines; selecting the control system of the plant to control rate of flow, temperature, pressure and concentration; determining flow rate and energy usage; analysing potential hazards to ensure a safe working environment.

Equipment manufacture and plant construction: Chemical engineers are involved in the manufacture of the necessary equipment, as well as in the factory layout.

Plant operation: Chemical engineers are responsible for: the testing and commissioning of plant units; the training of operating staff; the start-up of the plant; the efficient and cost-effective running of the factory and solving problems.

Management: As managers, chemical engineers are responsible for ensuring that the chemical plant operates at a profit.

Textile Engineering: These engineers design and develop processes, equipment and procedures for the production of fibres, yarns and textiles.

Engineering graduates usually begin work under the supervision of experienced engineers and are gradually given more responsibilities as they gain experience. Some engineers with experience and additional education move into administration or management. Many high-level executives in industry began their careers as engineers.

The chemical engineering industry includes: refineries; industries involved in the extraction of metallurgical materials from ores (for example, gold, steel, uranium); industries involved in the manufacture of fertiliser, explosives, paper, chemicals and plastics; industries involved in the processing of coal, and also the management of waste and effluent which may pollute the air and water.

Chemical engineers may be found in a wide variety of work settings ranging from classrooms, as teachers and lecturers, to research laboratories or construction sites. The actual work setting depends on the type of work and on the size, location and financial resources of the employer.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Engineering and Technology.

Note: The engineering faculties of some universities offer a support programme to help students complete the very demanding engineering course. The programme is aimed at students from communities which lack proper education facilities.

Further Training

Degree: The BSc degree in Chemical Engineering is offered at most universities.

Undergraduate students gain practical experience by working with an approved employer during university vacations. This is a prerequisite at all universities. After completion of a BSc degree in engineering, the graduate student registers at the Engineering Council of South Africa (ECSA) as an Engineer in Training. He or she then completes a training period of three years with an approved employer. After successful completion of this training period, registration as a Professional Engineer can then be obtained from ECSA.

Postgraduate: **Courses in welding engineering, coal science and technology, petroleum engineering and extractive metallurgy are offered. Doctoral research degrees can be taken in the fields of bioprocess engineering, catalysis, minerals processing, hydrometallurgy, environmental engineering, crystallisation and precipitation and chemical engineering education.**

Employment

- chemical manufacturers and other industries such as: petroleum refining, synthetic fuel manufacture, food processing, brewing, minerals processing, paper and pulp, pollution control, manufacture of synthetic fibres, fertilisers and explosives
- such organisations as: CSIR, AECI, Eskom, Sasol, NECSA, Sentrachem
- Atomic Energy Board
- Council for Mineral Technology (Mintek)
- government departments
- universities.

Further Information

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S A Society for Professional Engineers
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Tel: (011) 783-0765 Fax: 086 672-9430
E-mail: info@professionalengineers.co.za
www.professionalengineers.co.za

South African Institute of Chemical Engineers (SAIChE)
P O Box 2125
North Riding, 2162
Tel: (011) 704-5915 Fax: (011) 462-2612
www.saiche.co.za

Additional website: www.engineeringnews.co.za

Some Related Careers:

Agricultural Engineer, Analytical Chemist, Biomedical Engineer, Chemical Engineering Technician / Technologist, Chemist, Leather Chemist, Metallurgical Engineer, Petroleum Technologist, Pharmacist.

Advanced Light Source Research at Lawrence-Berkeley National Laboratory. < http://www.che.ncsu.edu/westmoreland/vseshadri.html >

CIVIL ENGINEER

Civil engineers are responsible for the planning, designing, maintenance and management of projects to do with the construction of roads, buildings, stadiums, airports, tunnels, dams, bridges, and water supply and sewage systems.

Civil engineering may be the oldest of the all the engineering disciplines and today, civil engineering encompasses a range of specialised fields which include structural design, marine, environmental, construction, hydraulic engineering, transportation and geotechnical engineering.

Civil engineers study, explore, implement and maintain the modern environment of road access, reservoirs of accessible and hygienic water, as well as other facilities. Many technological conveniences, so taken for granted in modern society, are maintained, implemented and designed by those trained in civil engineering.

Many civil engineers hold supervisory or administrative positions, from supervisor of a construction site to a city engineer. They may supervise the work of surveyors, draughtsmen, technicians and other workers, and may also carry out research, lecture, or serve as consultants for engineering, construction or architectural firms. Others may work in design, construction, research and teaching. The work environment, therefore, ranges from quiet modern offices to remote areas in rugged terrain.

Civil engineers may have to travel or move from place to place to work on different projects. The actual work setting depends on the speciality chosen and on the size, location and financial resources of the employer.

Engineering graduates usually begin work under the supervision of experienced engineers and are gradually given more responsibilities as they gain experience. Some engineers with experience and additional education move into administration or management. Many high-level executives in industry began their careers in engineering.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Geography, Engineering and Technology.

Note: The engineering faculties of some universities offer a support programme to help students become self-sufficient and capable of completing the very demanding engineering course. The programme is aimed at students from communities which lack proper education facilities.

Further Training

Degree: Civil Engineering is offered at many universities. The engineering degree requires a minimum of four years of study.

BTech degrees and diploma courses in civil engineering are also offered at universities of technology, leading to qualification as civil engineering technicians and technologists.

A person who has obtained a recognised BSc (Eng) or BEng degree is eligible for registration as a Candidate Engineer. After gaining a minimum of three years of appropriate practical experience, a civil engineer may register as a Professional Engineer under the auspices of the Engineering Council of South Africa (ECSA).

Postgraduate: Research can be undertaken in fields such as spatial data management, structural engineering and material, geotechnical engineering, transport studies, urban infrastructure design and management, water quality engineering, water distribution, civil infrastructure management and maintenance.

Employment

- government departments, provincial administrations and municipalities
- construction companies
- engineering or architectural firms
- Mittal Steel, Sasol, Eskom and CSIR
- universities of technology and universities
- self-employment, with the necessary experience and initiative, as a consultant.

Further Information

South African Institution of Civil Engineering
Private Bag X200
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E-mail: civilinfo@saice.org.za
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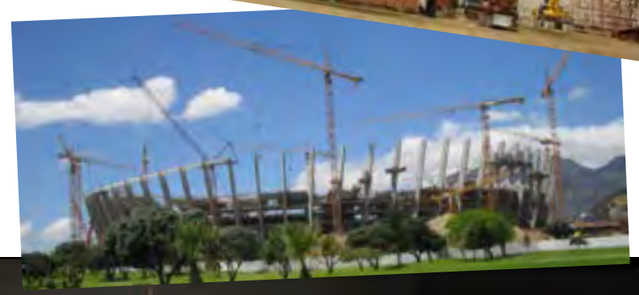
Some Related Careers

Aeronautical Engineer, Architect, Architectural Technologist, Chemical Engineer, Drainage Inspector, Industrial Designer, Industrial / Manufacturing Engineer, Quantity Surveyor, Town Planner.



The Cape Town Stadium in various stages of construction.

ELECTRICAL ENGINEER

Electrical engineers research, design, install, and test electrical and electronic equipment and supervise its manufacture. Their work involves the generation, distribution and management of all appliances and installations that generate or use electrical energy.

A steam turbine used to provide electric power.
< http://en.wikipedia.org/wiki/Electrical_engineering >

Electrical engineering is often associated with power generation and distribution of power. Power generation involves the generation of electrical power from a variety of sources: hydro electrical, thermal coal power, nuclear, as well as renewable sources of power such as solar and wind power. Distribution involves transmission lines and substations, which are used to distribute electrical energy for power, heating, lighting and other uses.

Areas of specialisations

The fact that there are so many varieties and sources of electrical power means that there are also numerous areas of specialisation in the field of electrical engineering. Specialisation may also include the design of electrical transmission systems, electric motors and generators, high-voltage engineering and power electronics, to name but a few. The nature of the work may include research and design of new products, the writing of performance requirements and the development of maintenance schedules. Electrical engineers test equipment, solve operating problems and estimate the time and cost of engineering projects. Many electrical and electronics engineers also work in areas closely related to computers.

There are various similarities, although also differences, between electrical and electronics engineering. Electronics engineering is often referred to as “light current” engineering and electrical engineering as “heavy current” engineering. The difference lies in terms of the storage, retrieval, transfer and processing of information associated with electronics engineering, versus the application of electrical energy associated with electrical engineering, which is now split into heavy and light current engineering. See Electronics Engineer for more details. However, there is some blurring between the two areas in today’s world and career handbooks today prefer to describe electronics engineering as a sub-division of electrical engineering.

Electrical engineers work in a variety of work environments depending on the nature of the work. These environments include offices, design centres or laboratories, as well as outdoors in the project management of large constructions and installations, for instance power stations.

Engineering graduates usually begin work under the supervision of experienced engineers and are gradually given more responsibilities as they gain experience. Some engineers with experience and additional education, move into administration or management. Many high-level executives in industry began their careers in engineering.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Electrical Technology.

Note: The engineering faculties of some universities offer a support programme to help students to become self-sufficient and capable of completing the very demanding engineering course. The programme is aimed at students with good marks, from communities which lack proper education facilities.

Further Training:

Degree: The four-year BEng degree in electrical engineering can be followed at most South African universities. Theoretical lectures are supplemented by tutorial classes and practical sessions that mostly take place in the laboratory.

Diploma: The three-year N.Dip. Electrical engineering can be obtained at most universities of technology for electrical engineering technicians and technologists. These universities of technology now also offer a degree in engineering in collaboration with universities. The course is a minimum of four years’ study.

TVETCollege: A national diploma in engineering can be followed at the majority of TVET Colleges.

After obtaining the diploma, and with appropriate practical training and experience, a person can be accepted by the Chief Inspector of either the Department of Labour (DOL) or the Department of Minerals and Energy (DME), as a candidate for the Certificate of Competence for factories or for mines, respectively.

To be legally appointed in terms of occupational health and safety legislation, junior electrical engineers (heavy current) with a degree or a diploma and at least two years’ appropriate post-qualification practical experience, must apply to the Chief Inspector (DOL or DME) for acceptance as a candidate. Once accepted, they must pass the two prescribed subjects - Plant/Mining Engineering and Legal Knowledge (different papers for factories and mines). Persons registered as Professional Engineers with ECSA may be exempted from the Plant Engineering paper.

Postgraduate: **This involves research leading towards an MSc or PhD. Graduates can specialise in fields such as control systems (climate control systems in buildings to navigational control systems in vehicles); optical systems (fibre optics etc); electromagnets; electronic design; remote sensing and space systems; semiconductor devices; signal; and image processing, communication (telecommunications, broadband communication, wireless networks, optical communication networks, digital communications).**

Employment:

- government departments
- the mining industry
- organisations such as Transnet, Eskom, Mittal Steel, CSIR, Sasol, Kentron, SABS, SABC, Denel, Portnet, and Metrorail
- municipalities
- universities and universities of technology
- manufacturers of electrical equipment
- private engineering consultants
- self-employment, with enough experience and initiative, working as a consultant or starting one’s own manufacturing or engineering company.

Further Information

Engineering Council of South Africa (ECSA)
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P O Box 751253
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www.saiee.org.za

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E-mail: info@ecasa.co.za
www.ecasa.co.za

Some Related Careers

Aircraft Avionician, Automotive Electrician, Chemical Engineer, Civil Engineer, Coal Technologist, Computer Hardware Engineer, Electrician, Electronics Engineer, Industrial Engineer, Mechanical Engineer, Mechanician, Sound Engineer.

ELECTRONICS ENGINEER

Electronics engineering is concerned with the generation, transmission and processing of information and includes computers, software, transmission networks, telephones, radio, television, signal processing and optics.

Electronics engineers design, develop, test and maintain electronic parts and systems for application in the fields of automation, communication, data processing, navigation, military arms and entertainment. Some manage manufacturing processes, while others may be responsible for the marketing of products.

Some examples of applications of electronics engineering are as follows:

- infrared cameras to "see" in the dark, an example of obtaining information: phenomena that cannot be observed by human beings are transformed by electronics technology to observable phenomena
- computers to solve complicated problems and to assimilate signals, an example of the assimilation of information
- electronic systems involving the control of mechanical and chemical processes, an example of the control of information
- communications, such as international telephone conversations and videophones, an example of the transference of information
- mass media, such as radio and television, an example of the distribution of information
- power electronics for the control of power generation equipment
- control of processes and production lines using remote control and data acquisition systems (SCADA, etc.).

Areas of specialisation

Biomedical Engineers: Apply engineering methods to solve medical and other life science problems.

Computer Engineers: Design computers and associated equipment, including microelectronics, which involves the design, testing and manufacture of microchips.

Mechatronic Engineers: Design and maintain machinery with electronic and computer control systems.

Telecommunication Engineers: Design and maintain telecommunications equipment such as optic cables, microwave techniques, cellular radio, satellite communications, etc.

Computer Systems Engineers: Design and manufacture circuit boards used for interfacing computers to other equipment and sometimes write software for controlling computer operations, etc.

Electronics engineers: Design, prepare and supervise designs, prepare specifications, estimates, tenders and contracts. Some are involved in establishing and monitoring performance, setting safety standards and specifying methods for modification, maintenance and repair of equipment and systems. Others may examine installations to ensure that they meet contract conditions.

They are likely to liaise with clients, other engineers, technical officers, technicians, trades people and other workers. Modern management abilities are important. Electronics engineers need to be able to participate in planning, organisation and the control of proceedings.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences. **Recommended Subjects:** Information Technology, Engineering and Technology.

Note: The engineering faculties of some universities offer a support programme to help students to become self-sufficient and capable of completing the very demanding engineering course. The programme is aimed at students from communities which lack proper education facilities. Only students with good symbols (marks) would be considered.

Further Training

Degree: The four-year BEng degree in electronic engineering can be followed at the most universities. Theoretical lectures are supplemented by tutorial classes and practical sessions that mostly take place in the laboratory.

Diploma: The three-year N.Dip. Electronic Engineering can be obtained at a university of technology, for electronic engineering technicians and technologists. Also offered now is a degree in engineering in collaboration with universities. The course is a minimum of four years' study.

TVET College: A national diploma in engineering can be followed at the majority of TVET Colleges.

Postgraduate: **Research leads to an MSc or PhD. Electronic engineers can specialise in signal processing, telecommunications engineering, control engineering, instrumentation engineering, computer engineering or design engineering.**

Employment

- organisations such as Eskom, SABS, CSIR, Telkom, Transnet, Denel, Kentron, Portnet, Metrorail, SABC and Sasol
- manufacturers
- mining industry
- electronics companies
- government departments
- universities and universities of technology
- private electronic engineering consultation firms and development laboratories
- large and small private companies involved with the design, development, production and marketing of electronic systems, subsystems and components of products
- self-employment, with enough experience and initiative, working as a consultant or starting one's own manufacturing or engineering company.

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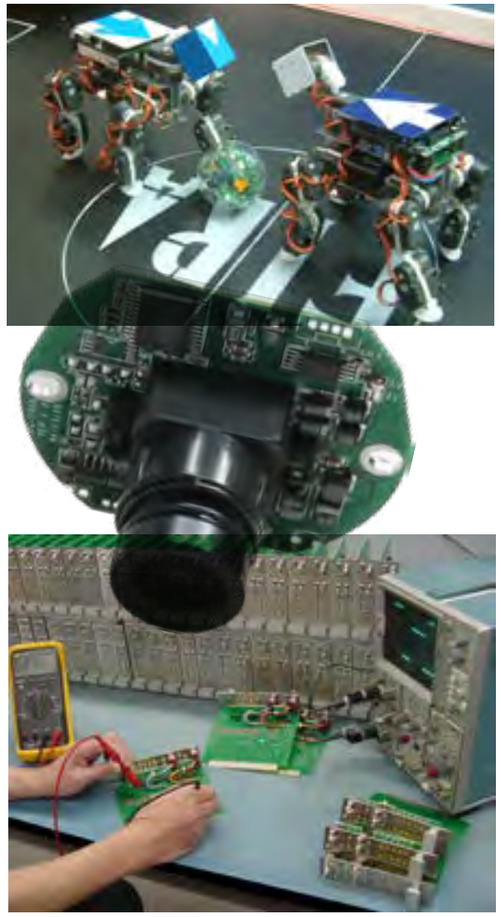
www.ecasa.co.za

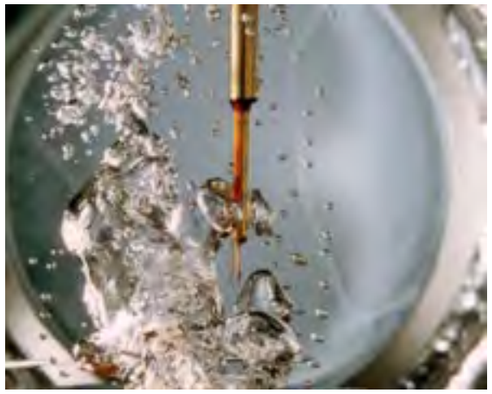
Some Related Careers

Aeronautical Engineer, Aircraft Avionician, Automotive Electrician, Computer Systems Engineer, Electrical Engineering Technologist, Electrician, Electronics Engineering Technologist, Industrial Engineer, Radio and Television Mechanic, Sound Engineer, Telecommunications Technician.



ENERGY ENGINEER

This is a relatively new field. An energy engineer is involved with the production of energy from natural resources, such as the extraction of oil and gas, as well as from renewable or sustainable sources of energy, including biofuels, hydro-, wind and solar power.



Energy engineers are focused on finding efficient, clean and innovative ways to supply energy. They work in a variety of roles, including designing and testing machinery, developing ways of improving existing processes, and converting, transmitting and supplying useful energy to meet our needs for electricity.

Energy engineers plan, design, organise and oversee the construction or remodelling of energy generation plants and design, develop or evaluate energy-related projects to reduce energy costs or improve energy efficiency.

They research and develop ways to generate new energy, improve the efficient use of energy through reducing emissions from fossil fuels, and minimise environmental damage.

Energy engineers use various engineering disciplines to prevent, control and remove environmental health hazards. They apply their knowledge and skills to such things as environmental impact assessment, natural resources management and pollution control. Work may include waste treatment, site clearing, or pollution-control technology.

Energy engineers can have an extremely varied workload, depending on the sector in which they work or the type of project involved.

Site work is typically on a shift basis, while design and research areas typically follow standard office hours.

Energy is a topic of huge importance and interest to individuals, industry and government. Climate change and the increased price of oil and gas as an energy source have prompted the government to make sustainable and renewable energy generation a priority. Consequently, the renewable energy industry is expanding rapidly.

As the demand for oil and gas rises, pressure for businesses to reduce carbon emissions and be more energy efficient increases. In turn, this has led to a growth in renewable or sustainable sources of energy such as solar, wind and hydropower.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting requirements for a degree course.

Compulsory Subjects:
Mathematics, Physical Sciences.

Recommended Subjects:
Information Technology, Engineering and Technology.

Further Training

Degree: A BSc (Eng) or BEng in a relevant engineering or science subject such as Electrical, Electro-Mechanical or Electronics is necessary, available at all universities.

Postgraduate: **Postgraduate study is required for research positions and career development.**

Possible courses are:
MSc (Eng) in Sustainable Energy Engineering requires a BSc (Eng) or equivalent with 65% average in final year.

Master in Energy
The postgraduate programme in renewable and sustainable energy studies focuses on the training of scientists, planners, economists, project developers and engineers to equip them to work in the field of renewable and sustainable energy (RSE).

MEng (Structured) degree.
MEng (Research) requires a thesis.

MPhil
PhD with research papers for publication.

Note: The engineering faculties of some universities offer a support programme to help students to become self-sufficient and capable of completing the very demanding engineering course.

The programme is aimed at students from communities which lack proper education facilities. Only students with good grades would be considered.

Professional qualifications and continuous training are an integral part of career development, and the diverse nature of the profession offers opportunities to move into different areas of work in order to gain new skills and experience. There are also opportunities to join the growing number of environmental consultancies, become self-employed or move into the education field.

It is essential to keep up to date with energy legislation, compliance and reporting requirements through training and continuous professional development (CPD). Attending internal and external training courses, relevant seminars and conferences is an effective way of keeping informed of current issues and refreshing your knowledge. Most large firms offer structured training and encourage professional status.

Employment

- energy management companies
- waste management companies
- factories

Further Information

Southern African Association for Energy Efficiency
Ground Floor Block E, 150 Linden Street Strathavon
Sandton, 2146
Tel: (063) 235-8031 Fax: 086 726 7135
E-mail: admin@saee.org.za
www.saee.org.za

South African Alternative Energy Association
31 Barrington Estate.
171 Bellairs Drive,
Randburg, Johannesburg
Tel: (071) 637-8466
E-mail: admin@saaea.org
www.saaea.org

Engineering Council of South Africa (ECSA)
Private Bag X 691
Bruma, 2026
Tel: (011) 607-9500
Fax: (011) 622-9295
E-mail: engineer@ecsa.co.za
www.ecsa.co.za

Eskom
Megawatt Park
Maxwell Drive
Sunninghill, Sandton
P O Box 1091
Johannesburg, 2001
Tel: (011) 800-8111 / 086 0037566 Fax: (011) 800-4299
www.eskom.co.za

Centre for Renewable and Sustainable Energy Studies
4th Floor Knowledge Centre
Corner of Banghoek and Joubert Street
Stellenbosch, 7600
Tel: (021) 808-4069
E-mail: crses@sun.ac.za
www.crses.sun.ac.za

The Energy Training Foundation
Tel: 084 513 6742 Fax: 086 720 8199
E-mail: info@entf.co.za
www.energytrainingfoundation.co.za

Some Related Careers

Electrical Engineer, Energy Conservationist, Hydropower Plant Process Controller, Nuclear Energy Engineer, Solar Power Engineer, Wind Energy Engineer.

Top: Wind turbines at Klipheuwel pilot experimental wind farm, on the West Coast near Cape Town. Erected by Eskom in 2002/3 Photo by John A Forbes < http://www.eskom.co.za/content/RW_0002KliphWindfRev5~2.pdf >

Left: Transporting a wind turbine.

MECHANICAL ENGINEER

Mechanical engineers research, develop, design, manufacture and maintain machines, machine components and systems in various fields of application.

They work on power-producing machines such as generators, engines and steam and gas turbines. They also work on power-using machines such as refrigeration and air-conditioners, robots used in manufacturing, elevators and escalators, and industrial production equipment. Mechanical engineering can be considered to be the cornerstone of modern technology because it applies the principles of natural science in a way that leads to the greater convenience, progress and safety of mankind.

Kevin Griger, a mechanical engineer, involved in the design of the bottom part of the CORKs used in a drilling project to get core samples in the Pacific.
< http://globetrottingv2010.blogspot.com/2010/08/scimath-career-8-mechanical-engineer.html >

Areas of specialisation

Transportation: These engineers, together with other engineering specialists, design and develop equipment such as aircraft, helicopters, missiles, ships, motorcars, trains, as well as the steam and gas turbines and petrol and diesel engines needed for propulsion.

Power generation: Engineers in this field attempt to provide the energy required by consumers. The demand on existing natural resources provides a challenge for engineers to provide energy and power without harming the environment or depleting resources.

Agriculture: By providing modern equipment such as threshing machines, tractors, harvesters and milking machines for food producers, engineers in this field assist in the economical production of food.

Mining: The wealth-producing minerals and mining industry is one of the sectors where great demands are made on the initiative of the mechanical engineer. Pumping plants, hauling machines, winding equipment, ventilation fans, conveyor belts, drilling machines and underground railways are a few of the devices which require the input of a mechanical engineer.

Environmental engineering: Specialist mechanical engineers create the controlled indoor environment that people need in order to work in comfort. Factors such as humidity, temperature and cleanliness of the air in the workplace are monitored, adjusted and controlled by these engineers. In this field of study the mechanical engineer works particularly closely with engineers from other disciplines.

Biomedical engineering: Heart-lung machines, artificial kidney machines, heart valves, pacemakers and operation monitors are all examples of the work of a biomedical engineer. Without this equipment the medical profession could not progress *(see biomedical engineer)*.

Industrial engineering: Mechanical engineers also play a major role in industrial and manufacturing processes such as production technology and quality control (see industrial engineer).

Other areas of specialisation include:

- transportation equipment
- fluid mechanics
- heating, ventilation and air-conditioning
- instrumentation
- machines for specialised industries such as rubber, petroleum and plastics
- construction

Mechanical engineers usually work in offices where the computer plays a major role. It is also necessary that the premises, for which the engineer designs equipment or coordinates maintenance, be inspected before commencing the work.

Engineering graduates usually begin work under the supervision of experienced engineers and are gradually given more responsibilities as they gain experience. Some engineers with experience and additional education move into administration or management. Many high-level executives in industry began their careers in engineering.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Technical Drawing, Mechanical Technology.

Further Training

Degree: A BSc in mechanical engineering can be followed at most South African universities.

Afterwards, a period of two years practical training is required before a person may register as a professional engineer with the Engineering Council of South Africa

Diploma: Universities of technology now offer a degree in mechanical engineering in collaboration with universities. The course is a minimum of four years' study.

Some TVET colleges offer courses for engineering technicians and technologists.

Postgraduate: **Several universities offer postgraduate studies in mechanical engineering, and some universities of technology offer postgraduate studies in mechanical engineering.**
Areas of specialisation for PhD Studies include:
Robotics & Neural Engineering; Solid Mechanics; Fluid Dynamics and Nanotechnology

Note: The engineering faculties of some universities offer a support programme to help students to become self-sufficient and capable of completing the very demanding engineering course. The programme is aimed at students from communities which lack proper education facilities. Only students with good grades would be considered.

Employment

- manufacturing industries
- government departments and organisations such as: CSIR, Eskom, NECSA, AECI, Sasol, Genmin, JCI, MINTEK, SABS
- mining companies
- consulting engineering firms
- universities and universities of technology
- self-employment, a registered mechanical engineer with the necessary experience and initiative can work as a consultant in any of the above-mentioned organisations or can also start own manufacturing engineering company.

Bursaries are also available from many of these institutions.

Further Information

Engineering Council of South Africa (ECSA)
Private Bag X691
Bruma, 2026
Tel: (011) 607-9500 Fax: (011) 622-9295
E-mail: engineer@ecsa.co.za
www.ecsa.co.za

Some Related Careers

Aeronautical Engineer, Agricultural Engineer, Biomedical Engineer, Electrical Engineer, Industrial Engineer, Metallurgist, Mining Engineer.

Work taking place on the tunnel infrastructure for the Gautrain in Johannesburg.

MECHATRONICS ENGINEER

The word mechatronic is composed of the word "mecha" in mechanics and "tronics" in electronics. A mechatronics engineer applies the principles of mechanics and electronics as well as computing to create smart machines which are able to interact with their environment.

These smart machines are made up of several parts: the mechanical system itself, the sensing system, and the control systems with the related software. Mechatronic engineers work in all aspects of the development of the smart machine, from design and testing right through to the manufacture of smart systems and products. Mechatronics is making it possible to generate simpler, more economical, reliable and versatile systems.

The field of mechatronics which started in Japan in the 1970's, is still relatively new and is rapidly growing as a specialisation within engineering. Advances in artificial intelligence (AI) mean that robots can now simulate the behaviour of humans by making decisions as they interact with their environment. Mechatronic engineers are at the cutting edge of designing human-machine interaction in various industries:

Many of the consumer goods we use today incorporate embedded systems, for example voice recognition and pattern recognition are used in cell phones, video games, washing machines and climate control units. In the medical field we see examples of biomedical limbs, implant devices and in robotics-assisted surgery. The military make use of unmanned aircraft and ground vehicles and the automotive industry use smart products to improve safety and increase fuel efficiency in engines. Unmanned aerial vehicles which have embedded controls can now perform tasks where the use of human labour may be dangerous, such as underwater exploration, extra-terrestrial mining or forestry.

Some examples of applications of electronics engineering are as follows:

- Study the feasibility, cost implications and benefits of new mechatronic equipment.
- Oversee the work of contractors in accordance with project requirements.
- Publish engineering reports documenting design details or test results.
- Travel to and present at conferences; view new designs, ideas or innovative technology.
- Monitor and calibrate automated systems to maximise the efficiency of production.
- Due to rapid advancements in the field, mechatronic engineers will spend a considerable amount of time analysing and updating prototypes and robotic systems.
- Apply electronic and mechanical processes and computers to tasks where the use of human labour may be dangerous (like underwater exploration, mining or forestry).
- Conduct modelling, simulations and analysis of complex mechanical, electronic or other engineering systems using computers.

Areas of specialisation

Student doing MSc Mechatronic Systems Engineering, a course designed for science and technology graduates as well as experienced engineers who wish to update their skills in the emerging areas of smart factories and smart cities, utilising Industry 4.0 technologies.
< http://www.mdx.ac.uk/courses/postgraduate/mechatronic-systems-engineering-msc>

Biomedical Engineers: Apply engineering methods to solve medical and other life science problems.

Computer Engineers: Design computers and associated equipment.

Rebotics Engineers: Design and construction of man made machines which can perform work normally done by humans

Telecommunication Engineers: Design and maintain telecommunications equipment such as optic cables, microwave techniques, cellular radio, satellite communications, etc.

Computer Systems Engineers: Design and manufacture circuit boards for controlling computer operations.

Electronics engineers: Design, prepare and supervise designs, prepare specifications, estimates, tenders and contracts.

Mechatronic engineers need to be able to participate in planning, organisation and the control of proceedings, so modern management abilities are important.

Engineering graduates usually begin work under the supervision of experienced engineers and are gradually given more responsibilities as they gain experience. Some engineers with experience and additional education move into administration or management. Many high-level executives in industry began their careers in engineering.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Technical Drawing, Mechanical Technology, Life Sciences.

Further Training

The BEng (Mechatronic) programme contains elements from the BEng (Mechanical) and the BEng (Electrical and Electronic) programmes. In order to combine all these elements in an optimal way, mechatronic engineers must have insight in each of these disciplines.

Degree: A BEng (Mechatronic) degree can be taken at US, UCT and NMMU. UCT offers mechatronics engineering under electrical engineering. NMMU offer a Bachelor of Engineering in Mechatronics. Most universities offering the BEng Degree in mechanical and electrical engineering incorporate mechatronics within the modules of the degree.

Diploma: Students may enrol for a BEngTech Mechanical Engineering specialising in Mechatronics at CPUT, CUT and TUT.

Postgraduate: Several universities offer postgraduate studies in mechatronic engineering, This involves research leading towards an MSc or PhD. Graduates can specialise in various fields to do with instrumentation, automation, robotics, bio-medical engineering or machine vision. To be accepted in MSc candidates must have studied a BEng or equivalent degree.

Employment

- hi-tech companies developing futuristic products
- government departments
- manufacturing industries
- consulting engineering firms
- lecturer at universities and universities of technology
- start own mechatronic engineering company.

Bursaries: To access information, go to https://www.gostudy.net/bursaries and select the required engineering field from the study field drop down menu.

Further Information

Computer Society of SA
P O Box 1714
Halfway House, 1685
ICT House
546 16th Road
Constantia Park [Unit No.3]
Midrand
Tel: (011) 315-1319 Fax: (011) 315-2276
www.cssa.org.za

Engineering Council of South Africa (ECSA)
Private Bag X 691
Bruma, 2026
Tel: (011) 607-9500 Fax: (011) 622-9295
E-mail: engineer@ecsa.co.za
www.ecsa.co.za

Some Related Careers

Electronics Engineer, Aeronautical and Aerospace Engineer, Agricultural Engineer, Environmental Engineer, Mechanical Engineer, Biomedical Engineer, Robotics Engineer.

On his visit to ABB's training center in Berlin, Germany, CEO Ulrich Spiesshofer engaged with trainees about the Fourth Industrial Revolution. Giving emplyees skills to master each new era of machines.
< http://new.abb.com/news/detail/2688/readying-the-work-force-of-tomorrow >

TELECOMMUNICATIONS ENGINEER

Telecommunications engineers are responsible for the development in the science and methods of telecommunications; the general and basic planning of future expansion; and the design and planning of automatic exchanges, carrier systems, telex systems, coaxial cable systems, microwave radio systems, optical fibre systems and videotext systems.

Telecommunications engineers are involved in the planning, design, commissioning and monitoring of complex telecommunications networks and associated broadcasting equipment. Many telecommunications design engineers work for major carriers as well as telecommunications and IT service providers.

Telecommunications engineering can cover any of the following fields: long distance microwave carrier and coaxial cable systems; foreign radio communications; electronic, automatic and manual exchange switching; overhead and underground line equipment networks; and telex, telegram and data transmission systems.

Telecommunications engineers use a variety of intricate telecommunications test equipment associated with their particular discipline and computers. They work mainly in offices, with excursions to the work place, e.g. telephone exchanges, carrier rooms, microwave radio rooms etc.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Engineering and Graphic Design.

Further Training

Degree: BEng Electrical / Electronic at most universities.

Diploma: N.Dip: Electrical Engineering at universities of technology.

Postgraduate: research for master's or PhD degrees in the fields of digital signal processing, optical fibre communications, telecommunications and data networks, cellular communication networks, digital systems design, microwave antennas, acoustics, laser and quantum optics.

MSc Telecoms and MEng Telecoms programmes are primarily aimed at graduates in Electrical Engineering and other relevant disciplines.

PGDipEng in Telecommunication and other postgraduate programmes in broadband communication / telecommunications / wireless networks leading to MSc, MEng and PhD. US – engineering research in many different fields, including Telecommunications, leading to MEng and PhD.

Employment

- organisations as Eskom, Phillips, Siemens
- other telephone companies
- cell phone companies

Further Information

Eskom
P O Box 1091
Johannesburg, 2001
Tel: (011) 800-8111 Fax: (011) 800-4299
www.eskom.co.za

Siemens
Private Bag x 71
Halfway House, Midrand, 1685
Tel: (011) 652-2000 Fax: (011) 652-2711
www.siemens.co.za

MTN
14th Avenue
Johannesburg, 2196
Tel: 083 135
www.mtn.co.za

Vodacom
158 Lunnon Street
Hillcrest
Pretoria
Tel: 082 271 2400
www.vodacom.co.za

Cell C
Cell C (Pty) Ltd Head Office
Tel: (011) 324-4000
150 Rivonia Road
Morningside
www.cellc.co.za

Some Related Careers

Aerospace Engineer, Civil Engineer, Computer Hardware Engineer, Computer Systems Engineer, Electrical / Electronics Engineer, Electrical / Electronics Engineering Technologist, Mechanical Engineer, Telecommunications Technician, Telecommunications Technologist.

Telecommunications Engineers at work

Antenna Telecommunications Tower

Mondli Guma

Mondli Guma was born in Ntuzuma Township in Durban, where he matriculated with distinction from St Francis' College in Mariannhill in 2002. Mondli was ranked second best student in the Durban South region and fourth in KwaZulu-Natal province. After matric Mondli studied a Bachelor of Science in chemical engineering at the University of Cape Town, which he completed in 2006 with honours. He also completed a Master of Science in engineering.

He now works at Anglo American and has been a candidate on the BLAST (Building Leaders and Shaping Talent) programme for the past 4 years. He recently completed an international assignment based in São Paulo, Brazil, where he worked as a safety and sustainability specialist. He has moved back to South Africa to take up a position as Business Development Project Manager with the Thermal Coal Business Unit of the company.

Part of Mondli's success can be attributed to an excellent education and supportive teachers and family members.
"With the help of some great teachers I discovered that I had a natural aptitude for maths and science. As a naturally inquisitive person, I enjoyed the analytical learning process that maths and science encouraged, as the way to learn about the natural world based on facts, theories and laws. I even took this on competitively, frequently participating in teams representing my school in Maths and Science Olympiads, Science Expos and bridge-building competitions".

Meet a Chemical Engineer

"By far the biggest challenge I faced while growing up was the availability of funds to pay for my education. Having a supportive family was incredibly valuable in building my self-confidence and willingness to competitively participate in various extracurricular activities at school. I was also fortunate to have teachers who recognized my potential and went out of their way to help me find and secure funding opportunities. As a result, I was able to secure various study grants, bursaries and scholarships to fund my entire high school, undergraduate and postgraduate education, as well as travel internationally to various conferences and assignments".

"By far the biggest challenge I faced while growing up was availability of funds to pay for my education. Born as an only child to a single parent, I was aware from a very early age that I needed to find ways to fund my school fees"

Mondli's choice of career was influenced primarily by his interest in maths and science at school. "With my interest in maths and science, engineering as a choice of study was a very natural and logical option for me after high school. During the tenure of my undergraduate studies I was looking forward to starting a metallurgist career with De Beers, who had offered me a bursary to study Chemical Engineering at the University of Cape Town".

However, during his postgraduate studies Mondli started taking a keen interest in the world of business. "I took on various internships during the holidays to increase my exposure to business and general management, as well as by participating in the various career fairs and graduate recruitment activities that were organized by the university. In the end I looked for career opportunities that would combine my interest in mining and my engineering background, with my desire to enter the business world."

Mondli believed that having had a good support system and network of people to encourage him, combined with buliding on strengths and interests, was incredibly important in helping him ensure success.

Venasan Pillay

Venasan was born in Pietermaritzburg, Kwa-Zulu Natal but moved to Durban shortly thereafter where he matriculated from Burnwood Secondary School in 1998. After matric he studied a BSc degree in chemical engineering at the University of Cape Town. He stayed on to complete a MSc. (ENG) in 2004, which included a six month stay in the Netherlands to carry out work at the Technical University of Delft.

Venasan admits that there were many factors that influenced his decision to study in a scientific field. First and foremost was his need for job security combined with his love of maths and science. "It occurred to me that South Africa, a country rich in mineral wealth and manufacturing facilities and one which would undergo lots of development in coming years, would require engineers. Therefore an engineering degree seemed a good choice in terms of securing future employment".

"I liked maths and science in school and therefore felt drawn to a field of study that could further expose me to this. People had told me that chemical engineering was a really tough degree and that many people fail it. I took this as a challenge and decided that I would overcome this 'monster' degree!"

Venasan admits that one of the biggest challenges he ever faced in his studies was at university in acclimatising to a new environment. "University was a challenge being in a different city from the one I had grown up in where familiar things were no longer close at hand".

Meet a Strategic Planner

Venasan currently works for Chevron South Africa (Pty) (Ltd) as the Supply and Operating Plan Coordinator based in Cape Town. "During the third year of my undergraduate studies, I got a bursary from Chevron with a work commitment attached to the agreement. This was something that suited me as it meant I got to work at a refinery, which to me represented real industry with major equipment, I was now going to be able to see and touch all the stuff I had learnt about on paper at university".

"University was a challenge. Being in a different city from the one I had grown up in where familiar things were no longer close at hand."

"Having studied engineering, I wanted to see what it was like to be in industry. University exposure to a field is quite limited, and one only really gets an appreciation of what it is like in the real world, by actually being in the workplace".

"I started off at the refinery as a production support unit engineer and this gave me a good platform upon which to build my technical knowledge as well as the softer skills required in the work environment. Something you don't learn at a tertiary institution is how to interact with people who are not in your peer or age group. I spent five years moving across different refinery technologies and then proceeded to move into a production planning role. This added a layer of economics onto my technical knowledge and kept me interested in working there".

Venasan has a keen interest in current affairs and keeping up to date with local and international news. He also enjoys sport. "I am a lover of cricket and soccer, but have found that my active participation has decreased with an increase in my age. My involvement in now limited to watching sport on TV where I keep track of my favourite teams."

"I am an avid consumer of knowledge and am constantly seeking to learn new things about various subjects. This ties into my love of travel where I am able to learn about new cultures, food and ways of living. In my downtime I like to read, spend time with my girlfriend, my family and friends or sometimes just find a quiet place to reflect and think about the nature of things!"

Motene Matshediso

Motene Matshediso is from Ga-Motlatla, near Ventersdorp. She went to school in Rustenburg and Johannesburg.
In 2006 she completed a chemical engineering degree at UCT. She also obtained a Management Advancement Programme from Wits Business School.

Motene is currently based in Kempton Park (Gauteng) and is working for Johnson Matthey South Africa in Germiston.

One of the focus areas in her work is Environmental Control Technologies (ECT) including the manufacture of autocatalysis for the automobile manufacturing industry. Autocatalysts are mainly made of the Platinum Group of Metals (Platinum, Rhodium, and Palladium) and are used in car engines for minimising the greenhouse gases (CO_2) responsible for the depletion of the ozone layer.

Motene says that the main factors influencing her choice of career were her passion for maths and science at school. This was reinforced by the fact that she always did well in these subjects, often performing top in her class.

Another motivation to choose engineering was the determination to make a difference in her community, and the fact that there was shortage of female engineers in South Africa.

Motene enjoys reading motivational books and recently completed "New Earth" by Eckhart Tolle. She enjoys running and recently completed the Two Oceans Ultra-marathon in five hours and fifty-three minutes.

Meet an Environmental Control Engineer

Motene faced many challenges growing up. The lack of mentorship, career advice and access to resources such libraries and computers were particulary challenging for her.

"The most challenging time was when I failed one of my courses and as a result I lost my sponsorship. I had to go out and work for a year before finishing my degree. What made me carry on was the thought that this setback was only a small part of my whole life. If I gave up on it I would probably regret it later".

Motene's goal is to complete her MBA and ultimately to venture into a business of her own one day.

Her role models are those people such as Raymond Ackermann, who have managed to identify a gap in the market and make a successful business out of it.

Motene believes firmly in being herself and in never giving up: "Our greatest glory is not that we succeed all the time but that we rise after falling".

Tana Joseph

Tana is from Montana, Cape Town. She attended Pinelands High School and completed her undergraduate degrees in physics at the University of Cape Town (UCT) in 2005 (BSc) and 2006 (BSc (Honours)). In 2009 she completed her master's focusing on the neutral hydrogen content of galaxies in nearby universes.

Tana has just completed her PhD at the University of Southampton and was awarded a SKA postdoctoral fellowship to do research in x-ray Astronomy at UCT.
"The main aim of my research is to use both x-ray and radio data to look for binary (double) stars in a nearby galaxy called the Small Magellanic Cloud".

Tana enjoys reading and watching crime or medical television shows. Recently, she started baking and running which, she says, are not activities that she would normally participate in, but she wanted to challenge herself and try something different and now has found that she is really enjoying them.

She has always loved science and she chose astronomy because she feels that there is still much to learn about the universe and there are many avenues of research to follow. The reason she studied physics at university was to become an astronomer.

Tana has other interests as well. She loves travelling to new places: "I enjoy travelling, meeting new people and talking to people about science". Being an astronomer allows her to do all of these things as part of her job.

Meet a Researcher

"I have travelled extensively over the course of my studies and I will have more opportunities to do so during my time as a SKA astronomer. I have also participated in various outreach activities and have been able to talk about astronomy research with the public and with other scientists".

Tana counts herself fortunate not to have been faced with serious challenges whilst growing up. "My parents have always encouraged me to do well at school and to work towards my goal of becoming an astronomer".
"I think perhaps the biggest challenge I have faced in terms

" The main aim of my research is to use both x-ray and radio data to look for binary (double) stars in a nearby galaxy called the Small Magellanic Cloud".

of my studies was the fact that there are not many women or people of colour in the sciences, especially during the time I was doing physics at UCT. At times I did feel a little isolated and lonely. However, I was again very fortunate in that there was another non-white female student in my classes who also wanted to be an astronomer. We have forged a very good friendship and have leaned on each other when things have become difficult".

Tana's advice to a young person wanting to study in the field of science is to *go for it*. "Doing a science degree gives you skills, such as problem-solving and critical thinking, which are sought after in other jobs as well. Therefore, doing science makes you employable as well as helping you make sense of the world around you".

Tana says that there have been times in her career when she has felt unmotivated and overwhelmed. "However, fellow students and my supervisor helped me to regain confidence in myself by telling me to focus on what I had already achieved. They pointed out that I had already presented my work at conferences and published my research in reputable peer-reviewed journals".

I realised that I had put in lots of hard work and effort over the years and I that I had the skills and knowledge necessary to pursue a job as an astronomer.

UNMANNED AERIAL VEHICLES

What started out as a platform for hobbyists is now poised to become a multimillion dollar industry. Aerial robotics, hyperspectral remote sensing and artificial intelligence are now used for environmental protection, storm prediction, food production and can even be used as delivery vehicles.

An Unmanned Aerial Vehicle (UAV), or drone is basically any aircraft flying in the sky without a pilot ranging in size from an airplane to a bumblebee. Most drones are made of carbon fibre making them light and easy to land without disturbing the environment. Drones have a human controller on the ground.

Drones make use of digital cameras to scan and help create 3-D maps. Hyperspectral imaging identifies features of plants and water by measuring reflected light; LiDAR measures how long it takes for an emitted pulse of light to reach a target and return to the sensor, it can be used to calculate the distance to an object and its height, which is used for 3-D maps.

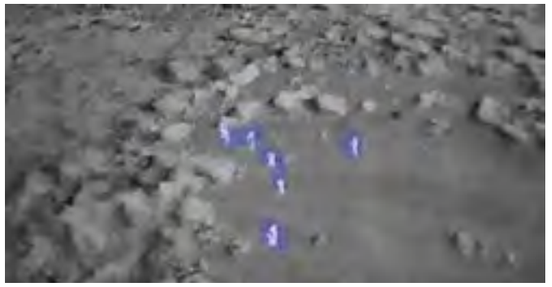
Although UAVs have been around for many years they have only recently become widely used for scientific research, conservation and for medical support.

UAV APPLICATIONS

Combat Poaching & Track Wildlife

One of the most innovative use of drones is in the fight against poaching in the Kruger National Park. They use BatHawk fixed-wing drones, fitted with cameras, video transmitters and telemetry, and with battery changes they can fly for more than eight hours over areas difficult to patrol especially at night. The aim of the project is to up surveillance and to help spot suspects quickly using thermal cameras. Thermal cameras detect heat from living creatures including humans operating under the cover of darkness. See image below. (https://oxpeckers.org)

Drones are tracking wildlife, counting animal populations, and



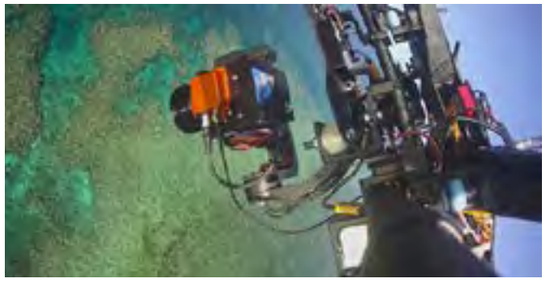
helping move animals as well as monitoring enforcement in conservation areas. (https://wildtech.mongabay.com/2016/05)

A small but noisy drone being used to guide elephants away from human areas.

Monitor and Track Coral Bleaching

The Great Barrier Reef is roughly the size of Japan and home to around 3,000 reefs stretching 2,300 kilometres. This makes it slow and costly to survey using traditional methods. For this reason drones are being used to monitor and track bleaching level changes for individual corals over time. Low-altitude drones can cover far more area in a day and are not hampered by cloud cover as manned aircraft and satellites are.

Drones fitted with hyperspectral cameras can identify reefs threatened by coral bleaching so that this can be more proactively studied and managed. See coral being photographed on opposite page. (https://www.uasvision.com/2017/09/04)



Monitor Volcanoes

There are few things more dangerous and difficult to monitor than an unstable volcano. This is why Einat Lev, seen below, a research professor and volcanologist, is using drones to study and improve eruption hazard assessments and predictions. She used drones equipped with a camera to take thousands of photos of the 2014-2015 lava flow of the Holuhraun volcano in Iceland, one of the largest lava flows in recorded history. The photos are being used to create a 3-D digital topographic map of the flow. A thermal camera recorded temperatures at cracks and hot springs. (http://blogs.ei.columbia.edu/2015/09/09/from-the-field-mapping-lava-flows-in-iceland/)

Delivery of Medicine

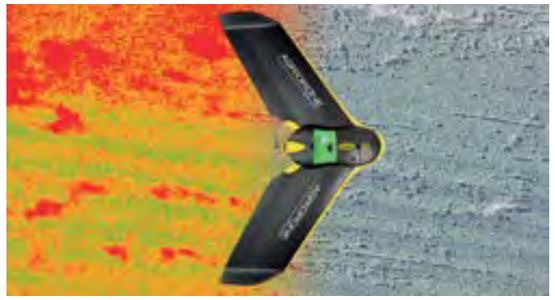
Due to lack of adequate transportation, drones are being used to deliver medicine from cities to rural or remote locations in West Africa. Using this zipline drone service, health professionals at clinics or hospitals call, text, or Whatsapp orders to their nearest distribution centre for the medical products they need. In as little as 15 minutes, the package containing the order is delivered by drone, landing by parachute in a designated area, the size of a few parking spaces. Hospitals are then notified via text message and the drone returns to the centre for its next delivery. The process is faster than any other mode of transport available.

Predict Storms

Drones are used in storm prediction, particularly useful for advanced warning of hurricanes and violent storms. Below, the swirling circulation pattern of Tropical Storm Frank off the southwestern coast of Baja California was captured by Ames Research Center's HDV camera mounted on the aft fuselage of NASA's Global Hawk unmanned research aircraft Aug. 28 during a hurricane monitoring flight. (http://research.noaa.gov)

Food Production

Drones are being used to measure the height of crops, study crop health and reaction to environmental factors. Flying close to crops, the drone uses a 2-D laser scanner to estimate crop height. Scientists here are also developing a drone that can pick leaves off crops so that they can be analyzed for crop health or to determine the identity of a weed. Natural damages on crops represent tens of million euros of expense every year. AIRINOV UAV can picture the entire crop with 30 cm precision in order to spot impacted zones and assess their size, see below. (https://www.airinov.fr/en/services/crop-damages/)



Conclusion

Drones are constantly being improved, being made smaller, cheaper and more capable. But while they have tremendous potential for scientific research, they have some drawbacks. Smaller ones cannot fly out of the controller's line of sight, and larger ones need a lot of people and technical expertise to fly them. There is also the risk of losing a drone through accidents. And because drone use in science is still in its infancy, scientists are building the guidelines as they go, finding their way programmatically, with funding agencies and working within the restrictions each country has for flying them.

PHYSICAL & CHEMICAL SCIENCES

Physical science, in contrast to the biological sciences, is the study of the physical world relating to non-living or inorganic systems. Disciplines of the physical sciences include astronomy, geosciences, mathematics, materials science, meteorology, physics and chemistry.

Chemistry, on the other hand, is one aspect of the physical sciences which has its own areas of specialisation including, biochemistry, organic chemistry, agro-chemistry, pharmacology, astrochemistry, and many more.

Chemistry and physics are both branches of science that study matter. The difference between the two lies in the scope of study. Chemistry is sometimes called "the central science" because it bridges the natural sciences, such as biology, geology and physics, with each other. The chemical reactions which take place in the body, for example, result in energy release in the muscles. Similarly, chemical reactions abound in the geology of earth, in the atmosphere and the oceans, and in the vast array of complicated processes that occur in all living systems.

Students wanting to study either the physical and chemical sciences at university usually need to excel in mathematics, physics and chemistry at school.

Excellent results in these subjects are often a prerequisite for entry into these fields. At university level, students studying physics will focus on physical phenomena relating to matter, space and time, whilst the study of chemistry places more emphasis on laboratory classes and understanding and applying models describing chemical bonds and molecular structure.

Physicists and chemists work across most sectors of industry and are in high demand, depending on the area of specialisation.

Physicists are employed to conduct research into space, medicine, energy, armament, and in a variety of manufacturing industries, to name a few. Many industries have developed as the result of physics research, most notably the semiconductor and electronics industries.

Chemists working in the chemical industry are employed in the petroleum, pharmaceutical and food industries. The components of modern chemistry, such as atoms, compounds, molecules and bonds have practical applications in almost all aspects of life and as such the opportunities for research and employment in the field of chemistry are very broad.

PHYSICAL & CHEMICAL SCIENCES STUDY PATHS

National Senior Certificate:
With Mathematics
and Physical Science

Each education institution has its own unique entry requirements for each of its programmes. It is important to check the entry requirements for the programme with the institution of your choice before you apply.

University
Bachelor of Science Degree

Majors in:
Physics
Biochemistry
Bionumeracy
Cell Signalling
Chemistry
Defence and Disease
DNA and Genomics
Genetics
Mathematics
Microbiology
Metabolism
Physiology
Protein Structure and Function
or any other related subject that is offered by the university.

University of Technology
National Diploma

Diploma in:
Biomedical and Clinical Technology
Chiropractic
Homeopathy
Medical Orthotics and Prosthetics
Pharmacy
Radiography
Somatology
Sport and Exercise Technology
or any other related qualification that is offered by the university of technology.

Internship / Workplace Experience

Workplace experience is a requirement for the completion of a national diploma at a university of technology.

Postgrad
A postgraduate degree or diploma is needed in order to specialise. Each institution will have specific areas that they will promote. With regard the plant and animal sciences these specialisation areas may include:

Biodiversity
Agro-ecosystems
Animal Nutrition
Oceanography
Pasture Nutrition
Parasitiology
Veterinary Science
Wildlife Sciences
and many more.

University of technology students who intend doing postgraduate studies at university will first need to check the acceptance requirements with the university concerned. Students studying a national diploma will need to complete a Bachelor of Technology Diploma and / or a Master of Technology degree as a requirement for entry.

ASTRONOMER

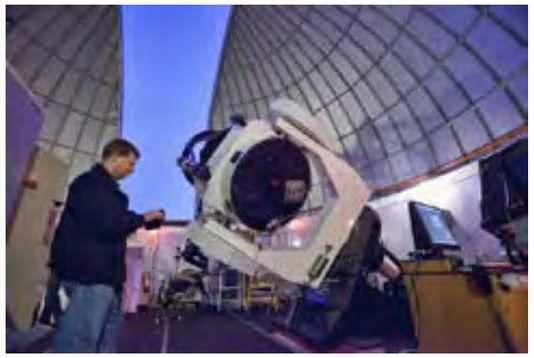
Astronomy involves looking at stars, comets and planets, as well as collections of stars such as globular clusters (up to 1 million stars) and galaxies (up to 100 million stars). Astronomy is also concerned with how and when the universe began (the Big Bang theory being one explanation) and what will happen to it in the future.

Astronomers research the nature, origin and evolution of astronomical objects to obtain a deeper understanding of the laws of physics. They are essentially physicists who use the universe as a laboratory.

Because one cannot travel to the stars in order to retrieve pieces of them for analysis in one's laboratory, one must use all other available information, such as radiation across the entire electromagnetic spectrum - from radio waves to gamma rays and cosmic rays - tiny particles that interact with the earth's atmosphere or magnetic field.

Astronomers use their knowledge of mathematics and physics to study the nature, origin and evolution of astronomical objects to obtain a deeper understanding of the universe. This knowledge can be applied to developing navigational systems that will enable us to find our way through space.

Information on astronomical objects is collected by detecting their signals through space-based, ground-based, optical, gamma ray, X-ray and radio telescopes in conjunction with sensitive detecting devices. This data is analysed, often with the aid of computers, and interpreted in the framework of mathematical models incorporating the ideas of modern physics.



Adam Block points the 32-inch Schulman Telescope at the evening sky in preparation for a public program.
Photo supplied by Dave Harvey.
< http://www.nano.org.uk/news/570/ >

Astronomers can work during the day or night. Many theoretical astronomers work normal hours and do not have to make any observations. Radio observations can be made during the day as well as at night, but much of the telescope's functions are pre-programmed and do not require the constant presence of an astronomer.

Optical and infrared astronomers do the observational part of their work at night. For every week-long "observing run" at night, an astronomer will spend six to ten weeks on a normal daytime schedule, analysing data and doing other work.

Observational astronomy occupies much less of the astronomer's time than analysing data. Observational astronomers plan research which involves the measurement of electromagnetic radiation (such as light waves). They analyse the results obtained and publish the findings so that others in the field will have access to the information.

Theoretical astronomers concentrate on developing theories concerning various aspects of the universe. It is possible to work in both theoretical and observational astronomy, although most astronomers tend to be more active in one or the other. Some astronomers also teach Mathematics or Physics at a university.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting degree requirements for a degree course

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences
Recommended Subjects: Information Technology

Further Training

Degree: BSc degree with physics, mathematics, engineering or chemistry as major subjects, or a specific undergraduate astonomy degree. Arts majors are also acceptable. Other recommended subjects are pure and applied mathematics, computer science, statistics and electronics.

Postgraduate: A master's degree is required for those wishing to pursue a career in the field of applied research and development. Those with a bachelor's degree can be employed as research assistants and technicians.

Areas of specialisation for PhD Studies may include Astronomy, Aatrophysics, Cosmology, Astrobiology, Solar Astrophysics and Planetary Geology

The professional astronomer has to obtain a PhD in Astronomy from an accredited university.

Students in the fields of physics, chemistry, applied mathematics, mathematics or astronomy, who obtain outstanding results at third or fourth year level (over 80 percent) may also be awarded bursaries for postgraduate studies in Astronomy by the universities themselves.

The South African Astronomical Observatory and the Radio Astronomy Observatory occasionally employ BSc graduates who may be encouraged to work for MSc or PhD degrees (as external students of a university).

A degree in astronomy is by no means limited to a career in that field. It gives a solid basis for various other graduate studies in science, technology or engineering fields. Graduates will be well prepared for job opportunities in areas related to astronomy, such as instrumentation design, software development, digital processing, computer science, telecommunication, laboratories, teaching, science education and writing, and even business.

Employment

- Square Kilometre Array (SKA)
- SA Astronomical Observatory
- Hartebeeshoek Radio Astronomy Observatory
- universities

Job opportunities are limited, but astronomers can usually obtain research grants anywhere in the world. Although they are not always employed in astronomy itself, astronomers are seldom unemployed, because of their high level of training in Physics.

Although astronomers cannot earn their own money directly as an astronomer, there are some who become free-lance astronomy or general science writers, or even science-fiction writers.

Further Information

Astronomical Society of Southern Africa (ASSA)
P O Box 9
Observatory, 7935
assa.saao.ac.za

South African Astronomical Observatory
Old Fraserburg Road
Sutherland, 6920
P O Box 25
Sutherland, 6920
Tel: (023) 571-1205 Fax: (023) 571-1413
www.saao.ac.za

South African Large Telescope (SALT)
Old Fraserburg Rd, Sutherland, 6920
Tel: (023) 571-1205
www.salt.ac.za

Wits Planetarium
University of the Witwatersrand
PO Box 31149, Braamfontein, 2017
Tel: (011) 717-1390
E-mail: planet@planetarium.co.za
www.wits.ac.za/planetarium

Hartebeesthoek Radio Astronomy Observatory
P O Box 443; Krugersdorp, 1740
Tel: (012) 301-3100 Fax: (012) 301-3300
E-mail: info@hartrao.ac.za
www.hartrao.ac.za

SKA South Africa Johannesburg Office
PO Box 522940; Saxonwold, 2132
Tel: (011) 442-2434; Fax: (011) 442-2454
enquiries@ska.ac.za
www.ska.ac.za

Some Related Careers

Astrophysicist, Chemist, Computer Scientist, Geologist, Geophysicist, Hydrogeologist, Metallurgical Engineer, Meteorologist, Mineralogist, Physicist, Statistician, Telecommunications Engineer.

The Mount Lemmon Observatory from the outside.

The Mount Lemmon Observatory. CSS astronomers Steve Larson and Ed Beshore work on their new 1 meter telescope.

ASTROPHYSICIST

An astrophysicist is an astronomer who studies the physical components of celestial objects. As an academic subject, astrophysics is a combination of physics and astronomy. Astrophysicists study the physics of the universe along with the interactions between various objects of outer space. Subjects such as electromagnetism, statistical mechanics, molecular physics and quantum mechanics come within the scope of modern astrophysics research.

Astrophysicists can either study the theoretical aspects of space or apply their fundamental knowledge of physics to explore various occurrences in space, such as dark matter, black holes, stellar evolution, super clusters and neutron stars. They use their knowledge of physics, mathematics and computing to investigate the formation of planets, stars and galaxies.

Research and development is the primary focus of an astrophysicist. Basic research is conducted to gather scientific knowledge, while advanced research may lead to the development of scientific devices and research equipment. The responsibility of astrophysicists includes analysis of data and statistics, archiving, plotting, logging, evaluating and reporting the results of the research. They may have to coordinate data received from various satellites and telescopes, and use theoretical models to compare this data and align images. Observational astrophysicists work to maximise viewing time of different stellar events.

Possible tasks are to:

- analyse research data to determine their significance, using computers
- collaborate with other astronomers to carry out research projects
- develop and modify astronomy-related programmes for public presentation
- measure radio, infrared, gamma and x-ray emissions from extraterrestrial sources
- raise funds for scientific research
- develop instrumentation and software for astronomical observation and analysis
- develop theories based on personal observations or on observations and theories of other astronomers
- direct the operations of a planetarium
- present research findings at scientific conferences and in papers written for scientific journals
- review scientific proposals and research papers
- study celestial phenomena using a variety of ground-based and space-borne telescopes
- calculate orbits and determine sizes, shapes, brightness and motions of different celestial bodies
- teach astronomy or astrophysics.

South Africa has a long tradition in astronomy, due to its favourable climate and geographical location. The following exciting installations are situated here:

SALT, the Southern African Large Telescope, is the largest single optical telescope in the Southern Hemisphere. It is located in Sutherland, and is able to record distant stars, galaxies and quasars a billion times too faint to be seen with the unaided eye.

MeerKAT, the Karoo Array Telescope, is the world's first radio telescope, consisting of 64 dish-shaped antennae, each 12 m in size, and is a prototype for the international Square Kilometre Array (SKA).

SKA will be the world's biggest telescope and one of the biggest scientific projects ever. Many large antennae and other radio-wave receivers, spread over 3 000 kilometres, will be linked together by optic fibre cables, creating a radio telescope at least 50 times more powerful, and 10 000 times faster than any other radio telescope currently in existence. The signals produced will be processed and interpreted by computers, forming images. The major portion of SKA will be built in the Northern Cape Province, and another section in Western Australia.

In addition to their grasp of astronomy, mathematics, physics and general principles of science, astrophysicists must have an inquisitive, creative mind. Formulating new concepts about distant astronomical phenomena often requires the ability to visualise complex concepts completely, as well as being able to express such ideas mathematically. Astrophysicists will sometimes work with other scientists and researchers, and the need to communicate effectively may be required. However, they may also spend long hours performing solitary research and calculations, and need to be able to operate independently and outside social interactions.

Astrophysicists tend to work in an indoor, comfortable environment, often in a laboratory or classroom setting. They sometimes travel to distant locations to collect data, especially when the telescopes they use are located in remote areas. Those that work for a university can both teach classes and conduct research.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Computer Science, Additional Mathematics.

Further Training

Degree: BSc in physics, mathematics or engineering, or a specific undergraduate astronomy degree.
Other recommended subjects at university: pure and applied mathematics, computer science, statistics, electronics and chemistry.
Undergraduate astronomy courses are offered at several universities.

The BSc degree in astrophysics is by no means limited to a career in astronomy. It gives a solid basis for various other graduate studies in science, technology or engineering fields. Graduates will be well prepared for job opportunities in areas related to astronomy, such as instrumentation design, software development, digital processing, computer science, telecommunication, laboratories, teaching, science education and writing, and even business.

Postgraduate: A master's degree is required for those wishing to pursue a career in the field of applied research and development. Those with a bachelor's degree can be employed as research assistants and technicians.

Areas of specialisation for PhD studies include: Optical Communication and Image Processing, Dark Matter, Asteroseismic Data Analysis and Modelling of Stars and Stellar Populations.

A PhD in astronomy or astrophysics from an accredited university is generally the basic academic requirement for becoming an astrophysicist.

Astrophysicists usually start their careers as a fellow or intern in a research institute. Modern laboratory and research techniques can be learned while assisting advanced scientists during such internship programmes. Those with a post doctoral degree and relevant work experience can apply for permanent positions in government laboratories.

Graduates in astronomy are equipped to conduct research at the cutting edge of astrophysics and space science and will have the broad science skills needed in any modern technological society.

Employment

Because of the shortage of local astronomers, there are good employment prospects for an academic career in astrophysics, particularly in South Africa.

- astronomical research facilities such as HartRAO, SAAO, SKA and MeerKAT
- universities or colleges, teaching physics, mathematics or astronomy
- museums
- government agencies
- research organisations
- biotechnology companies
- planetariums
- private organisations

Further Information

Astronomical Society of Southern Africa (ASSA)
c/o SAAO
P O Box 9
Observatory, 7935
info@assa.saao.ac.za
assa.saao.ac.za

The South African National Astrophysics and Space
Department of Astronomy
University of Cape Town
Private Bag, Rondebosch, 7701
Tel: (021) 650-4042
www. star.ac.za

South African Astronomical Observatory and
South African Large Telescope (SALT)
Old Fraserburg Road
Sutherland, 6920
P O Box 25
Sutherland, 6920
Tel: (023) 571-1205 Fax: (023) 571-1413
www.saao.ac.za

Some Related Careers

Astronomer, Engineer, Physicist.

ENVIRONMENTAL CHEMIST

Environmental chemists are responsible for analysing the affects of chemicals on soil, air and water environments, and they are also responsible for devising solutions to environmental problems.

The main aim of environmental chemists is to locate and neutralise threats of pollution to people, animals and plants, using their knowledge of chemical properties and reactions. They conduct qualitative and quantitative chemical analyses or experiments in laboratories for quality or process control, or to develop new products or knowledge.

Expert analysis of radioactive water

"Environmental chemist" is a general term. In fact, most chemists in the field would probably describe themselves more specifically by the work they do. They may focus on collecting and analysing samples using chromatography or spectroscopy, or developing remediation programmes, or changing production processes to yield a more environmentally-friendly product, or providing expert advice on safety and emergency responses, or on dealing with government regulations and compliance issues.

Environmental chemists commonly spend their time monitoring and designing waste management and disposal sites, as well as providing risk assessment for construction and other projects that could potentially harm the environment.

They will need to write technical papers or reports, or prepare standards and specifications for processes, facilities, products or tests. They will have to confer with scientists or engineers to conduct analyses of research projects, interpret test results, or develop non-standard tests.

Work is often done in an indoor laboratory. However, when studying chemicals in the environment, a riverbed or stream may become the laboratory. Some companies have sophisticated indoor ecosystems in which they test their products, while others collect data outdoors.

Many opportunities exist to move into different areas of expertise, often outside the laboratory. Many chemists return to school to study public policy, law, or business applying their chemistry know-how in new ways. For example, knowledge of chemical processes is often vital for an individual who works in a corporation's regulatory affairs department and who must ensure compliance with government regulations.

Environmental management is becoming a popular career track. Students who hold degrees in environmental sciences are finding jobs throughout the chemical industry, often working alongside geologists, biologists, and chemists.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Geography, Life Sciences.

Degree: BSc in chemistry, chemical engineering, environmental science or a related field. Courses in biology, analytical chemistry, geology, hydrology or toxicology would be useful.

Most environmental chemists emphasise that a solid foundation in chemistry is important to this work. Chemistry students interested in applying their training to an environmentally-orientated job are encouraged to take courses in environmental studies.

Postgraduate: The following programmes related to environmental chemistry may be followed:
BSc Honours: Environmental Chemistry and Chemical Trace Analysis courses; PGD Env.Science: Environmental Chemistry course.

Employment

- chemical industry
- private consulting firms
- Government agencies – Department of Agriculture, Environmental Protection Agency
- waste management companies
- colleges and universities

Further Information

Society of Environmental Toxicology and Chemistry (SETAC)
Av. de la Toison d'Or 67 b 6
B-1060 Brussels, Belgium
Tel: (+32) 2 772 72 81 Fax: (+32) 2 770 53 86
www.setac.org

The South African Chemical Institute
School of Chemistry
University of Witwatersrand
Private Bag X3
Wits, 2050
Tel: (011) 717-6705 Fax: 086 766 9041
E-mail: saci.chem@wits.ac.za
www.saci.co.za

Some Related Careers

Air Pollution Control Engineer, Environmental Impact Assessor, Rehabilitation Engineer, Environmental Manager, Materials Scientist, Toxicologist, Waste Management Engineer.

Spanish researchers looked at the antimicrobial activity of 3 essential oils in combatting mould. Cinnamon came out on top when it came to mould. They reported that the incorporation of cinnamon essential oil into wax paraffin packaging can prolong the freshness of bread by up to 10 days.
< http://prospect.rsc.org >

The Laboratory for advanced environmental chemistry at Kyushu University, Japan.
<http://suisin.jimu.kyushu-u.ac.jp>

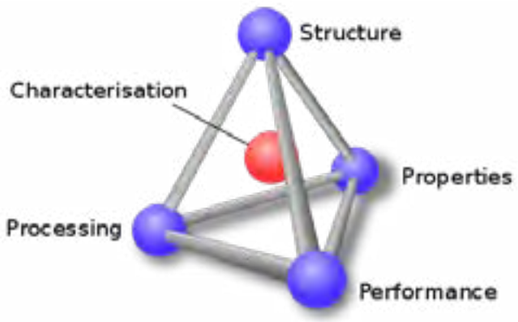
MATERIALS SCIENTIST

Materials scientists study the structures and properties of various materials such as metals, alloys, ceramics, semiconductors and polymers. The purpose of these studies is to understand and characterise materials and to develop new materials which will be of commercial and scientific benefit.

The financial yield of selling finished products is generally much higher than that of selling natural resources that are still in ore form, for example. Materials scientists find and develop creative and economical ways of converting natural resources into final products. This covers a very broad spectrum of materials and products and these scientists perform a range of different functions in various industries.

Areas of specialisation

- guidance of technical staff in developing materials for a specific use of a projected product
- mining and processing materials
- extraction of certain elements from minerals
- processing minerals into materials such as metals, ceramics and plastics
- the use of materials in engineering structures
- disposal of waste materials
- managing a furnace or rolling mill
- the conduction of laboratory experiments in the production of materials, to confirm the feasibility of processes and techniques for potential users.



A concept within materials science in which the properties of materials are based on four different principles: Structure, Processing, Properties, and Performance. These four concepts together provide the characterisation of the material.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: None.

Further Training

Degree: BSc / BEng Metallurgical Engineering / Extraction Metallurgy. BSc Chemistry can also lead to this specialisation.

Graduates with a BEng degree and three years' practical experience can register as Professional Engineers with the Engineering Council of South Africa (ECSA).

Diploma: N.Dip. Metallurgical Engineering offers training for metallurgical engineering technicians.

Training for technologists includes university of technology courses in materials science, engineering, mathematics, quality control, computer applications and metallurgical engineering. Usually, employing companies require recently qualified diploma graduates to undergo a period of further in-service training before they are accepted as fully qualified materials scientists or engineers.

Postgraduate: BEng Hons, MEng and PhD.
Some universities offer integrated undergraduate and postgraduate programmes which span the full spectrum of metallurgy, including materials science or a special restricted intake programme combining materials science with chemistry, physics or metallurgy.

Employment

Employers include manufacturers of micro-processors and computers, electronic equipment and products, and producers of plastics, ceramic, steel, glass, etc.

Companies and statutory organisations that employ materials scientists include:

- Mittal Steel
- Council for Mineral Technology - Mintek

- Eskom
- CSIR
- Samancor
- NECSA
- Sasol
- Anglo American
- Rand Mines
- Gencor
- JCI
- De Beers
- Columbus Stainless Steel
- Huletts Aluminium
- self-employment; with enough experience, one can start their own business and work as a consultant, particularly in the fields of welding, casting, corrosion and failure analysis.

Several dyed polymer resins for an injection moulding process

C. Dvoracek is a graduate student researcher at John Hopkins University working on synthesising quantum dots and fluorescent nanoparticles to target cancer for treatment. <http://materials.jhu.edu/index.php/admissions/stories/charli-dvoracek1#3>

Further Information

Any of the above-mentioned potential employers, universities or universities of technology.

Mintek
Information and Communication Division
Private Bag X3015
Randburg, 2125
Tel: (011) 709-4111
asdenquiries@mintek.co.za
www.mintek.co.za

The South African Institute of Mining and Metallurgy
P O Box 61127
Marshalltown, 2107
Tel: (011) 834-1273/7 Fax: (011) 838-5923
www.saimm.co.za

Some Related Careers

Assayer and Sampler, Engineering Geologist, Extraction Metallurgist, Geotechnologist, Metallurgical Engineer, Mineralogist, Mining Engineer.

Research laboratories delve into the extremes of matter to make energy cleaner, devices faster, materials stronger and people healthier. < http://materials.jhu.edu >

NANOSCIENTIST

Nanoscientists design, develop and supervise the production of materials, devices and systems of unique molecular or macromolecular composition, applying principles of nanoscale physics and electrical, chemical and biological engineering.

Nanoscientists (also known as nanosystems engineers) study structures of 100 nanometres (nm) or less. Since a nanometre only measures one billionth of a metre, it is difficult to imagine anything smaller. Nanotechnology is expected to become one of the most strategic and dominant technologies in the next 10 to 20 years. Nanotechnology will have an almost endless string of applications in biotechnology, biology and biomedicine.

Nanotechnology has had several commercial applications in advanced laser technology, hard coatings, photography, pharmaceuticals, printing, chemical-mechanical polishing and cosmetics. Soon there will be lighter cars using nanoparticle-reinforced polymers, more energy efficient batteries, insulin that can be taken orally, artificial joints made from nanoparticulate materials and low-kilojoule foods with nanoparticulate taste enhancers. Nanoscience is playing an increasingly important role in enhancing energy efficient transport systems in the automobile and plane manufacturing industry.

Nanoscientists create designs or prototypes for nanosystem applications, such as biomedical delivery systems and atomic force microscopes.

Nanoscientist Molly Stevens is working on techniques to enable a damaged heart to repair itself or bone tissue to regenerate. Photo by: Andy Hall for the Observer .
< http://www.nano.org.uk/news/570/ >

They design or engineer nanodevices using three-dimensional computer-aided design (CAD) software. They coordinate or supervise the work of suppliers or vendors in the designing, building or testing of nanosystem devices, such as lenses or probes.

They design or conduct tests on new nanotechnology products, processes or systems, and engineer production processes for specific nanotechnology applications, such as electroplating, nanofabrication or epoxy. They conduct research related to a range of nanotechnology topics, such as packaging, heat-transfer, fluorescence detection, nanoparticle dispersion, hybrid systems, liquid systems, nanocomposites, nanofabrication, optoelectronics and nanolithography.

Nanoscientists daily tasks include laboratory work and analysis, meetings with students and internal meetings, computer work, writing articles, numerous discussions about research findings, and much reading to keep up with current information.

Knowledge of nanoscale science and technology will be increasingly important during upcoming years and decades.

As nanoscale science and technology come to have increasing impacts on many aspects of our daily lives, the opportunities for careers in these fields are increasing rapidly. A major challenge for the field is the education and training of a new generation of skilled workers.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Computer Science.

Further Training

Because nanoscience is such a wide field, there is no one defined path to follow. One could start with BSc honours in physics, chemistry, biochemistry or engineering, and then specialise at master's and doctorate level.

Potential fields of study include:

Biology, chemistry, physics, environmental science, agricultural science, engineering, medicine, materials science, forensic science, law and business ethics.

Not everyone working in the field will require a doctorate degree in one of these fields. A skilled workforce trained at a variety of levels is needed to meet the projected workforce challenge of seven million workers.

Employment

Career opportunities, exist in areas such as:

- electronics / semiconductor industry
- materials science, including textiles, polymers and packaging, amongst others
- car and aerospace industries
- sports equipment
- pharmaceuticals, including drug delivery and cosmetics
- biotechnology and medical fields
- optoelectronics
- environmental monitoring and control
- food science, including quality control and packaging
- forensics
- university research
- national security and the military

Nanoscale science and technology are fuelling a revolution in manufacturing and production, creating new materials and novel processes. Not only will the areas listed above continue to grow and benefit from nanotechnology, but the following fields are expected to undergo developments on a massive scale:

- medicine: diagnostics and therapeutics (e.g. drug delivery)
- energy: capture, storage and use, fuel cells, batteries
- environmental remediation: in conjunction with genetically modified microbes
- robotics: many uses
- manufacturing: self-assembly; "bottom-up" fabrication of novel and innovative materials
- commerce: radio frequency identification (RFID) and "smart" tags

Further Information

Some additional sites to explore:

www.nano.gov

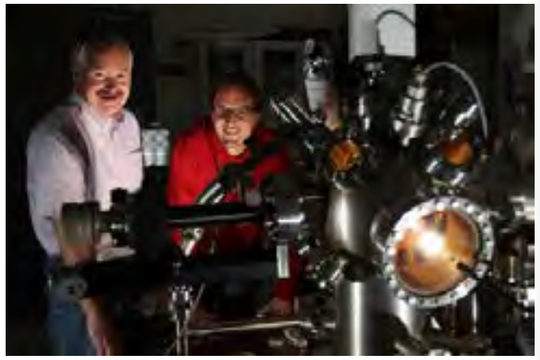
www.tinytechjobs.com

www.workingin-nanotechnology.com

www.nanostudent.com

Some Related Careers

Biotechnologist, Materials Scientist, Medical Researcher



Prof. John Boland, and Prof. Jonathan Coleman, principal investigator at CRANN, work on a novel method of being able to split graphite down into individual layers of graphene, which could be used to make stronger and lighter materials.
< http://www.siliconrepublic.com/innovation/item/>

Raechele Butler, a student at Bryant High School in Tuscaloosa, works in the laboratory at UA during the Nanoscience Internship program.
< http://uanews.ua.edu/2007/07/area-teens-join-ua-professors-in-nanoscience-program/>

NUCLEAR ENGINEER

Nuclear engineers study the energy released when the atomic core is split. Some high-technology weapons and medical breakthroughs exist as a result of nuclear energy. These engineers are responsible for the use and control of the energy and accompanying radiation that result from a nuclear reaction. They also generate, use and maintain nuclear energy.

Nuclear engineering includes research, design, safety analyses, testing, education and fuel management. The power industry dominates nuclear engineering. Nuclear engineers use equipment such as biological shields, instruments and thermal shields for their designs and developments. Nuclear engineering requires teamwork and involves supervision, analyses, assessments, training and storage. Nuclear engineers working at power plants are also involved in the quality of water and food.

Nuclear energy is used for sterilisation, pest control and the production of fertilizers. Nuclear engineers also do genetic research to improve food strains and their resistance to harmful elements.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Engineering and Technology.

Further Training

Degree: BSc degree majoring in Physics and Chemistry or Physics and Mathematics.

Postgraduate: **BSc Honours degree specialising in physics, chemistry or other relevant fields. An MSc or PhD is recommended, especially for a career in research.**

Areas of specialisation for PhD studies include: Applied Nuclear Instrumentation; Reactor Safety Analysis and Health Physics. The management of nuclear waste for example, is an area of growing concern worldwide.

Employment

- universities
- large hospitals
- Directorate for Radiation Safety, Department of Health
- organisations such as: SABS, Eskom
- NECSA
- The National Accelerator Centre
- nuclear safety companies

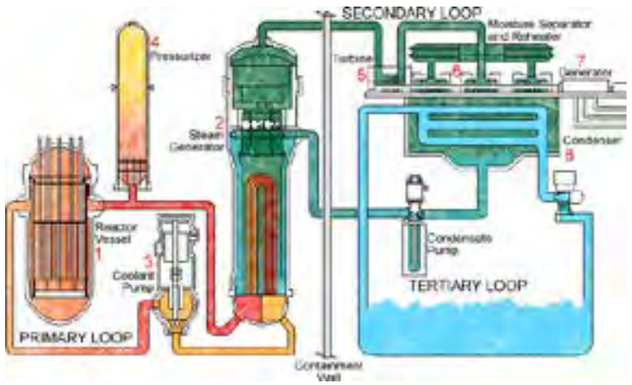
Positions in this field are not plentiful and competition is fierce. Those that are better qualified stand a better chance.

Further Information

Any of the above-mentioned potential employers.

Some Related Careers

Chemist, Civil Engineer, Computer Scientist, Electrical Engineer, Geophysicist, Hydrologist, Mathematician, Medical Physicist, Nuclear Instrument Technician, Nuclear Scientist, Physicist, Radiation Protection



The Nuclear Operating Model at Koeberg Power Station

Spliting atoms - Associate Director Mark Tillack at the Centre for Energy Research leads a team doing research at UC San Diego. <http://www.realscience.us/2008/12/09/split-atom/>

Koeberg Nuclear Power Station is responsible for the electricity supply to the Western Cape. <http://www.eskom.co.za/c/article/12/koeberg/>

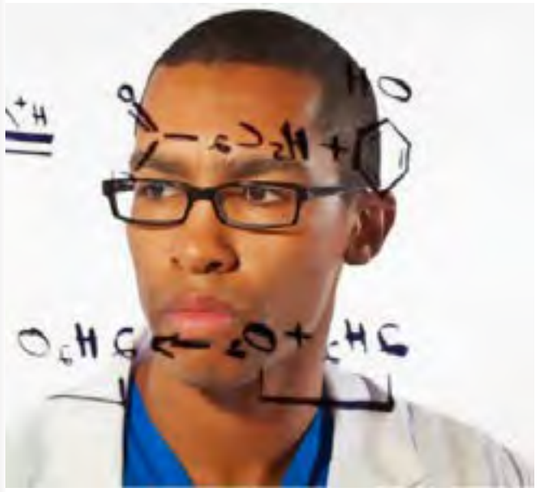
PHOTONICS ENGINEER

Photonics engineers develop the tools and technical applications of light. The science of photonics is the generation, transmission, modulation and detection of light.

Advances in technology and communications move at the speed of light. Much of our communications system is based on transmitting information, in the form of light, through optical fibres. Photonics engineers are concerned with devising and improving sources of light and the optical fibres through which the light travels. They need to have a thorough knowledge of physics, engineering and optics.

Photonics engineers, for example, help to save lives by designing laser tools that are used in delicate eye and heart surgeries; develop better fibre optics to transmit large amounts of data around the world in the blink of an eye; design LED-based car headlights that are stylish, energy-efficient and bright enough for driving safely; dazzle and entertain crowds by developing specialised lasers for rock concerts and art installations.

In the first few years of the 21st century, the Digital Age, one can send and receive e-mail from around the world in a few minutes. Surgeons routinely perform laser surgery that results in less bleeding and faster healing time. The Air Force defends the skies using electronics-based aircraft that can almost fly themselves. The connection in all of these is photonics technology!



Phototonic engineers require a sound understanding of mathematics, physics and chemistry.

Photonics engineers can investigate a variety of areas:

- Design, test and modify laser equipment and components for manufacturing, defence, telecommunications and medicine. Lasers can be made from semiconductors or from gas.
- Improve the quality and design of fibre optics technology.
- Devise methods for reducing the cost of manufacturing lasers, optical fibres, and fibre-optics.

As the need increases for humans to share information faster using precision equipment, photonics engineers can expect to be at the forefront of cutting-edge technology.

Photonics engineers should learn how to use systems for computer-assisted design and drafting (or CADD) and computer-assisted manufacturing (or CAM). The laser and fibre-optics field is advancing rapidly, and engineers in this profession must continually update their knowledge to maintain their expertise by taking classes.

Most photonics engineers begin as assistants to experienced engineers. As they gain experience, they may become supervisors or specialise in a particular aspect of laser or fibre-optics technology. Some engineers advance to management positions. A few engineers with the necessary education can become research directors or principal engineers. Engineers may also advance by starting their own consulting or manufacturing companies.

Most photonics engineers work in office buildings, laboratories, or industrial plants. Some engineers travel extensively to plants or work sites abroad. Many engineers work normal office hours but, at times, deadlines or design standards may bring extra pressure to a job, requiring engineers to work longer hours.

Careers in lasers and photonics are what we call "emerging careers." Advances in the field are creating new job opportunities in a variety of industries, which may fuel extensive job growth.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Applied Technology.

Further Training

Degree: Bachelor's degree in a field such as electrical engineering, mechanical engineering, engineering science, or engineering physics – all universities.
Some colleges and universities offer degrees in optics technology or photonics.

Diploma: Photonics is listed as a scarce skill. There is a need for qualified and skilled people in photonics and related fields. This fast-growing industry is in need of trained technicians.

Postgraduate: **Certain positions in the laser and fibre-optics profession, such as optical designer, require an advanced degree. A master's degree will take one or two years of additional full-time study. It generally takes about four years of study after earning a bachelor's degree to receive a PhD, which is required to teach at the university level in this field as well as for industrial research and development positions.**

Employment

Some of the jobs in the field of lasers, photonics, and holography include:

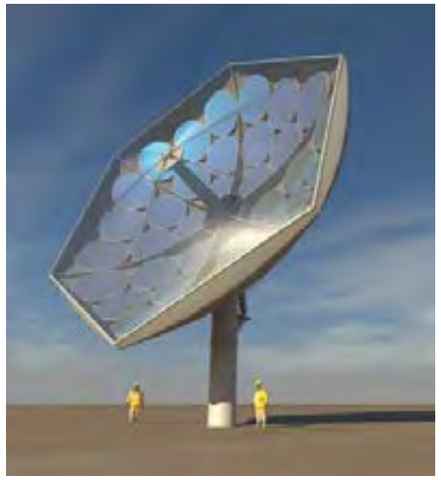
- industrial laser companies
- medical laser offices
- companies that design and run laser light shows
- laser manufacturing company
- optical engineering company
- fibre-optic packaging company
- optics/laser manufacturing company.

Further Information

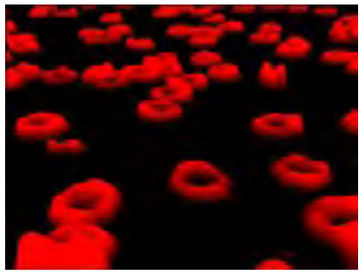
Photonics Division of the South African Institute of Physics
www.lasers.co.za

Some Related Careers

Electrical Engineer, Laser Display Artist, Mechanical Engineer, Physicist.



Rendering by Airlight Energy of the prototype high-concentration photovoltaic thermal system under development by an international collaboration of researchers. Find out more at: http://www.photonics.com/Article.aspx?AID=54279#sthash.xosJxu3o.dpuf
< http://www.photonics.com/Article.aspx?AID=54279 >



Red blood cells struck with laser light generate high-frequency sound waves that could help researchers to differentiate normal blood cells from abnormal ones for the diagnosis of blood-related diseases. Courtesy of Strohm et al. Biophysical Journal.
< http://www.photonics.com/Article.aspx?AID=54334 >

Fibre-optic products such as these thin faceplates can be used with medical x-ray systems.
< http://www.photonics.com/Article.aspx?AID=54273 >

PHYSICIST

Physicists are scientists who study the fundamental properties of matter. This ranges from the microscopic world of subatomic and molecular particles, to the macroscopic world of cosmology and astrophysics. Systematic observation and experimentation provide the data from which theories describing the fundamental forces and laws of nature can be developed.

Physics is the science that deals with the structure of matter and the interactions between the fundamental constituents of the observable universe. Its object of study, therefore, ranges from quarks (tiny particles making up the nuclei of atoms) to quasars (apparently star-like objects, but brighter than billions of stars put together), found at the edge of the universe. Nothing is too small or too big for the physicist to investigate - the entire universe is their field of study.

Physicists usually specialise in one of the following:

Experimental physicists: supply the fundamental data on which physics is founded. They spend a lot of time in the laboratory where new phenomena are examined through systematic and exact measurements, and experiments are performed to test existing theories.

Theoretical physicists: formulate the laws of nature that determine the properties and transformation of matter and energy. This is done in mathematical terms and electronic computers are often used for the calculations.

Plasma sphere with smooth magenta-blue flames. One powerful stream of plasma is directed upwards.

Areas of specialisation

- Solid-state physics and material science
- Nuclear, particle and radiation physics
- Optics and spectroscopy
- Environmental physics
- Medical physics and biophysics
- Solar-terrestrial physics, astronomy and astrophysics
- Plasma physics
- Engineering physics

With some employers, physicists can do original research, while with others they apply their knowledge to the solution of specific problems.

Physicists usually work regular hours in offices and/or laboratories, but they may be required to work longer hours if they are intensely involved in their research. In general, the work is not hazardous. Some physicists may spend time working away from home to use national or international facilities that have unique equipment.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: None.

Further Training

Degree: BSc Physics and Mathematics as majors and complementary courses in such subjects as chemistry, geology, astronomy, applied mathematics, statistics, most universities.

Diploma: N.Dip. Analytical Physics for those who want to become physical technologists.

Postgraduate: **BSc honours is the minimum requirement to become a physicist. Most South African universities offer honours, master's and PhD degrees in this field. Many employers prefer physicists to be qualified to a doctorate level.**

Physicists can enter the career of medicine, working with MRIs, PET scans or photon beam accelerators. Some study nuclear fusion energy, others go into the field of energy exploration.

Employment

- manufacturers of materials
- manufacturers of equipment
- hospitals
- mining companies
- research organisations
- universities and universities of technology
- government departments
- organisations such as CSIR, NECSA, Mintek, Sasol, SAB
- self-employment; with appropriate experience may act as a private consultant.

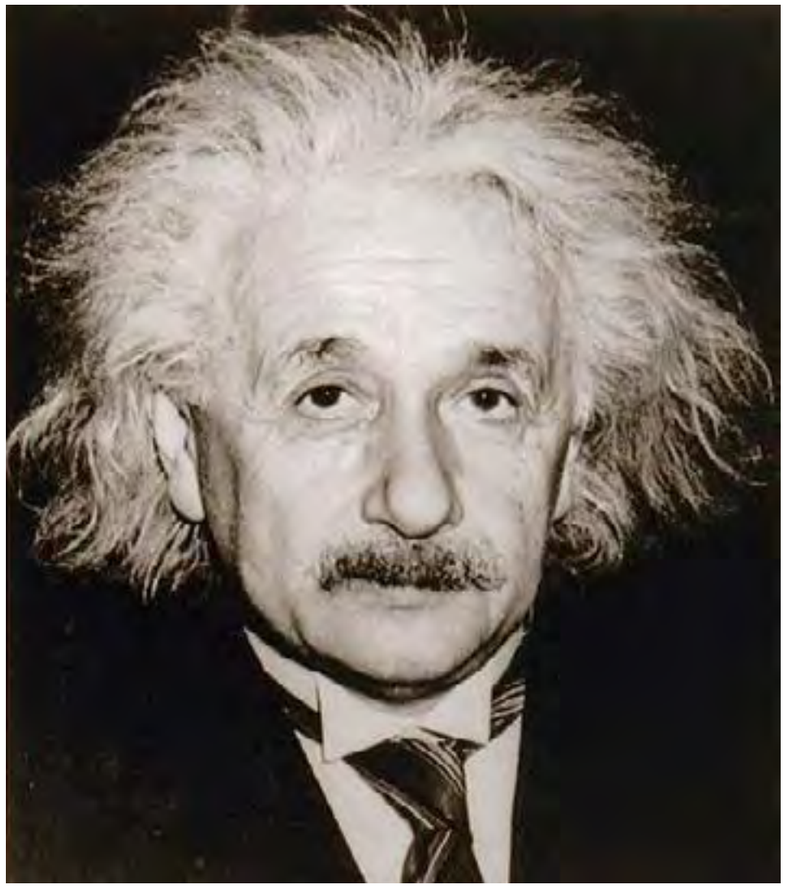
Further Information

Any of the above-mentioned tertiary educational institutions or potential employers.

The SA Institute of Physics
Postnet Suite 165
Private Bag X025
Lynnwood Ridge, 0040
Tel: (012) 841-2627 Fax: 086 648-8474
www.saip.org.za

Some Related Careers

Astronomer, Astrophysicist, Biophysicist, Botanist, Chemist, Computer Scientist, Engineer, Geophysicist, Hydrologist, Mathematician, Meteorologist, Nuclear Physicist, Nuclear Scientist, Statistician.



Albert Einstein (14 March 1879 – 18 April 1955) was a German-born physicist who developed the general theory of relativity, one of the two pillars of modern physics alongside quantum mechanics.
< http://hayleyf2222.files.wordpress.com/2012/02/ >

SPACE WEATHER ANALYST

Space weather analysts are atmospheric scientists who investigate atmospheric phenomena and interpret meteorological data gathered by surface and air stations.

The sun's activity causes large changes in the sun's plasma and energetic particle populations, and these changes are responsible for the "space weather" that affects earth. Space weather can impact the upper atmosphere and may influence long-term climate trends.

The study of "space weather" or the effect of plasma eruptions on the sun that reach the earth. www.un-spider.org

Space weather analysts study and forecast space weather, such as solar flares, geomagnetic storms and particle events. All three can impact human activity.

Solar flares can disrupt radio communications. Sometimes a Coronal Mass Ejection (CME), a giant blob of plasma hurled from the sun, accompanies a flare.

Geomagnetic storms occur when a CME hits the earth's magnetosphere. A geomagnetic storm creates an aurora, but can also cause a variety of highly undesirable consequences. Electrical current surges in power lines, interference in the broadcast of radio, television and telephone signals, and problems with defence communications are all associated with magnetic storms. Odd behaviour in air and marine navigation instruments has been observed, and a compass anywhere on earth is certainly affected. These storms are known to alter the atmospheric ozone layer.

Sometimes energetic particles (protons) are ejected during a solar flare. These particles can cause satellite malfunctions and increase the radiation hazard for astronauts in low-earth orbit.

Major solar activity is a very serious concern in space flight. Communications may be disrupted. Large solar disturbances heat the upper atmosphere, causing it to expand and create increased drag on spacecraft in low orbits, shortening their orbital lifetime. Spacecraft could potentially tumble and burn up in the atmosphere.

For example, they use weather balloons, radar systems, satellites and sensors to monitor the weather and collect data. The data they collect and analyse are critical to understanding air pollution, drought, loss of the ozone layer and other problems. Atmospheric scientists also use graphics software to illustrate their forecasts and reports for public and other uses. They warn the nation and clients via radio, television, newspapers and other media if a damaging solar storm is due or underway.

Many atmospheric scientists work with scientists and professionals in other fields to help solve problems in areas such as commerce, energy, transportation, agriculture and the environment. For example, some atmospheric scientists work on teams with other scientists and engineers to find the best locations for new wind farms, which are groups of wind turbines used to generate electricity. Others work closely with hydrologists to monitor the impact climate change has on water supplies and to manage water resources.

Meteorologists can progress into this career.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Geography, Information Technology.

Further Training

Degree: Atmospheric scientists typically need a BSc or BEng, either in atmospheric science or a related scientific field offered by most universities.

Postgraduate: Atmospheric scientists who work in research usually need a minimum of a master's degree, and preferably a PhD in atmospheric sciences or a related field. Most graduate programmes do not require prospective students to have a bachelor degree in atmospheric science; an undergraduate degree in mathematics, physics or engineering provides excellent preparation for graduate study in atmospheric science. In addition to advanced meteorological coursework, graduate students take courses in other disciplines, such as oceanography and geophysics.

Employment

- Weather Bureau, Department of Environmental Affairs &Tourism
- weather stations all over South Africa
- Department of Agriculture
- CSIR
- universities
- energy providers and traders
- forecast offices of airports and airforce stations

Further Information

Department of Environment Affairs & Tourism
315 cnr Pretorius & Lilian Ngoyi St
Fedsure Forum Building
North Tower, 2nd Floor
Private Bag X447
Pretoria, 0001
Tel: (012) 310-3911
www.environment.gov.za

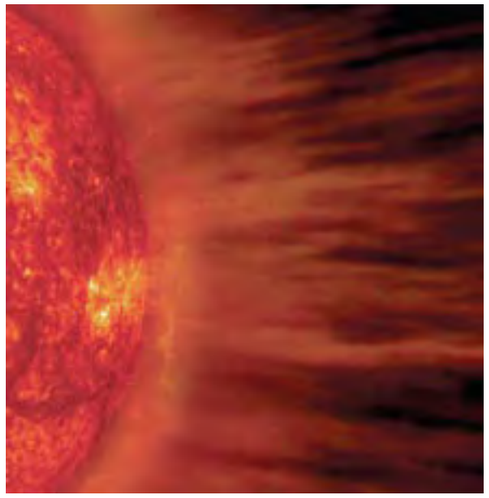
CSIR
P O Box 395
Pretoria, 0001
Tel: (012) 841-2911 Fax: (012) 349-1153
E-mail: enquiries@csir.co.za
www.csir.co.za

South African Weather Service
442 Rigel Ave South
Erasmusrand
Private Bag X097
Pretoria, 0001
Tel: (012) 367-6000
E-mail: webmaster@weathersa.co.za
www.weathersa.co.za

Bethlehem Weather Office
Private Bag X15
Bethlehem, 9700
Tel: (058) 303-5571/2 Fax: (058) 303-2352

Some Related Careers

Astronomer, Ecologist, Geographer, Geologist, Hydrologist, Meteorologist, Oceanographer.



Researcher Katariina Nykyri of Embry-Riddle Aeronautical University, has reported the first detailed description of the mechanism by which solar wind fluctuations can change the properties of so-called space hurricanes, affecting how plasma is transported into the Earth's magnetic shield, or magnetosphere. Gaining deeper insights into how solar wind conditions affect space hurricanes may someday provide better space-weather prediction (The study can be found in the Journal of Geophysical Research - Space Physics - Sept 2017)

GOESR-Weather-Satellite

WASTE MANAGEMENT \ ENGINEER

Waste management engineers organise and manage waste disposal, collection, and recycling facilities. They may also be responsible for waste treatment and street cleaning operations. Some posts combine waste management and recycling functions, while others split them into separate jobs.

Tasks often include overseeing waste management schemes, such as at landfill sites; supervising the transport of waste so that air, land or water sources are not contaminated; assisting with the development, promotion and implementation of new waste disposal schemes; ensuring compliance with current legislation in the transportation, handling and disposal of waste; collating statistics and compiling reports, often to strict deadlines; dealing with enquiries and complaints from members of the public; investigating and following up claims of illegal dumping; consulting with residents, community groups, councillors, housing associations and traders' associations about waste management issues, identifying their requirements and providing appropriate solutions; developing research projects; and contributing to the activities of national groups concerned with waste disposal.

Recycling means the remanufacturing of recovered materials, as opposed to re-use, where the recovered product is simply re-used for similar purposes, e.g. beverage bottles.

Management of Toxic Waste

Recycling of waste involves the separation at source of recyclable materials from the general waste stream and the re-use of these materials.

The objectives of recycling are to save resources as well as to reduce the environmental impact of waste by reducing the amount of waste disposed at landfills. To meet these objectives, waste separation at source is proposed, as the quality of recyclable materials is higher when separated at source. In addition, recycling has the potential for job creation and is a viable alternative to informal salvaging at landfills, which is undesirable due to the problems of health and safety associated with this form of salvaging.

The ultimate aim of recycling is the protection of the environment and public health by reducing the ever-increasing volumes of waste being generated by developing societies, and by reducing the amount of natural resources necessary for the manufacture of any product.

Incinerator and water-treatment plant operators monitor and operate computerised control systems and related equipment in solid and liquid waste treatment plants to regulate the treatment and disposal of sewage and wastes, and in water filtration and treatment plants to regulate the treatment and distribution of water.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Geography, Economics.

Further Training

Degree: BSc with subjects such as mathematics, physics, chemistry, climatology, or BEng Civil Engineering, BTech Civil Engineering.

Diploma: N.Dip. Environmental Science or engineering - universities of technology. BTech Waste Management Certificates in Integrated Waste Management, environmental law, hazardous waste disposal, implementing environmental management standard would be useful.

Postgraduate: **MSc Civil Engineering (with ECSA), or equivalent, followed by PhD.**

Doctoral research may be highly specialised or may follow an integrated approach to the management of water, soil and waste as well as its social impact.

Employment

- municipalities
- waste incineration plants companies
- recycling companies
- industrial organisations
- environmental agencies
- renewable energy companies
- self-employment, as a consultant

Further Information

Institute of Waste Management
Weltevreden Shopping Centre
Corner Kanniedood and Rinyani Streets
Weltevreden Park
P O Box 79
Allen's Nek, 1737
Tel: (011) 675-3462 Fax: 011) 675-3465
E-mail: info@iwmsa.co.za
www.iwmsa.co.za

South African Waste information Centre
Department of Environmental Affairs
Environment House,
Cnr. Steve Biko & Soutpansberg Road,
Pretoria
Private Bag X447,
Pretoria, 0001
Tel: (012) 399-9832/1 Fax:(012) 359-3625
E-mail: sawic@environment.gov.za
sawic.environment.gov.za

Some Related Careers

Civil Engineer, Energy Plant Manager, Gas or Petroleum Controller, Power Plant Controller, Planning Engineer, Refuse Remover, Scrap Merchants.

Bales of compressed plastic bottles at a recycle station

Modern urban wastewater treatment plant

Recycling plant for scrap metal

Sharmila Goedhart

Sharmila was born in Paarl and grew up in Cape Town. Her parents moved around quite a bit, so she attended various schools as a child. She matriculated from Rylands High School.

Sharmila completed all of her degrees in physics, with a specialisation in astronomy at master's and PhD level. She completed a BSc and BSc (Hons) majoring in physics at UCT and an MSc at North-West University, Potchefstroom. She completed her PhD while based at HartRAO, registered at North-West University.

She is currently working as the Senior commissioning scientist for the Square Kilometre Array project (SKA).

Sharmila was always interested in science as a child. She was encouraged by her maths and science teachers. As a child she read a lot of popular science books and was inspired by the writing of Isaac Asimov, Arthur C. Clarke and Carl Sagan.

Shamila has a wide variety of interests: "I am a creative person and like to try out various arts and crafts. My current hobbies include jewellery making (beaded and metal-working), lapidary and drawing. My workroom is cluttered with various supplies and unfinished projects. I am married, and have two dogs that are terribly spoilt".

Meet an Astronomer

Whilst growing up Shamila had a number of challenges to face: "I had an autistic brother and it was very difficult for our family to cope with him. I think I used to escape into books as a way of dealing with it. We were not very well off, but my father always made sure I had what I needed for my education. He saved up for two years to buy me my first computer which I used from standard 9 and through my undergrad degree. Fortunately I had a bursary when I went to university. University was a lot harder than school - I really had to work very hard but I enjoyed it".

" We were not very well off, but my father always made sure I had what I needed for my education. He saved up for two years to buy me my first computer which I used from standard 9 and throughout my undergrad degree".

Shamila's advice for young people is to keep on going despite the difficulties one faces: "Don't be afraid to ask questions, and if your teachers can't answer them, go out and find the answers for yourself. We all have bad days, and sometimes the work load just seems impossible. I wanted to make something of my life and failure was never an option for me".

"I believe in being myself and never giving up ... if something is worth doing, then it is worth doing well".

Shamila's goal is to make a difference in life and make a positive contribution to society. "As a scientist I want to increase our knowledge of the Universe".

Shamila couldn't chose one role model who had inspired her, she said there were so many people who had motivated her by overcoming their hardships and achieving great things.

Audrey Dikgale

Audrey is from a village called Ga-Dikgale, and grew up in Polokwane, where she attended Taxila Secondary School which is part of an Indian Community called Nirvana. She studied a BSc majoring in physics and applied mathematics at the University of Limpopo.

Audrey is a Telescope Operator at the SKA Engineering Office control room (currently operating KAT-7), in Pinelands, Cape Town. She does sometimes visit the SKA site in the Karoo where she interacts with technicians and infrastructure teams on-site. Her choice of career was influenced by the fact that she never wanted to be office bound. "I always hoped I would get the best of both worlds, i.e. working in the field and the office".

Audrey has always performed well in physics and maths especially at high school. She admits that she was never good at history or accounting. She loves science because it explains everyday life situations. Audrey loves new challenges and embraces change. Her goal is to finish her honours degree in Astonomy then to do a masters degree. She hopes to be a great SKA scientist and to be able to make a difference in the lives of young girls from disadvantaged backgrounds.

"I guess, with regards to where I originally came from, I wanted to be an example, proving that no matter where you come from, you can make it if you believe in yourself".

Audrey says that there were many challenges when growing up: " I, being the first born, always felt the pressure to be

Meet a Telescope Operator

responsible from a young age, and had to take care of my younger sister when my mom could not do it". Audrey acknowledges that her mother played a big role in her success. "My mother definitely pushed me hard and helped where she could, and always told me that with education you can't go wrong, you will never struggle. That definitely pushed me hard because I did not want to struggle as an adult".

"Science opens doors and explains how everyday life works. It also clears up most myths that are believed by people in rural areas, like rainbows are those things that God puts up to stop the rain!"

"Science is a broad discipline; it allows you the opportunity to discover any dicipline you would like to go into. Science opens doors and explains how everyday life works. It also clears up most myths that are believed by people in rural areas, like rainbows are those things that God puts up to stop the rain!".

Audrey says that there were some difficult points in her studies when she felt like giving up. "There was a lot of pressure during exam times. I think the problem was the fact that I never wanted to fail in anything I took part in".

Audrey believes in being true to herself. Her motto in life is: "Never give up ... you cannot be defeated by something that cannot speak".

Audrey's role model is Oprah Winfrey. "She is a very strong woman. Growing up watching her, has also taught me a lot, but most of all, the blessing of giving without expecting anything in return. She created an empire out of nothing; with no formal education; bad family history; abuse, and rose above it all to become a woman that other women can identify with, and look up to. I admire her strength, her work ethic, her generosity, and her wisdom".

Audrey still does outreach at schools, and feels that what will give her the reward, is knowing that she has planted a seed where there seemed no hope.

SKA in South Africa

Africa's share of the iconic SKA (Square Kilometre Array) project means that the continent is set to become a sought-after science destination.

South Africa is hard at work to make the SKA a reality. Construction on the MeerKAT telescope, an array of 64 dishes, is scheduled for release in 2018. The SKA has already led to the detection of dozens of new galaxies, which have never been spotted before. .

Why is it called the "SKA"?

The joint collecting area of all the receivers that make up the SKA add up to one square kilometre – that is why the instrument is called the "Square Kilometre Array".

The SKA – what, who and where?

Thousands of SKA dishes will be constructed in South Africa (in the Karoo, not far from Carnarvon), with outstations in eight African partner countries, namely Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia. All these dishes are in remote locations, where they are best protected against man-made electronic signals that interfere with faint radio signals from the distant Universe.
More SKA dishes, as well as the so-called "sparse aperture array" consisting of thousands of low frequency antennae are being built in Western Australia.

MeerKAT antenna construction in March 2014

What does the SKA look like?

The SKA is made up of three different kinds of antennas which are designed to work at different frequencies.
The three types of antennas are:

- Dishes – looking more or less like a DSTV antenna, but much bigger – about 13 m in diameter
- Huge, flat disk-shaped antennas – about 60 m wide
- Small upright radio antennas – about 1,5 m high

Cutting-edge Science

Over the next decades, many top scientists and research students will use the SKA, an instrument powerful enough to sense radio waves from objects millions or even billions of light years away (a light year is the distance light can travel in one year, at a speed of 300 000 km/s), to help us understand how stars and galaxies form and change and what "dark matter" really is.
Once complete, the thousands of SKA dishes and other types of radio receivers will work together as one gigantic, virtual instrument that will be 50 times more powerful and 10 000 times faster than any other radio telescope in existence.

Who pays for the SKA?

While the SKA is being built in Africa and Australia, the involvement is global. SKA member countries around the world are helping to design, construct and operate the instrument and will also share the cost. In South Africa, funding for the project comes from the Department of Science and Technology, via the country's National Research Foundation.

Skills for the future

The SKA will collect and process vast amounts of data and will stimulate cutting-edge advances in high-performance computing. Producing the thousands of dishes required for the SKA within the project's time scales will also demand an entirely new way of building highly sophisticated and sensitive scientific instruments – that should lead to new innovations in manufacturing and construction. This mega-project is therefore an ideal platform to excite young people about a career in science, engineering and technology and to deliver skills that will be in demand in the global knowledge economy of the future.

Job creation

The SKA SA Project invests in developing skills through its dedicated Human Capacity Development Programme. To date, the project has created a total number of 7 284 direct and indirect jobs for the local community. Some of the jobs were created through the building of the new road leading to the SKA core site, 90 km away from the Carnarvon town, almost halving the time it took to travel to the core site on a gravel road.

Follow SKA South Africa on www.facebook.com/skasouthafrica or go to **www.ska.ac.za** for newsletters, photos, videos and more.

The SKA will collect and process vast amounts of data and will stimulate cutting-edge advances in high-performance computing. After the International Space Station and the Large Hadron Collider, the SKA is the world's next great science project.

It is anticipated that the SKA will help answer some of the world's biggest mysteries like the origins of the universe.

Find out more at **www.ska.ac.za/students.**

COOL FACTS ABOUT SKA

- The data collected by the SKA in a 24-hour period, would take nearly two million years to play back on an iPod.
- The SKA will generate enough raw data every day to fill 15 million 64 GB iPods.
- The SKA central computer will have the processing power of about one hundred million PCs.
- The SKA will use enough optical fibre to wrap twice around the Earth.
- The dishes of the SKA will produce 10 times the current global internet traffic.
- The aperture arrays will produce more than 100 times the current global internet traffic.
- The SKA super-computer will perform 1018 (1 000 000 000 000 000 000) operations per second – equivalent to the number of stars in three million Milky Way-size galaxies.

EARTH SCIENCES

Earth Sciences refer to the study of the planet earth. Many would argue that the earth sciences are in fact a specialisation of the planetary sciences. The earth sciences, however, do carry a special significance, not only because they deal with the planet on which we live, but also because the earth is the only known life-bearing planet in our universe.

The earth sciences are also known as “geosciences”.

Earth scientists are both historians and futurists in that they try to understand how the earth evolved to the way it is now, in order to try to predict events in the future. To do this, earth scientists use a holistic assortment of the sciences including mathematics, chemistry, physics and biology.

There are many areas of specialisation within the earth sciences, such as geology, physical geography, geophysics, soil sciences, oceanography, glaciology and atmospheric sciences, to name a few.

Each of these areas has its own specialisations. For example, the atmospheric sciences have sub-specialisations such as atmospheric gases, meteorology, climatology, and so on.

Earth scientists can work in a laboratory setting or in the field, or as is often the case, in a combination of the two. Certain types of field work can be quite dangerous yet also exciting, for example when one studies volcanoes, tropical weather patterns, glaciers, atmospheric gases, and so forth.

Field work involves the collection of physical samples and then the analysis of these samples.

Earth sciences is becoming an increasingly important area of study, with vital research conducted into topics such as global warming, sustainable development and general atmospheric sciences. These are all very important for our long term survival on earth.

EARTH SCIENCES STUDY PATHS

National Senior Certificate:
With Mathematics
and Physical Science

Each education institution has its own unique entry requirements for each of its programmes. It is important to check the entry requirements for the programme with the institution of your choice before you apply.

University
Bachelor of Science Degree

Majors in:
Geology
Geography
Mathematics
Physics
Environmental Sciences
Oceanography
Geo-informatics
or any other related subject
offered by the university.

University of Technology
National Diploma

Diploma in:
Chemistry
Engineering
Oceonography
Surveying
Mathematics
Environmental Sciences
Agriculture
or any other related qualification offered by the University of Technology.

Internship / Workplace Experience

Workplace experience is a requirement for the completion of a national diploma at a university of technology.

Postgrad

A postgraduate degree or diploma is needed in order to specialise. Each institution will have specific areas that they will promote. With regards to the earth sciences these specialisation areas may include:
Active tectonics
Earthquake hazards
Geo-informatics
Magma and volcanoes
Cenozoic oceans
and many more.

University of technology students who intend doing postgraduate studies at university will first need to check the acceptance requirements with the university concerned. Students studying a national diploma will need to complete a Bachelor of Technology Diploma and / or a Master of Technology degree as a requirement for entry.

AIR POLLUTION ANALYST

An air pollution analyst is someone who is trained to research, inspect and investigate levels of air pollution, and to take the necessary steps to ensure good air quality so that public health concerns are addressed.

Air pollution analysts conduct research, perform tests, collect samples, and perform field and laboratory analysis to identify sources of environmental problems and recommend ways to prevent, control and remedy these problems.

Air pollution analysts assess the likely impact that potential activities, projects and developments may have on the environment, and recommend whether such developments should proceed. They develop and coordinate the implementation of environmental management systems to enable organisations to identify, monitor and control the impact of their activities, products and services on the environment. They conduct audits to evaluate the environmental impact of existing activities, processes, wastes, noises and substances.

They assess the compliance of an organisation with government and internal environmental regulations and guidelines, and they identify violations and determine appropriate remedial action. They provide technical advice and support services to organisations on how best to deal with environmental problems in order to reduce environmental damage and minimise financial loss. They develop conservation plans.

Air pollution analysts may work in indoor environments to determine the air quality in homes, businesses and government offices. They can work for companies that serve private citizens, or for government agencies that monitor conditions in the workplace.

Those who work outdoors typically work for government agencies to monitor compliance with air quality regulations. They may use specialised equipment to measure air pollution, determine whether businesses are in compliance with local, municipal and government air quality regulations, and issue warnings to companies that do not comply.

Although air pollution control specialists can be found in all parts of the country, most work in urban areas where industry and traffic are heaviest.

Air pollution analysts therefore play a key role in evaluating and reducing the impact of air pollution on people and ecological systems.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course, where appropriate.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

There are various possible pathways for this occupation.

Degree: BSc Geography and Environmental Health Management – most universities.
BSc Chemistry – all universities.
BChemical Engineering - most universities.

Diploma: N.Dip. and BTech Environmental Health – universities of technology.

After completion of the National Diploma in Environmental or Public Health, the graduate could register with the Health Professions Council of South Africa (HPCSA) as an Environmental Health Practitioner, and then practise as an Environmental Health Practitioner in environmental pollution control.

Postgraduate: **BSc Hons or BScEng can be followed by MSc and PhD with coursework, and research into an area of interest.**

Areas of specialisation for PhD studies include: Environmental Pollution and Remediation; Marine Conservation, Wetland Science for Pollution Control; Oil and Gas Management; Acoustic and Noise Control, Marine Biodiversity and Biotechnology; Marine Planning for Sustainable Development; Climate Change.

Employment

- government and state departments
- laboratories, research institutions
- tertiary institutions such as universities
- non-profit organisations engaged in combating or preventing pollution
- self-employment, as a consultant

Further Information

National Association for Clean Air (NACA)
P O Box 8370
Halfway House, 1685
17 Riverview
Brakfontein Road
The Reeds
Centurion
Tel: 071 683 9770 Fax: 086 513 7490
www.naca.org.za

South African Education and Environment Project
B15 Waverley Court
7 Kotzee Road,Mowbray, 7700
Tel: (021) 447-3610
www.saep.org

SGS South Africa (Pty) Ltd
Huawei Office Park
Building No 1
Western Service Road
Woodmead, 2191
Tel: (011) 800-1000
www.sgs.co.za

Integrated Environmental Management (IEM)
Provides a philosophy that is concerned with finding the right balance between development and the environment. It provides a framework of published guidelines (available from the Department of Environmental Affairs and Tourism) to ensure that environmental considerations are addressed.
http://www.enviropaedia.com

Some Related Careers

Environmental Health Officer, Health Inspector, Occupational Hygienist, Water Care Technologist.

CARTOGRAPHER

Cartographers draw up and revise maps of the earth's surface, and make this information available to the user in a format that is easy to use.

Cartographers work closely with surveyors and geologists and make use of a number of sources for their work, including aerial photographs, field reports, historical manuscripts and other charts and statistical reports. They produce charts using photolithography, drawing and etching techniques. They also work with computer programs and photogrammetry (the science of accurately plotting maps and plans from photographs taken with calibrated cameras, usually from the air, but occasionally also from ground stations), which give a three-dimensional perspective of the landscape.

Cartography is concerned with four different map processes:

- linework: sketching lines and engraving
- colour separation: the preparation of different masks for each separate colour for multi-colour maps)
- positioning of letters and symbols
- reproduction of maps

The types of maps produced depend on the purpose for which the maps are required. These may include:

- topographical maps
- maritime charts
- cadastral maps that show farm boundaries
- climatic maps indicating variance in climatic parameters
- road maps, street plans and tourist maps
- geographical and geological maps
- town and regional structure plans
- aeronautical charts and maps, which indicate routes and provide navigational information.

Cartographers usually work in well-equipped offices. The sophistication and standard of the equipment depend on the financial resources of the employer.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.
Each institution has its own entry requirements.
Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Geography.

Further Training

Aspirant cartographers apply for posts as learner drawers with potential employers. If accepted, they undergo theoretical training at a university of technology and practical training with the employer concerned, under the supervision of an experienced cartographer.

Diploma: National Diploma: Cartography is a 3-year course offered at universites of technology. Students receive 2 years' theoretical training at the university of technology and 1 year's practical training with their employer. In some institutions, students have the option to study for a fourth year to obtain a BTech.

Degree: BSc Geomatics, BSc Landsurveying

Postgraduate: **GIS (Geomatics) is offered at Honours and Masters level. Areas of specialisation for PhD studies include: Aviation Cartography; Public Policy and Admisitration; Geodesy and Cartography and Geoscience and Geomatics.**

Employment

- various government departments
- large municipalities
- private concerns
- mining companies
- photogrammetric enterprises
- universities and universities of technology
- research institutions
- self-employment on a contract basis

Further Information

National Geo-spatial Information (NGI)
Department of Rural Development and Land Reform
Van der Stel Building,Rhodes Ave
Private Bag X10
Mowbray, 7705
Tel: (021) 658-4300 Fax: (021) 658-4301
Email: ngi@drdlr.gov.za
www.ngi.gov.za

Some Related Careers

Architect, Architectural Technologist, Draughtsman, Geodetic Surveyor, Hydrologist, Land Surveyor, Topographical and Engineering Surveyor.

CLIMATE CHANGE ANALYST

Climate change analysts evaluate scientific data and carry out research on the climate. The climate data often includes, but is not limited to, information about atmospheric temperature, ocean conditions, ice masses and greenhouse gases. Climate change analysts use this data to create models and to predict probable changes in the earth's climate in the future, as well as what impacts, if any, these changes may have on natural ecosystems and civilisations. They evaluate both the economic and physical impacts of such changes.

Climate change analysts have to be well-versed in both science and policy, typically focusing mainly on either one aspect or the other. Climate change analysts who focus on science are more heavily involved in detailed mathematical modelling of the scientific data. They collaborate closely with the scientists who gather the climate data and work with them to analyse the information and put it in the context of current environmental practices. They might also model how changes to existing government policies could alter the effects of climate change.

Climate change analysts who focus on policy deal less with primary data; and instead, concentrate more on evaluating the published body of climate data in order to draw conclusions and make predictions from multiple studies. These predictions are used to lobby for or against proposed policy changes. They spend a lot of time communicating their findings to non-scientific audiences such as lawmakers and corporations, as well as the general public.

Climate change analysts mainly work indoors. A substantial amount of their time is spent working on a computer, analysing data and writing research papers and speeches.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Compulsory Subjects: Mathematics, Physical Sciences
Recommended Subjects: Life Sciences, Economics, Geography

Further Training

Degree: A bachelor's degree in environmental science, or a related field with an emphasis on studying weather data or the environment and resource conservation, is necessary. Students' courses should include Public Policy and Economics.

Postgraduate: **Students who would like to concentrate more on the science and mathematical modelling aspects of climate change analysis would need a graduate degree (masters or PhD), with courses including Mathematics, Statistics, Computer Science and Physics.**

Employment

- research organisations and institutions
- government departments
- meteorogical departments

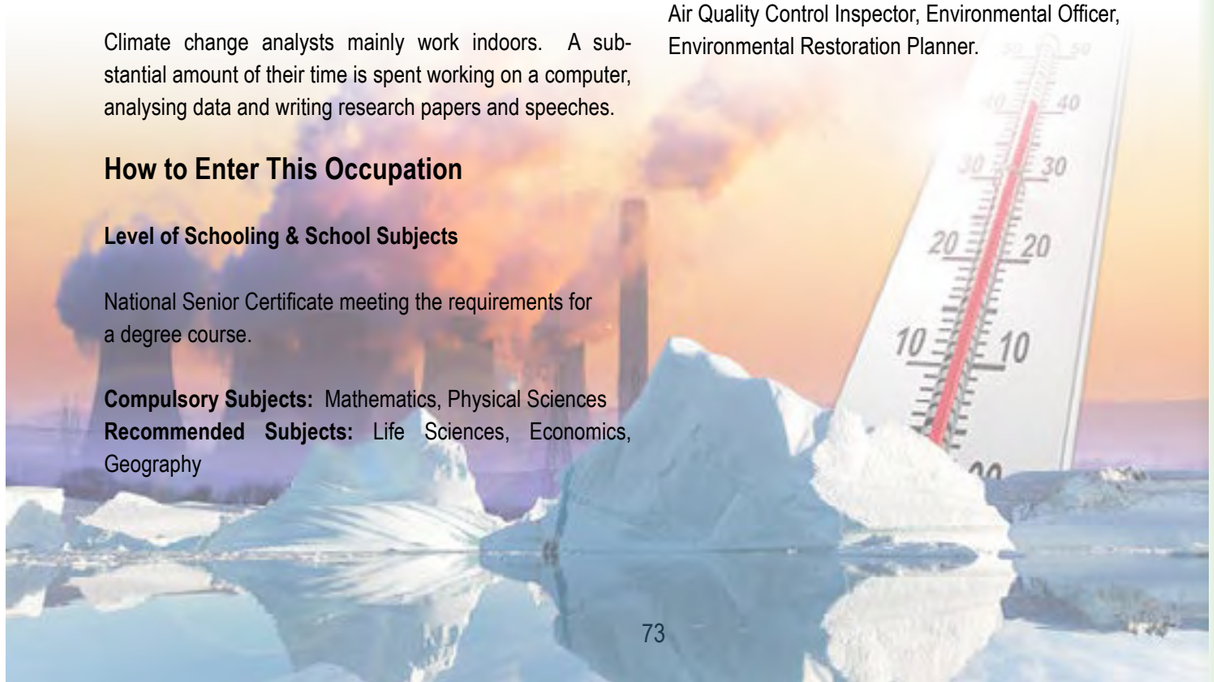
Further Information

Climate Change (World Bank)
www.worldbank.org/en/topic/climatechange
Climate Change Knowledge Portal
http://sdwebx.worldbank.org/climateportal

The Daily Climate
E-mail: feedback@ehsciences.org
www.dailyclimate.org

Related Careers

Air Quality Control Inspector, Environmental Officer, Environmental Restoration Planner.



GEOLOGIST

Geologists conduct theoretical and applied research to extend knowledge of the surface and subsurface features of the earth, its history, and the operation of physical, chemical and biological systems that control its evolution.

Geologists conduct programmes of exploration and research to extend knowledge of the structure, composition and processes of the earth and to locate and identify hydrocarbon, mineral and groundwater resources. They also plan and implement programmes of hydrocarbon and mineral extraction, and they assess and mitigate the effects of development and waste disposal projects on the environment.

These scientists plan, direct and participate in geological, geochemical and geophysical field studies, drilling and geological testing programs, and seismic, electromagnetic, magnetic, gravimetric, radiometric, radar and other remote sensing programmes. They also plan, direct and participate in the analysis of geological, geochemical and geophysical survey data, the analysis of core samples, drill cuttings and rock samples in order to identify chemical, mineral, hydrocarbon and biological composition, and also in the analysis of well logs, other test results, maps, notes and cross-sections.

Geologists develop applied software for the analysis and interpretation of data. They assess depositional environments and geological age, and they assess the size, orientation and composition of mineral ore bodies and hydrocarbon deposits.

They also identify deposits of construction materials and determine their characteristics and suitability for use as concrete aggregates, road fill or other applications. They assess the movement of ground and surface waters, and they advise in areas such as waste management, route and site selection, and the restoration of contaminated sites.

Geologists recommend the acquisition of land, exploration and mapping programmes, and mine development, and they conduct geological and geophysical studies for regional development, site selection and the development of public works projects.

Geologists identify and anticipate natural risks, such as slope erosion, landslides, soil instability, subsidence, earthquakes and volcanic eruptions, and they may supervise and coordinate well drilling, completion and work-over, as well as mining activities.

Geological research helps in locating mineral deposits, predicting earthquakes, and advising on the suitability of sites for buildings, dams and highways. The knowledge obtained is also used in a wide variety of ways, from determining the components of plaster on walls of buildings where lime and other mixtures are used, to the discovery and refinement of oil and other energy sources.

Geology is a very broad-based science, which draws from virtually every other science including the natural, engineering and economic sciences. There are various careers within the field of geology, for example: cartography, economic geology, environmental geology, engineering geology, geochemistry, geotechnology, geohydrology, geophysics, mineralogy, mining geology, palaeontology and petroleum geology.

Areas of specialisation

The broad areas of specialisation within this field include earth material, earth processes and earth history. The sub-specialities include economic geology, mineralogy, geochemistry, geophysics, palaeontology, marine geology, mineral economics, engineering geology and environmental planning.

Basic mapping: is the drawing of a map on which geological information, such as the distribution of different rocks, is shown. This is one of the most important tasks of geologists.

Economic geology: studies the deposit of economic minerals and processes leading to their formation.

Environmental geology: studies recent sediments deposited in river valleys, on beaches and in the oceans, in order to acquire information on aspects such as climatic changes, erosion of coastlines and the influence of human activities on the environment.

Geological engineers: study the physical and chemical properties of rocks and soil in order to ensure that dams, roads, tunnels and buildings are built at the most suitable sites and in the most cost-effective manner. They also study materials used in road construction.

Geohydrologists: study the water-storing capacity of various geological formations and the flow of groundwater in these formations. The development of cavities in rocks through cracks and faults as well as the chemical solution of rocks are also studied by geohydrologists. Postgraduate study and specialisation at an honours degree level is essential for a career as a geohydrologist.

Palaeo-scientists: study fossils to make deductions concerning the climate that prevailed during deposition and the environment where the organisms occurred. This information is used to understand the origin and formation of certain minerals in sedimentary rocks and to find further resources. The study of fossils also contributes to our knowledge of factors that led to species extinction and the origin of new species.

Geologists work in a variety of settings. They may work outdoors at a site under investigation, with conditions varying from sub-zero temperatures to the scorching heat in a desert. In addition, they may work indoors in laboratories, offices and classrooms.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences, Geography, Economics, Information Technology.

Further Training

Degree: BSc with geology as a major - available at most universities. Geological science or geoscience; a second major in chemistry, physics or mathematics is recommended. Computer science and statistics are also useful majors with geology because of the rapidly growing application of these fields.

Some universities specialise at the BSc (Hons) level in subjects such as geochemistry, geohydrology, geophysics, sedimentology or engineering geology.

The minimum qualification required for registration as a Professional Natural Scientist (Geology) at the South African Council for Natural Scientific Professions, is a BSc (Hons) degree or a four-year BTech degree in geology from a university of technology.

Postgraduate: Postgraduate study (for master's and doctor's degrees) is possible at most South African universities. Areas of specialisation for PhD studies include: Geoscience; Earthscience; Environmental Science and Geology.

Those who study at universities of technology register as geotechnologists and work closely with geologists in various fields.

Employment

- petroleum and mining companies
- consulting geology, geophysics and engineering firms
- government departments (Geological Survey, Water Affairs, Museums)
- Chamber of Mines
- CSIR
- Council for Mineral Technology (MINTEK)
- civil engineering firms
- universities of technology and universities
- self-employment, as a consultant

Further Information

Geological Society of South Africa
P O Box 91230
Aukland park, 2006
Tel: (011) 358-0028
Email: info@gssa.org.za
www.gssa.org.za

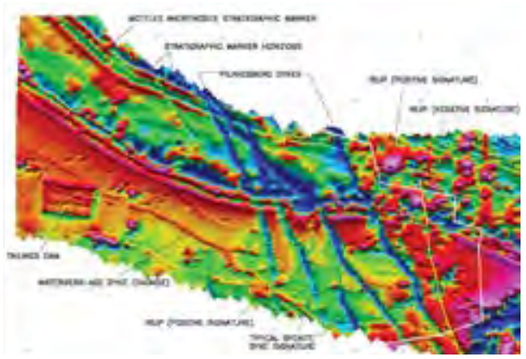
Council for Geoscience
Private Bag X112
Pretoria, 0001
Tel: (012) 841-1911 Fax: (012) 841-1221
www.geoscience.org.za

Some Related Careers

Agricultural Economist, Agronomist, Ecologist, Geographer, Hydrographical Surveyor, Meteorologist, Mineralogist, Oceanographer, Physicist, Sedimentologist.

GEOPHYSICIST

Geophysicists study the earth's physical features, including its atmosphere and hydrosphere. They examine and measure seismic, gravitational, electrical, thermal and magnetic forces, using the principles of physics, mathematics and chemistry.



Exploration of the Bushveld

Geophysicists analyse data to compute the earth's shape, estimate the composition and structure of the earth's interior, determine flow patterns of ocean tides and currents, and help locate petroleum and mineral deposits. They investigate the origin and activity of volcanoes, glaciers and earthquakes.

They compile data to prepare navigational charts and maps, predict atmospheric conditions, prepare environmental reports, and establish water supply and flood control programmes. Some may also study other planets. Solid earth, fluid earth and upper atmosphere are three general fields of geophysicists.

Geophysics involves the use of a number of techniques used to solve specific problems. The most important of these are the gravity technique, the magnetic method, seismic techniques, electric and electromagnetic methods, and radiomagnetic methods.

Geophysicists generally spend a certain percentage of their time in the field carrying out geographical measurements, while the rest of the time is spent in the laboratory or office, processing, interpreting, modelling, evaluating and reporting the results.

How to Enter This Occupation

Level of Schooling & School Subjects
National Senior Certificate meeting the requirements for a degree course.
Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Science.
Recommended Subjects: Geography.

Further Training

Degree: BSc majoring in geography - all universities, or majoring in geography and environmental management / Sciences / Studies.

Also courses available at universities of technology.

The entry requirement for this career is a BSc (Hons) in Geophysics or Physics.

Postgraduate: BScHons Geophysics is one option. Areas of specialisation for PhD studies include: Climate Change; Data Science; Geo-Resources Engineering and Ocean Science.

Employment

- mining groups
- government departments (Geological Survey, Water Affairs)
- Chamber of Mines
- research institutes, such as CSIR
- universities of technology and universities
- consulting companies
- Mintek
- self-employment, as a consultant

Further Information

Geological Society of South Africa
P O Box 91230
Aukland park, 2006
Tel: (011) 358-0028
Email: info@gssa.org.za
www.gssa.org.za

Council for Geoscience
Private Bag X112
Pretoria, 0001
Tel: (012) 841-1911
E-mail: info@geoscience.org.za
www.geoscience.org.za

Some Related Careers

Astronomer, Biophysicist, Chemist, Ecologist, Geographer, Geohydrologist, Geologist, Metallurgical Engineer, Meteorologist, Mineralogist, Oceanographer, Palaeontologist, Physicist.

Time-domain electromagnetic sounding in southern Nevada. Sarah Gonzalez (SwRI) operates the Geonics Protem.
<http://www.boulder.swri.edu/~grimm/>

Installing CRANE workstations. Top: Connecting a seismometer (in the plastic vault) to a digitiser that converts signals into electronic data. Both units will be buried underground. Bottom: Mounting the solar panels that power the CRANE workstations. (Photos supplied by Jeff Gu.)
< http://www.physics.ualberta.ca/Physics%20News/2012/June/GeophysicsprojectconnectswithcommunitiesacrossAlberta.aspx>

GIS SPECIALIST

Geographic information systems (GIS) specialists use specialised computer programs and software to create maps. The world of cartography (map-making) has undergone significant changes in the last decade, mostly revolving around the emerging technology of GIS, a type of software that can combine socio-economic, demographic, political and environmental data. GIS specialists use this software to create maps or graphs.

A geographic information systems specialist uses computer software to create maps with geographical data.
< http://www.ehow.com/about_7221610_job-description-gis-specialist.html>

GIS specialists consult with users to identify the needs of their project and determine the necessary applications. They conduct research and locate any existing databases that may help with the project. They gather and analyse data and determine how best to display it using GIS software.

The data they collect may come from a number of different types of sources, such as aerial photographs, existing maps, satellite photography and field analysis. They apply their knowledge of spatial feature representations to design appropriate databases. They often use digitizers or direct inputs to enter and coordinate information about the land. They are also responsible for maintaining the various GIS equipment, including plotters, digitisers, colour printers and video cameras.

A GIS specialist creates geographic maps containing political borders, transportation networks and environmental resources by using computer software programs. He/she is responsible for developing and maintaining geographic, political and environmental databases that are pertinent to the region.

The specialist must design and update GIS databases using various mathematical techniques, such as coordinate geometry and real analysis.

GIS specialists usually work in clean, well-lit and well-ventilated offices. They generally work in their own cubicle equipped with computers and automated mapping equipment. Some GIS professionals do fieldwork to collect data.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting requirements for a degree course

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Geography, Information Technology.

Further Training

Degree: BSc or BEng in engineering, forestry, geography, physical sciences or a related discipline, specialising in computer science, e.g. BSc (Geomatics) in Geoinformatics; BSc double major degree, GIS together with any other science / agriculture course. GIS is offered at Honours and master's level.

Postgraduate: MSc, followed by doctoral degree. Areas of specialisation for PhD studies include: Aviation Cartography; Public Policy and Admisitration; Geodesy and Cartography and Geoscience and Geomatics.

It is important for GIS specialists to keep up with new technology and practices in the field through extension courses and professional association seminars.

Employment

- government agencies
- utility companies
- architectural engineering firms
- urban planners
- natural resource management companies
- self employment as a consultant

Further Information

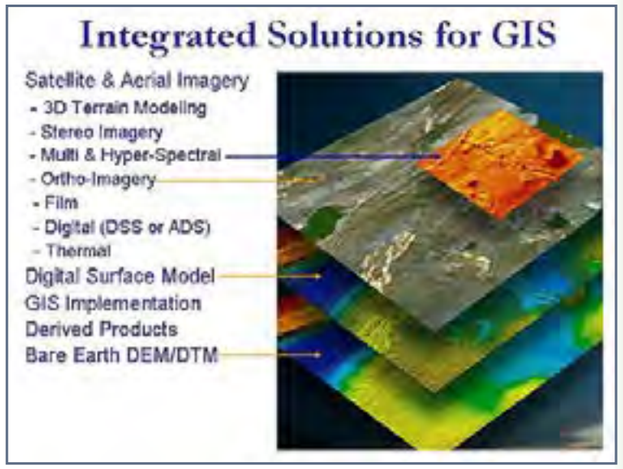
Geo-Information Society of South Africa
www.gissa.org.za

South African Geomatics Institute
Secretary
P O Box 201446
Durban North, 4016
Tel: (031) 563-9481
Fax: (031) 563-5254
www.sagi.co.za

National Geo-spatial Information (NGI)
Department of Rural Development and Land Reform
Van der Stel Building,Rhodes Ave
Private Bag X10
Mowbray, 7705
Tel: (021) 658-4300 Fax: (021) 658-4301
Email: ngi@drdlr.gov.za
www.ngi.gov.za

Some Related Careers

Cartographer, Computer Aided Drafting Operator, Geographer, Town Planner.



<http://www.satimagingcorp.com/svc/gismapping.html>

Digitising maps at the ESRI international user conference.
June 18, 2007 in San Diego, California.

HYDROLOGIST

Hydrology is a field of study that focuses on the management of water. A hydrologist makes an accurate assessment of the available water and future needs, and makes recommendations on long-term management practices.

Hydrologists study and do research on the earth's water how it is distributed on and below the surface of the earth as well as in the atmosphere. They try to secure the optimal utilisation of the country's water resources by advising civil engineers on the flow of rivers and where to build the most economical water schemes, to ensure that sufficient water of acceptable quality can be supplied in the most cost-effective manner.

Hydrologists also advise design engineers on the frequency and magnitude of floods in order to minimise flood risks and to ensure the best operation procedures for flood control and drought periods. They identify underground water as sources of water supply, evaluate the effect of human activities on the quantity and quality of water, and study the interaction between components within the hydrological cycle.

Water is a scarce commodity and part of the job of a hydrologist is to identify problem areas and make recommendations as to how these problems should be solved. A hydrologist should understand the needs of water users, including agricultural, domestic and industrial users, as well as the possible options available for water resource development.

Work is not confined to an office, but includes short periods of fieldwork. For geohydrologists, fieldwork is particularly important. A great deal of work is done outdoors when visits are made to catchment areas, rivers, dams and consumer areas for observation. Work indoors is carried out in offices and laboratories where field information is received, analysed and interpreted, and where water is tested for its chemical, physical and biological quality.

Office work also includes administrative duties such as the compilation and editing of reports, the processing of data, liaison with clients, and planning of new projects.

How to Enter This Occupation:

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Geography.

Further Training

Degree: BSc majoring in one of the following: hydrology, geology, geography, biochemistry, microbiology, chemistry, engineering, statistics, computer science, applied mathematics, mathematics or physics. Hydrology or groundwater studies courses can be followed.

Postgraduate: for appointment as a hydrologist, the minimum requirement is an honours degree, with one or more of the following as the principal field of study:

- **Applied Hydrology: Computer Science, Operations Research, Statistics, Civil Engineering**
- **Geohydrology: Geology, Geohydrology, Geophysics, Geochemistry, Applied Geophysics and Mathematics**
- **Hydrological Research: Chemistry, Soil Physics, Botany, Zoology, Geography**
- **Basic fields of study: Hydrology, Mathematics, Applied Mathematics, Physics, Geography, Chemistry**
- **Water Quality: Botany, Zoology, Microbiology, Chemistry and Limnology.**

The Department of Water Affairs and Forestry offers an in-service training programme in the following form:

- Internal lectures
- Seminars
- Field training
- Computer programming
- Analytical methods

Further Information

Hydrological Services
Department of Water Affairs
Private Bag X313
Pretoria, 0001
Tel: 0800 200 200
www.dwaf.gov.za

Water Institute of South Africa
1st Floor, 5 Constantia Park 546
16th Road
Midrand
P O Box 6011
Halfway House, 1685
Tel: 086 111 9472
www.wisa.org.za

Employment

- Department of Water Affairs and Forestry
- CSIR
- water boards and municipalities
- universities and universities of technology
- engineering firms
- self-employment; a skilled hydrologist can open a private practice and act as a consultant

Some Related Careers

Biologist, Chemist, Civil Engineer, Ecologist, Geologist, Geohydrologist, Meteorologist, Physicist.

USGS hydrologists sampling plants in the Everglades. <http://pubs.usgs.gov/fs/FS-010-99/html/fig02.html>

Water samples being collected from a natural stream to evaluate the quality of the water.

Sac State hydrogeologist Professor Tim Horner monitors steelhead trout spawning grounds on the American River. <http://www.csus.edu/news/080107fish.stm>

OCEANOGRAPHER

Oceanographers study the sea and all its different facets, such as the sea floor, marine life, ocean currents, the physical and chemical composition of the water, and also the air above the ocean. The entire field, including the deep ocean and the continental shelf regions, as well as the shore with its dunes and the tidal rivers, fall within the sphere of activity of oceanographers.

Sylvia Earle - an oceanographer, explorer, author, and lecturer.
(Photo supplied by Bates Littlehales)
< http://www.nationalgeographic.com/explorers/bios/sylvia-earle/ >

Oceanographers carry out geological, geophysical and geochemical surveys, as well as research into the dynamics of ocean currents, the interaction between wind and waves, and temperature and humidity on the water surface.

Areas of specialisation

Marine Biology: This involves all aspects of plant and animal life in the sea. Marine biologists study the occurrence, distribution and development of plants and animals and how they are influenced by environmental factors.

Physical Oceanography: Physical oceanographers study the physical properties of water, such as temperature, salt content and density and phenomena such as currents, waves and shores. They also study the interaction between the sea and the air above it and how this influences the weather and climate.

Marine Geoscience: Geological oceanographers are concerned with the processes involved in the formation of the sea floor and coastline, underwater land formation and the physical composition of the ocean floor, and current processes of erosion, sedimentation and silting.

Marine Chemistry: Chemical oceanographers study the chemical composition of seawater and the effect of chemicals on the marine environment. Pollution of seawater offers new challenges to chemical oceanographers to determine the influence of that pollution on the quality of the water.

Coastal and Ocean Engineering: This is the application of engineering techniques to the coastal zone. It is essentially a branch of civil engineering that interfaces with the marine sciences. It involves the development and maintenance of harbours, coastal recreational facilities, inlet pipes for seawater, effluent outfalls and the general management of the coastal zone.

Oceanographers also work in laboratories on land, but, by the very nature of their work, they periodically work on a research ship or smaller boat. The development of underwater respiratory apparatus, specialised diving equipment, research submarines and deep-sea vehicles makes it possible for the oceanographers to stay under water for long periods and do research on marine life. The final component of the work is the computer processing of the data collected, with the aid of modern equipment. Oceanographic technicians support oceanographers in their research projects and in the laboratories.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BSc degree with zoology, botany, marine biology as major subjects with supporting courses in physiology, geology, statistics and mathematics - most universities.
BSc (Physical Oceanography).

Diploma: N.Dip. Marine Engineering.
N.Dip. Maritime Studies
N.Dip. Oceanography

Postgraduate: **Training is offered particularly at the coastal universities. Some have geology departments that are very much involved in marine work. An honours degree is the minimum qualification to become a researcher.**

Employment

- universities
- Department of Environmental Affairs & Tourism
- Soecor
- Mossgas
- CSIR
- Anglo American Corp of SA
- SA Navy
- marine research laboratories
- museums
- self-employment, as a consultant for companies in the coastal zone and marine environment

Job opportunities for oceanographers are limited.

Some Related Careers

Aquatic Scientist, Ecologist, Game Ranger, Ichthyologist, Marine Biologist, Microbiologist, Physiologist, Scuba Diving Instructor, Zoologist.

Further Information

Department of Environment Affairs & Tourism
315 cnr Pretorius & Lilian Ngoyi St
Fedsure Forum Building
North Tower, 2nd Floor
Private Bag X447
Pretoria, 0001
Tel: (012) 310-3911

Marine Research Institute
University of Cape Town
Oceanogrphy Department
Private Bag X 3
Rondebosch, 7701
Tel: (021) 650-5312/5442
E-mail: ma-re@uct.ac.za
www.ma-re.uct.ac.za

Oceanographic Research Institute
P O Box 10712
Marine Parade
Durban, 4056
Tel: (031) 328-8222
E-mail: ori@saambr.org.za
www.saambr.org.za

Oceanographers with a conductivity/temperature/depth (CTD) rosette aboard a research vessel.
(photo supplied by Bob Pickart). < http://dallasmurphy.com >

Gina Ziervogel

Gina is an Associate Professor in the Department of Environmental and Geographical Science. She studied an undergraduate degree at UCT (in Environmental and Geographical Science and Oceanography) and then did an honours degree at Rhodes University. Gina completed her PhD in Geography at the University of Oxford.

The focus of Gina's research is on climate change with specific interest in how municipalities plan for climate risk and adapt to climate change. This is such a relevant field of interest considering the water problems experienced by Cape Town and other parts of South Africa.

Gina was awarded a P-rating by the NRF (National Research Foundation), which recognises 'up-and-coming researchers under the age of 35 as potential national and world leaders in their fields'.

"I am really glad I studied environmental science. I did it because I was excited about it, even though I wasn't sure what the job opportunities would be. And it has been so worth it".

Gina was born in Johannesburg but moved to Cape Town when she was one; she attended Camps Bay Primary and Camps Bay High School and developed her love of the outdoors by spending time walking, camping and exploring new places. We interviewed Gina and here are some of her answers:

Meet a Geographer

What factors influenced your choice of career / study?
"I was interested in doing either medicine or environmental science. My dad and mom were both in the medical field and took me through the pros and cons of that. Their advice was to follow my passion which was more around the environment".

What do you consider to be your greatest achievements?
"It is important to see my academic and other achievements as part of my life. So bringing up my 2 children while working full-time is something important to me. From a work point of view, I was awarded the Distinguished Young Woman Researcher in Humanities and Sciences Award in 2015 and the UCT Young College of Researchers award in 2013".

"What excites me is that the South African government, is now asking for input from scientists".

What is the main focus of your work?
"My work has been concerned with understanding how to adapt to climate impacts while meeting social development needs. I am particularly interested in how municipalities engage with citizens and local organisations with regard to these issues. One of the challenges in this field is addressing institutional barriers. For example, when trying to find ways of reducing flood risk in informal settlements or of improving access to water, it is as much about the people and processes as it is about the infrastructure and technology. My work has looked at these barriers and opportunities".

What were some of the challenges that you faced in your career?
"Going to university at Oxford was an incredible experience and privilege but also hard. When things were tough I was far away from home, had little money and felt lonely".

What advice would you give to a young person in your field?
"Get involved in social, political and environmental activities. It is not about asking, 'what job can I do if I study geography?' – as the work in this field is hard to define". It is about doing what you love and creating opportunities as the world is changing rapidly".

What is your goal?
"My goal is to use science and an understanding of our world, to find ways to change it for better. I am interested in finding ways that local knowledge can be used to help cities become more resilient. City governments need help in learning how to listen to citizens and engage with them better".

Thakane Ntholi

Thakane is a Scientist at the Council for Geoscience and is also the Programme Manager for the Mine Environment and Water Management Project (MEWMP). She is originally from Thaba Nchu in the Free State. She spent a few years living with her grandmother in Lesotho. She attended St Augustine's Primary School and Tlotlanang Combined School. As a child, Thakane's interests varied greatly, however she has always had a fascination with nature - especially the mountains.

Although she passed matric with merit, she decided to improve her maths marks, which were compromised by her being hospitalized just 2 months before final exams. She rewrote her Maths paper and was accepted into a BSc Earth and Environmental Sciences majoring in Geology and Chemistry at University of Cape Town (UCT). Following financial exclusion in her first year she was fortunate enough to receive a bursary from the Department of Environmental Affairs, Freestate. She completed her BSc. (Hons) and MSc. in Geology before moving to the Nelson Mandela University to do a PhD in Geology.

Thakane is established herself within her field in the hope of pursuing a successful career in science. Her goal is to inspire other young people to follow in her footsteps. We interviewed Thakane, here are some of her answers:

Tell us about your your love of science!
"I am driven by my love for nature and a deep desire to protect it. I have always enjoyed being outdoors on top of a hill in the early mornings or outside watching moon and stars late in the night. When I got to university and was exposed to Geology, I became more fascinated by the processes that create and control the earth and its beauty".

Meet a Geologist

What were some of the challenges that you faced growing up?
"There were lots of challenges growing up, most of them financial. That said, my mother did her best to ensure we got a decent education. My biggest challenge at school was being different. Some teachers said I was too forward, and I was teased for aiming beyond my reach".

"Be true to Bo oena. Bo oena is a Sesotho phrase loosely translated to 'the essence of you'. When you are true to your essence, you become content with your journey and are not afraid to follow your passion, change your mind or explore uncharted waters. You become the best of yourself and run your own race".

Did you ever feel like giving up? What made you carry on?
"My first year of study was difficult because of the change of environment, high workload and having to work independently. A fixed routine was my saving grace. I did feel like giving up, particularly during my PhD. My family, mentors and friends were my support base, especially during those times I wanted to give up because I just felt I didn't have what it takes".

What is your belief or motto in life?
"Be true to Bo oena. Bo oena is a Sesotho phrase loosely translated to 'the essence of you'. When you are true to your essence, you become content with your journey and are not afraid to follow your passion, change your mind or explore uncharted waters. You become the best of yourself and run your own race".

What advice would you give to a young person wanting to study in the field of science?
"Do it! Science is not as scary as it is made out to be, nor is it just for 'smart' people. With hard work, patience and determination it can be done … science is a forever evolving field and there are very slim chances of ever being bored".

Who do you most admire?
"I am inspired by Prof. Maarten de Wit (my Supervisor and mentor) – his journey is geology is an example of what happens when you believe in your own dream. Prof, Marian Tredoux - she is the reason I pursued a PhD, and Dr Kwezi Mzilikazi, my close friend and mentor, my everyday example that it is possible".

COMPUTER SCIENCES

With the evolution of the Internet, personal computers are becoming as common as the television and the telephone in the household. As much as computers have become a part of our daily lives, they have also become an integral part of modern science. They are essential in helping scientists to understand the world around us.

Computers have changed the face of science in that scientists are no longer constrained to doing just experiment-based or theoretical research. Now scientists can enter results and data into a computer and the computer, utilizing mathematics and abiding by the physical laws, is able to recreate a virtual physical world. Scientists compare results from models, with real events to verify the accuracy of their models, fine tuning the evolving models as they go. Successful models generate data that matches well with reality in a wide range of circumstances.

Supercomputers have especially revolutionized the scientific process and are used in everything from meteorology, to molecular biology, to astronomy, to environmental science.

Models can also help us improve our understanding of natural phenomena and the laws of physics by taking advantage of a natural laboratory that produces conditions, such as high temperatures, powerful magnetic fields, or large distances, that are unattainable in laboratory settings.

The field of computer science is often associated with writing computer programs. Computer science is the systematic study of the processes (or algorithms) that underlie the storage of information, whether such information is encoded in bits and bytes in a computer memory or transcribed in genes and protein structures in a human cell. The fundamental question underlying all of computing is: what computational processes can be efficiently automated and implemented?

To tackle this seemingly simple question, computer scientists work in many complementary areas. They study the very nature of computing to determine which problems are (or are not) computable. They compare various algorithms to determine whether they provide a correct and efficient solution to a concrete problem. They design programming languages to enable the specification and expression of such algorithms. They design, evaluate, and build computer systems that can efficiently execute such specifications. And, they apply such algorithms to important application domains.

COMPUTERS SCIENCES STUDY PATHS

National Senior Certificate:
With Mathematics
and Physical Science

Each education institution has its own unique entry requirements for each of its programmes. It is important to check the entry requirements for the programme with the institution of your choice before you apply.

University

Bachelor of Science Degree

Majors in:
Applied Mathematics
Bioinformatics
Database Architecture
Geographical Information Science
IT and Music
Operational Research
Software Development
Systems Analysis
or any other related subject offered by the university.

University of Technology

National Diploma

Diploma in:
Computer (Electronic) Engineering
Computer Systems Engineering
Computer Science
Information Technology
Software Engineering

or any other related qualification offered by the university of technology.

Internship / Workplace Experience

Workplace experience is a requirement for the completion of a national diploma at a university of technology.

Postgrad

A postgraduate degree or diploma is needed in order to specialise. Each institution will have specific areas that they will promote. With regard to the computer sciences these specialisation areas may include:

Artificial Intelligence
Computer and Information Security
Spatial Databases
Cyber-Physical Systems
Distributed and Cloud Computing
Neural Networks
Robotics
Telecommunications
and many more.

University of technology students who intend doing postgraduate studies at university will first need to check the acceptance requirements with the university concerned. Students studying a national diploma will need to complete a Bachelor of Technology Diploma and / or a Master of Technology degree as a requirement for entry.

COMPUTER PROGRAMMER

Computer programmers create, modify and test the forms, scripts and code that tell the computer what to do. They serve as the link between the operator and the computer.

The work of computer programmers is both demanding and rewarding. In general terms, they are people who write programs for specific purposes or needs, whether it is to create a virtual reality game or a database system, to control machinery or to program a company's telephone system.

These programs are detailed instructions which list the specifications that the computer must follow to solve a problem or handle information in a logical order. Systems analysts provide the specifications for a particular task. Programmers write the programs and translate them into a computer language such as Visual Basic, Delphi, Pascal, Cobol, Java, Oracle, Informix, C and C++, to name but a few. The sequence of instructions is carefully entered on the keyboard and checked to make sure that it is correct and that it will produce the desired information. If errors occur, the program is changed and rechecked until the desired results are produced. Computer programmers works closely with systems analysts to produce programs based on the specifications derived from the needs of the client.

The work of computer programmers involves researching and documenting computer users' requirements; analysing the objectives and problems specified by the systems analyst; and determining what steps need to be taken and in what order, then translating these steps into computer language commands. They test programs and software applications and then "debug" them. They also need to document what the programs do and how they do it, by preparing user manuals and help screens.

Areas of Specialisation

Network programmers work with vendor networking languages to support the implementation or modification of network configurations.

Database programmers are involved in the development of programs to suit the access to and maintenance of databases.

Analyst programmers design and analyse clients' needs and create complex design structures for translation into a programming language.

Multimedia programmers are involved with systems, applications and programming issues. This includes conversion between platforms and the initial writing of code for incorporation of text, graphics, video, animation, digital / analogue photographs, audio and 2/3D modelling.

Systems software programmers write, maintain and update programs that control the overall functioning of computers.

In addition to the degrees and diplomas listed below, programmers can acquire a certificate offered by most FET colleges.

Most large computer firms have their own training departments where intensive in-service training courses are offered and trainees have the opportunity to work on the firm's own computers. A number of private firms also offer training courses.

How to Enter This Occupation:

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements

Compulsory subjects: Mathematics.
Recommended Subjects: Information Technology, Computer Applications.

Further Training

Degree: BSc Computer Science or Information Systems or Information Technology as major, or a BCom degree with information systems - all universities.

Diploma: Relevant diplomas are offered by most universities of technology and some private colleges.

Postgraduate: **Honours in computer science can be followed by MSc and PhD at most universities.**

It is essential to upgrade knowledge continuously because systems and security threats are constantly changing.

Employment

- government and provincial departments
- large computer companies
- research organisations
- large business and industrial organisations
- insurance companies
- educational institutions and libraries
- transport enterprises
- mining companies
- any company or business using computer systems and networks
- self-employment; a skilled and entrepreneurial computer programmer can start his or her own business.

Further Information

Institute of Information Technology Professionals South Africa (IITPSA)
P O Box 1714
Halfway House, 1685
ICT House
546 16th Road
Constantia Park [Unit No.3]
Midrand
Tel: (011) 315-1319
Fax: (011) 315-2276
E-mail: info@iitpsa.org.za
www.iitpsa.org.za

IEEE Computer Society
www.ieee.org

Some Related Careers

Computer Data Administrator, Computer Network Controller, Computer Operator, Computer Security Specialist, Computer Support Specialist, Computer Systems Analyst, Computer Technician, Computer Terminal Operator.

An example of Html coding.

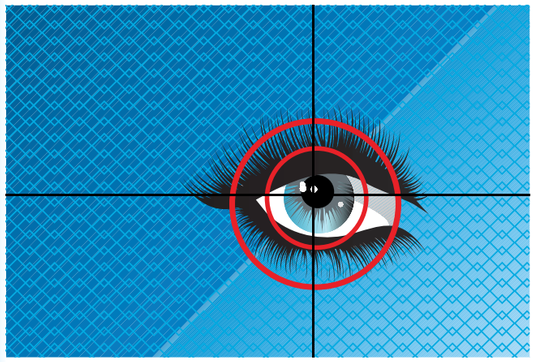
COMPUTER SECURITY SPECIALIST

Computer security specialists assess administrative, physical and technical security risks to information, software and hardware; and develop policies, procedures and contingency plans to prevent or minimise the effects of security breaches and concerns.

Computer security specialists also known as Information technology specialists, or systems security analysts, play a vital role protecting and safeguarding information in computer files against accidental or unauthorised modification or disclosure.

To keep up-to-date with new developments, systems security analysts share information via e-mail, use web-based resources that send out alerts about new threats (e.g. computer viruses), attend technical training courses and conferences, and read computer-related journals, magazines and newsletters.

The work of a computer security specialist depends upon the type of equipment and the data that is stored. For example, the type of equipment and media for information management include the following: modems, fax machines, manuals, wide and local area networks, telephones, computer printers and scanners, authentication server software, notebook and protocol analysers, network monitoring software, computer terminals and mainframes, notebook computers, internet directory services software and virus protection software.



A retinal scan or "iris scanner" is a biometric technique that uses the unique pattern of the person's retina to identify them.

The duties of computer security professionals may vary from the strategic planning and computer security measures to detailed implementation, maintenance and upgrading measures.

These include developing and writing policies and procedures for the computer security department; entering commands into the computer in an attempt to circumvent the new security measures in order to test the system; modifying security data files to incorporate new software into the firm's security software; reviewing employee violations of computer security procedures recorded by the computer; monitoring current reports of computer viruses to determine when to update virus protection systems; and reporting employee violations to user department managers.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Information Technology, Computer Applications.

Further Training

Degree: BSc Computer Science or Information Systems or Information Technology as major, or a BCom with information systems - all universities.

Diploma: Relevant diplomas are offered by most universities of technology and some private colleges.

Postgraduate: **Honours in computer science can be followed by MSc and PhD at most universities.**

It is essential to upgrade knowledge continuously because systems and security threats are constantly changing.

Employment

- government and provincial departments
- large computer companies
- research organisations
- large business and industrial organisations
- insurance companies
- educational institutions and libraries
- transport enterprises
- mining companies

- any company or business using computer systems and networks
- self-employment; a skilled and entrepreneurial computer specialist can start his or her own business.

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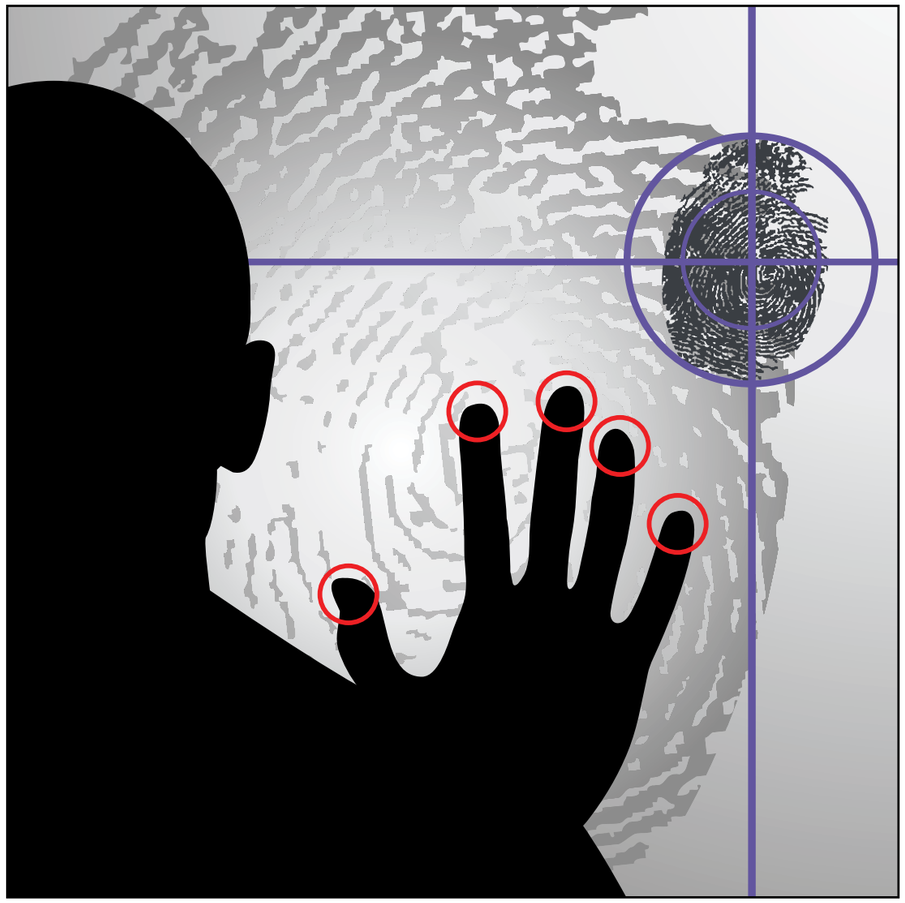
Tel: (011) 315-1319 Fax: (011) 315-2276
E-mail: info@iitpsa.org.za
www.iitpsa.org.za

IEEE Computer Society
www.ieee.org

Some Related Careers

Network Administrator, Network Engineer, Security Manager.



Computer security cybercrime biometrics fingerprint (biometrics or biometric authentication refers to the identification of people by their physical traits, such as fingerprint, hand geometry, face, DNA or iris. (Graphic Designer - Debra Hughes)

COMPUTER SOFTWARE ENGINEER

Computer software engineers apply the principles and techniques of computer programming, engineering and mathematical analysis to the design, development, testing and evaluation of the software and systems that enable computers to perform their many applications. This requires an Electronics Engineering qualification with more software subjects and less engineering subjects

Computer software engineers design and develop many types of software including software for operating systems, network distribution systems and compilers, and which convert programs for faster processing. Software engineers program computers using various programs, for instance, Assembler, C++ and Java. The major part of their work is, however, developing algorithms and analysing and solving programming problems.

Software engineers are also required to solve technical problems that arise and should therefore have a good knowledge of hardware components, for instance, microprocessors, embedded controllers, personal computers, routers and transmitters. They should also have the skills to develop the necessary software in order to implement a complete system operating on a variety of platforms, such as Windows, Windows NT and UNIX. Because computer systems and technology are rapidly evolving, the tasks performed by a computer software engineer have become more complex and specialised.

Areas of Specialisation

Computer applications: the design, implementation and modification of general computer applications software and specialised utility programs. Software engineers develop both packaged systems and systems software, or create customised applications.

Computer systems: the construction and maintenance of a company's computer systems, and planning for future growth. This may include the setting up of intranets, or telecommunications networks that link computers within organisations.

Project management: the management and delivery of a project in consultation with other members of a team. A core team may comprise engineering, marketing, manufacturing and design people who work together until the product is released.

Software engineers normally work in an office environment. Their job requires a fair amount of interaction with customers and co-workers and may require spending time away from the office in order to consult with clients at their premises. However, as technology advances, software engineers are increasingly able to communicate via e-mail, and by using the internet, to connect to a customer's computer remotely in order to identify and correct developing problems.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory subjects: Mathematics, Physical Sciences.
Recommended subjects: Information Technology, Computer Applications.

Note: The engineering faculties of some universities offer a support programme to help students become self-sufficient and capable of completing the very demanding engineering courses. The programme is aimed at students from communities which lack proper education facilities.

Further Training

Degree: BEng Computer Engineering or Electronic Engineering - most universities.
A person who has obtained a recognised BSc (Eng) or BEng degree is eligible for registration as Engineer in Training.
After gaining at least three years, appropriate practical experience, a computer engineer may register as a Professional Engineer under the auspices of the Engineering Council of South Africa.

For computer scientists, Bachelor of Information Technology degrees are offered at some universities. The more theoretical majors lead to specialised work in computer science and programming.

Postgraduate: Honours in computer science can be followed by MSc and PhD at most universities. It is essential to upgrade knowledge continuously because systems and security threats are constantly changing.

Employment

- companies that supply and service computers
- government departments
- provincial administrations
- computer bureaus
- such companies as: Spoornet, Telkom, Denel
- universities and universities of technology
- any company or business using computer systems and networks
- self-employment, a registered engineer with the necessary experience and initiative, as consultant

Further Information

Computer Society of SA
P O Box 1714
Halfway House, 1685
ICT House
546 16th Road
Constantia Park [Unit No.3]
Midrand
Tel: (011) 315-1319
Fax: (011) 315-2276
www.cssa.org.za

Engineering Council of South Africa (ECSA)
Private Bag X691
Bruma, 2026
Tel: (011) 607-9500 Fax: (011) 622-9295
E-mail: engineer@ecsa.co.za
www.ecsa.co.za

Society for Professional Engineers
P O Box 78433
Sandton, 2146
Tel: (011) 783-0765
www.professionalengineers.co.za

Information Technology Association of South Africa
P O Box 6697
Halfway House, 1685
Tel: (011) 312-3040/50
www.ita.org.za

Project Management South Africa (PMSA)
P O Box 4328
Rivonia, 2128
Tel: (011) 257-8003 Fax: 086 639 8258
E-mail: admin@projectmanagement.org.za
www.projectmanagement.org.za

Related Careers

Computer Hardware Engineer, Computer Scientist.

Cloud Computing

C++ Programming Language

Trevor Parscal coding in the Wikimedia Foundation offices
<https://en.wikipedia.org/wiki/Software_engineering>

DATABASE ADMINISTRATOR

A database is a collection of information that is electronically stored and organised. Database administrators use database software to store and manage information. They will often set up database systems and are responsible for making sure that those systems operate efficiently (usually referred to as database performance tuning). They also ensure that the data they store is backed up regularly, stored effectively, and that the data is secure from unauthorised access. Ensuring that the data is available, by maximising database uptime, is also an important function of the database administrator.

The database for which an administrator is responsible can consist of various applications that are linked together. For example, one company may have a program where all their client details are captured, another where each client's information and billing structures are captured, and a third for the service or product the client sells. All these programs are then combined into one database. Database administrators make sure that the programs are accurately linked, test the data integrity, and distribute the latest version of each application accordingly.

They prevent data duplication, book the source code of each application in and out of the library, are responsible for the replication of data when a company operates on a wide area network (WAN), and draw up reports on all the information for clients and users.

Database administrators (DBAs) are often promoted to a senior database administrator and then into a strategic management role within the company, such as a MIS Manager and eventually even on to a Chief Technology Officer role.

Areas of Specialisation

Some DBAs specialise in a certain field, such as database security, and become experts in that particular area.
The opportunities for database administrators are increasing, as the IT industry progresses.

They work indoors, in an office, and in meeting rooms to provide feedback. Offices are usually situated close to those of the development team.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Information Technology, Computer Applications.

Further Training

Degree: BSc Computer Science or Information Systems or Information Technology as major, or a BCom with Information Systems - most universities.

Diploma: Relevant diplomas are offered by most universities of technology and some private colleges.

Postgraduate: Honours in computer science can be followed by MSc and PhD at most universities.

It is essential to upgrade knowledge continuously because systems are constantly changing.

Employment

- government and provincial departments
- large computer companies
- research organisations
- large business and industrial organisations
- insurance companies
- educational institutions and libraries
- transport enterprises
- mining companies
- any company or business using computer systems and networks

Further Information

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www.cssa.org.za

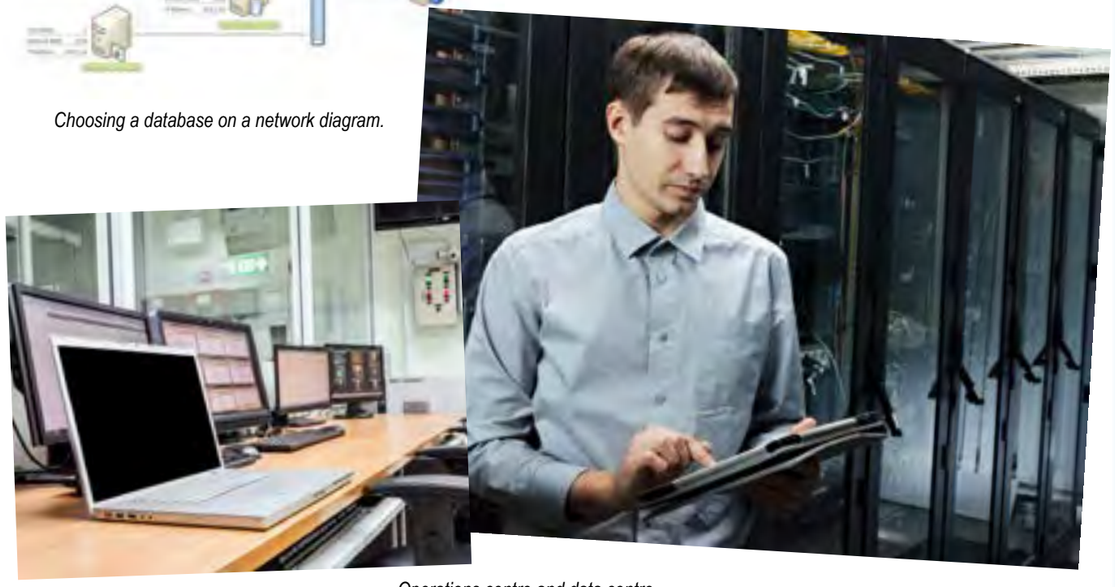
Information Technology Association of South Africa
P O Box 6697
Halfway House, 1685
Tel: (011) 312-3040/50 Fax: 086 693 3783
www.ita.org.za

Some Related Careers

Data Capturer, IT Database Analyst, IT Hardware Technician, IT Network Administrator, IT Network Controller, IT Project Manager, IT Software Developer, IT Technical Support.

Database Administrator in the data centre.

Choosing a database on a network diagram.



Operations centre and data centre.

GAME DESIGNER (MULTIMEDIA)

Game designers invent, build, produce and promote computer games. Game design is like being a film director, but for a computer simulation (imitates the appearance of reality). They are limited only by their own imagination and the customer's budget.

Game designers are the creative thinkers in the development of a game, and they become the story-tellers in how the game is to be played. They produce the game design document and develop games for educational, entertainment or computer platforms. There are different styles of computer games:

- simulation - where the player takes on a real-world simulation
- strategy - where the player takes on opponents using strategic and tactical moves
- role-playing - where the player controls characters in fantasy or science-fiction environments
- action - where the player needs a quick eye and reactions to make his or her moves against a character.

The degree of programming is dependent on the type of game. In small projects, game designers do the design and most of the programming, whereas in larger projects, they may do the design only and the programming will be done by other people. They work with a team of programmers, developers and animators.

Game Designer using a tablet to create characters in a game. (Photo by Jason Decker)
< http://blog.commongoodvt.org/2013/01/media-maven-lunch-webcast-gaming-the-nonprofit-space/game-designer-gallery-horizontal/ >

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Information Technology, Computer Applications.

Further Training

Computer science-related degree for programmers, art qualification for game artists.

Most tertiary institutions offer computer courses in programming.

Degree: BSc Software Development, BSc Information Technology: Computer Games Design, BIS Multimedia.

Diploma: N.Dip. Information Technology

Postgraduate: **Honours in computer science can be followed by MSc and PhD at most universities.**

Employment

- computer software companies
- advertising agencies
- game developing companies
- self-employment, with appropriate experience

Further Information

The following websites:

www.gamedev.net

www.ea.com

Some Related Careers

Graphic Designer, Multimedia Developer, Website Designer.

With most of the best games, the designers figured out a way to be creative within severe technical limits. Metroid Prime was a perfect example of designing within technical limits.
< http://www.gamasutra.com/view/feature/132597/the_designers_notebook_bad_game_.php?print=1 >

Students can prepare for careers in the video game industry by earning an associate of applied science degree.
< http://www.jccc.edu/game-development/ >

MOBILE APPLICATION DEVELOPER

Mobile phones (cell phones) have become as important as our wallets and purses in everyday living, and development in this area is moving at a very fast pace. Mobile devices have become a tremendous source of entertainment, communication and information, and also jobs for millions.

Mobile application developers produce application software for low-power handheld devices, such as personal digital assistants, enterprise digital assistants or mobile phones. These applications can be pre-installed on phones during manufacturing, downloaded by customers from various mobile software distribution platforms, or delivered as web applications to provide an "application-like" experience within a web browser. Application software developers also have to consider a lengthy array of screen sizes, hardware specifications and configurations because of intense competition in mobile software and changes within each of the platforms.

Criteria for selecting a development platform usually include the target mobile platforms, existing infrastructure, and development skills. When targeting more than one platform with cross-platform development it is also important to consider the impact of the tool on the user experience. Performance is another important criterion, as research on mobile applications indicates a strong correlation between application performance and user satisfaction.

Mobile applications are first tested within the development environment using emulators, and later subjected to field testing. Emulators (hardware or software which duplicates the functions of one computer system on another) provide an inexpensive way to test applications on mobile phones to which developers may not have physical access.

Applications (apps) rarely grab consumers' attention without having truly innovative and useful features. Examples of useful skills in an app designer would be the ability to add 3-D gaming, social media sharing, GPS check-ins or product coupon elements. The key to writing apps that people will want to use is to be disciplined over functionality in order to make the app as easy to use as possible, and not to be persuaded to cram in more than a limited screen can handle.

The mobile application developer will be required to design, develop, test, document, deploy, support and sustain the mobile apps. Meticlous attention to elegant design, performance, user experience, and clean and documented code is required, together with a sense of modern web and user experience design, graphics, layout, transitions and feedback on the mobile platforms. They must be able to work closely with engineering on app design.

Steps in becoming an application developer:

- after obtaining a degree in computer science, learn the basics and work on projects to furnish your skills
- analyse your abilities and decide whether you are a creative or analytical person
- build your knowledge base by creating your own software applications
- start to build something simple on your own
- develop a plan of what you want to develop in an application
- create a team of knowledgeable, experienced and reliable developers
- make a log file and keep it updated about your progress related to the development
- contact other developers who build apps in other categories and discuss it with them
- build relationships with other developers so that you can gain new ideas and skills
- code up and release your first app, show it to your friends for their feedback
- attend a mobile conference or seminar to launch your application.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Information Technology, Computer Applications.

Further Training

Degree: BSc Computer Science or Information Systems or Information Technology as major, or a BCom with information systems at most universities. Choose a platform such as Flash, Java, CSS, Python, etc, and work on it.

Diploma: Relevant diplomas are offered by most universities of technology and some private colleges at universities of technology.

Postgraduate: Honours in computer science can be followed by MSc and PhD at most universities.

It is essential to upgrade knowledge continuously because systems and security threats are constantly changing.

Employment

- mobile phone and tablet companies
- businesses
- pharmaceutical companies
- companies involved in application design.

Further Information

Computer Society of SA
P O Box 1714
Halfway House, 1685
ICT House
546 16th Road
Constantia Park [Unit No.3]
Midrand
Tel: (011) 315-1319 Fax: (011) 315-2276
www.cssa.org.za

ISETT (Information Systems Electronics & Telecommunication Technologies)
P O Box 5585
Halfway House, 1685
Tel: (011) 461-3926 Fax: (011) 805-6833
www.isett.org.za

IEEE Computer Society
www.computer.org

www.entrepreneur.com/article/226270#ixzz2VoZ9DjS2
www.wikihow.com/Become-a-Mobile-Application-Developer

Some Related Careers

Computer Software Engineer, Computer Scientist, Game Designer (Multimedia).

NETWORK ARCHITECT

A network architect designs and builds data communication networks for organisations. These networks range from a small connection between two offices in the same building, called local area networks (LANs), to wide area networks (WANs) spanning across offices in different geographic locations and across countries.

Network architects create the plans for data communication networks by graphically mapping the layout of fibre cables to all the service points or nodes and data flow between the components. They map out the topology of the network which is the entire network structure and work with computer systems engineers who help build the network they have designed. They may build test networks using network modelling tools to determine what hardware and software will need to be used. They decide what routers, adaptors, network drivers, hubs and other hardware should be used, how the cables will be laid and where other hardware will go.

Network architect must be business-minded in determining the most efficient and secure way for information transfer to take place keeping in mind the company's budget, its number of employees and the future needs of the company in terms of scalability. They analyse current and future data traffic to estimate how growth might affect the network. They also need to be practical and may be responsible for determining how to grant the employees of an organization access to the internet and in-house information databases in the most affordable and efficient way.

<http://www.s2networks.com/data_images/people/lan-plan.jpg>

Network architects analyse systems for issues and devise inventive new solutions to eliminate problems as they are identified. They must work with computer programmers and network engineers to fix software problems. They rely on their knowledge and experience of hardware, software systems and network platforms to address a variety of business needs within different types of industries, and determine the costs of implementation and maintenance.

Network architects plan the implementation of security patches or other counter measures which must be taken into consideration when designing networks to counteract vulnerabilities. They increase the efficiency of communications of computer systems for a variety of uses, such as banking, finance, sales, scientific research, and more while keeping in mind network safety as a key goal.

The complex nature of the job necessitates that network architects are usually experienced staff with a number of years' experience working in network administration or with other information technology (IT) systems. They should also have an extensive knowledge of an organization's business plan so that they will be able to design a network that can help the organization achieve its goals.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Compulsory Subjects: Mathematics.
Recommended Subjects: Information Technology, Computer Applications.

Further Training

In order to become a network architect, you typically need a bachelor's degree in computer science, information systems, computer engineering, or a closely related field.

Degree: BSc Computer Science – all universities
Each institution has its own entry requirements.

A person who has obtained a recognised BSc (Eng) or BEng degree is eligible for registration as Engineer in Training. After gaining at least 3 years of appropriate practical experience, a computer engineer may register as a Professional Engineer under the auspices of the Engineering Council of South Africa.

Postgraduate: BHonours in Computer Science can be followed by MSc and PhD at most universities.
It is essential to upgrade knowledge continuously because systems and security threats are constantly changing.

Employment

Demand for network architects will increase as firms continue to expand their use of wireless and mobile networks. Designing and building these new networks, as well as upgrading existing ones, will create opportunities for network architects. However, the adoption of cloud computing, which allows users to access storage, software, and other computer services over the Internet, is likely to cause a decrease in the demand for network architects in some cases.

Employment can be found in:

- large computer companies
- government departments
- provincial administrations
- insurance companies
- banks
- universities and universities of technology
- self-employment; a registered engineer with the necessary experience and initiative, as consultan

Designing Distributed TSN Ethernet-Based Measurement Systems
<http://www.ni.com/white-paper/53850/en/>

Network Architect who has studied Advanced Data Center Architecture and become an expert in converged infrastructure, multicloud hybrid computing, application or infrastructure as a service, and analytics.
<https://www.cisco.com/>

Further Information

Computer Society of SA
P O Box 1714
Halfway House, 1685

ICT House
546 16th Road
Constantia Park [Unit No.3]
Midrand
Tel: (011) 315-1319 Fax: (011) 315-2276
www.cssa.org.za

Engineering Council of South Africa (ECSA)
Private Bag X 691
Bruma, 2026
Tel: (011) 607-9500 Fax: (011) 622-9295
E-mail: engineer@ecsa.co.za
www.ecsa.co.za

Society for Professional Engineers
P O Box 78433
Sandton, 2146
Tel: (011) 783-0765
www.professionalengineers.co.za

Information Technology Users Council of South Africa
Fussell House Office Park,
Office Suite Two – North Wing,
48 Athol Oaklands Road,
Melrose North, 2196
Tel: 10 203 9003
https://ita.org.za/ituc/

Some Related Careers

Systems Analyst, Programmer, Network Engineer
Advanced Data Center Architect.

SYSTEMS ANALYST

Systems analysts analyse an organization's current computer systems and procedures, and design solutions to help the organization operate more efficiently. Systems analysts bring both business and information technology (IT) together by developing an understanding of the needs and limitations of both.

Systems analysts consult with the client in order to determine the client's needs and requirements. They then decide whether and how computers or computer applications could be used to improve them. The next step is to draw up diagrams of how the work is to be done and work out the new system's requirements and specifications. In some cases, the system analyst may work with a systems architect and network engineer to draw up detailed charts and diagrams that indicate the various components involved.

They specify the inputs to be accessed by the system, design the processing steps and format the output to meet the users' needs. Analysts use techniques such as structured analysis, data modelling, information engineering, mathematical model building, sampling and cost accounting to plan the system.

They then check the feasibility and workability of a conceptual design. This may include the preparation of cost-benefit and return-on-investment analyses to help management decide whether implementing the proposed system would be financially feasible.

Once the client's systems requirements have been determined, systems analysts may then oversee the system's development and write programs and system specifications to meet these requirements. Finally, they test the new system with users of the system and consult with the stakeholders to ensure that targets are met. Analysts conduct in-depth tests and analyse information and trends in the data to increase a system's performance and efficiency.

Analyses of data center

Systems analysts use a variety of techniques, such as data modelling, to design computer systems. Data modelling is the process of documenting a complex software system design as a flow diagram using text and symbols to represent processes and data flows.

Analysts calculate requirements for the amount of memory, storage, and computing power the computer system may need. They prepare the flow diagram or other kinds of diagrams for programmers or engineers to use when building the system. Analysts also work with other computer specialists to solve problems that arise after the initial system is set up.

Most systems analysts gain experience in the economic sector or industry they work in. For example, an analyst might work predominantly with financial computer systems in a banking sector or with computer systems in a manufacturing sector.

Systems analysts who supervise the initial installation or upgrade of IT systems from start to finish are sometimes called IT project managers. They monitor a project's progress to ensure that deadlines, standards and cost targets are met according to company IT policies.

Software quality assurance (QA) analysts do in-depth testing and diagnose problems of the systems they design. Testing and diagnosis are done in order to make sure that critical requirements are met. QA analysts also write reports to management recommending ways to improve the systems.

Programmer analysts design and update their system's software and create applications tailored to their organization's needs. They do more coding and debugging than other types of analysts, although they still work extensively with management and business analysts to determine the business needs that the applications are meant to address.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Electrical Technology.

Further Training

In order to become a systems analyst, you typically need a bachelor's degree in computer science, or computer engineering, or a closely related field.

Degree: BSc Computer Science or Information Systems – all universities. UP, UCT and Damelin offer short courses in Business and Systems Analysis.

Postgraduate: **Honours in Computer Science can be followed by MSc and PhD at most universities.**

It is essential to upgrade knowledge continuously because systems and security threats are constantly changing.

Employment

- government and provincial departments
- large computer companies
- research organisations
- large business and industrial organisations
- insurance companies
- educational institutions and libraries
- transport enterprises
- mining companies
- any company or business using computer systems and networks
- a skilled entrepreneurial systems analyst can start his or her own business.

Further Information

Computer Society of SA
P O Box 1714
Halfway House, 1685
ICT House
546 16th Road
Constantia Park [Unit No.3]
Midrand
Tel: (011) 315-1319
Fax: (011) 315-2276
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Bruma, 2026
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E-mail: engineer@ecsa.co.za
www.ecsa.co.za

Information Technology Users Council of South Africa
Fussell House Office Park,
Office Suite Two – North Wing,
48 Athol Oaklands Road,
Melrose North, 2196
Tel: 10 203 9003
https://ita.org.za/ituc/

Some Related Careers

Computer Software Engineer, Computer programmer, Computer Scientist, Systems Engineer, Computer Operations manager.

The Business Systems Analyst provides the solutions and ideas which are backed by technology. They take their time to understand the company's needs while balancing both business and technical skills.
< https://damelinonline.co.za/importance-business-systems-analyst-workplace/ >

SYSTEMS ENGINEER

Systems engineers are mainly responsible for coordinating all the computer-related systems available in a company. They work closely with database administrators, and develop and change databases to ensure an environment that is streamlined and automated.

Systems engineers are also responsible for the integration of systems and maintenance of the system flow. They must have extensive knowledge in a similar environment where functions such as engineering, development and the integration of systems are central to the company concerned.

Advanced knowledge of database design is essential to be a successful candidate for this career. Systems engineers also integrate databases with all their tables and information into the technical hardware used by the company. This takes place in conjunction with the network administrator.

Systems engineers work closely with the development team in an office environment, occasionally visiting server and backup rooms to ensure that the complete system is engineered in a successful and automated way.

Some examples of such systems are water and food distribution networks, experimental manned space flights and military defence programmes. Systems engineers also work on telephone systems, electrical power systems, and sewage systems.

Digital systems engineer David George with the latest reconfigurable open architecture computing hardware board - ROACH-2 at SKA.
<http://www.ska.ac.za/media/meerkat.php>

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Information Technology, Electrical Technology.

Further Training

Degree: Useful courses would be computer science - software, programming, electrical / electronic engineering, network systems, database management, etc.

Diploma: Offered at universities of technology.

Postgraduate: **BEng Hons. Industrial, BSc Appl.Sc, MEng Industrial and PhD for industrial and systems engineers. MSc Eng 50/50 Systems and Control Engineering, MEng Systems and Control Engineering.**

Employment

- government agencies
- computer companies
- any large corporate company that needs a dedicated coordinator / engineer to maintain its IT environment.

Further Information

International Council on Systems Engineering S A
INCOSE SA
P O Box 67018
Highveld Park, 0169
Tel: 083 302 6528 Fax: 086 536 8122
www.incose.org.za

Some Related Careers

Database Administrator, Network Administrator, Network Engineer

A systems engineer focusing on a chip for the motherboard.

Systems engineering techniques are used in complex projects: spacecraft design, computer chip design, robotics, software integration and bridge building.
< http://en.wikipedia.org/wiki/Systems_engineering >

The Concurrent Design Facility at ESTEC.
Many separate elements go into making a space system, with individual subsystems developed by specialist teams. System engineers, however, focus on the space system as a whole. They translate the needs from the users, design its architecture, define its building strategy and oversee the integration of subsystems to form the final result.
< http://www.esa.int/Our_Activities/Space_Engineering/Systems_Engineering_incl._cost_engineering >

Lize van der Heever

Lize grew up in Paarl and matriculated from Paarl Girls' High in 1983. She considers herself fortunate to have attended a small girls-only school which offered every pupil many opportunities an provided an environment in which the girls could really excel and grow in all aspects.

Lize studied a BSc Honours majoring in computer science and maths at the University of Stellenbosch. This was a surprising choice considering the fact that she had never worked on a computer before. "I was in two minds about studying computer science (to which I had very little exposure by the time I finished matric as it wasn't a subject that was available at our school). By the time I had to make a final decision I had not even worked on a computer".

"I can't remember what finally made me decide to study Computer Science, but I really like being a software engineer and it is a perfect fit for the way my brain works, my personality and what makes me tick."

Lize currently works for the Square Kilometre Array Project (SKA) South Africa on the MeerKAT project. Lize is the technical lead for the Control And Monitoring (CAM) subsystem of the MeerKAT project and is responsible for the technical quality and appropriateness of the system developed by the team. The CAM subsystem controls all activities of the MeerKAT telescope, monitors the health of the telescope, raises alarms to the operators for problems that need attention or for safety-critical conditions, and prevents the telescope equipment from being damaged by overheating, power failures or strong winds.

Meet a Computer Scientist

The team also develops the display interface of the telescope for use by the operators and engineers.

Lize says that she always knew that she wanted to be in a mathematical or engineering kind of career. She considers herself fortunate to have an easy childhood and schooling with not too many challenges and many opportunities. "At the time I did not fully appreciate how lucky and blessed I was, but looking back at it later I understand just how important early opportunities and a solid schooling are to prepare learners for further studies and a professional career".

" I was in two minds about studying Computer Science as it wasn't a subject that was available at our school. By the time I had to make a final decision I had not even worked on a computer".

"I believe that the only way to truly get rid of the inequalities of the past is to sort out our educational system for the current generation".

Lize is a travel enthusiast and likes to experience new countries and cultures. She loves the outdoors, especially the sea and the beach. "At my bedside there is always a good book that I am busy reading (recently on a Kindle) and I love classic and art movies. I do not like to spend too much time on computers and in front of electronics in my free time as I feel that one should make time to do other things too, but do like the amazing amount of information that is at your fingertips online and often find myself spending an evening googling on some interesting topic or a new place that I haven't seen before".

Lize's advice to young people: "If this is something you are interested in and would like to do – just go for it! Everything is achievable if you believe in yourself and put in the hard work required". She likes the motto which says: "Shoot for the moon, even if you miss you will still land among the stars".

Mpho Josephine Mbele

Mpho was born in Gauteng, but grew up in Lejweleputswa district of the Free State. After completing school, she achieved a BTech, cum laude, from the CUT in 2011.

Mpho is currently enrolled for her Master's degree in Information Technology (IT) at the Central University of Technology (CUT). She is also a lecturer in IT. She is only one of three black women (out of 20 students) currently enrolled for her master's degree, leading the way for other black women.

Mpho received an award from the Department of Science and Technology for her outstanding work in research. She received scholarships from Ivy Matsepe-Casaburri trust fund and TATA international to further her studies.

Mpho has published two papers in peer-reviewed international conference proceedings, and CUT-sponsored a trip to Benin (Africa) to present her work. She was a presenter at the Free State Research Colloquium hosted by Department of Treasury in 2017.

We asked Mpho about her work and her motivation to achieve the things she has done. Here is what she said:

What work are you doing right now?
"Right now, I'm a lecturer at CUT, Welkom Campus, focusing on networking and IT Essentials. I also assist the programming lecturers. However, I do programming in my free time as well, to assist new students and high school learners by teaching them mobile programming".

Meet an IT Lecturer

What made you go into this field?
"After finishing my studies, I started working as a programmer at Free State IT because I have a passion for solving problems. Being a lecturer as well allows me to rub off skills to upcoming young programmers in the making".

What factors influenced your choice of career / study?
"I wanted to be part of the game changers in my community, and the country as a whole, by providing solutions to mitigate issues such as environmental pollution we are faced with in my home at Lejweleputswa".

"Science and technology is our future, take a risk and be part of the people who will provide solutions to issues we as the world are facing"

What were some of the challenges that you faced growing up (at home, at school and at university)?
"I grew up near mines so I would say mine waste and gases associated with them was, and still is, one of the challenges I was faced with when growing up; others are poverty and lack of finances. But I did not let them destroy my dream of where I want to be."

What advice would you give to a young person wanting to study in the field of science?
"Science and technology is our future, take a risk and be part of the people who will provide solutions to issues we as the world are facing".

Did you ever feel like giving up? What made you carry on?
"Remembering the real reason I am doing this, my community, they made me carry on".

What is your belief or motto in life?
"Do what I can, when I can to make a difference and leave the rest to the Man Above".

What is your goal?
"Researching about critical challenges in our Country of which we can use Technology to tackle them"

Who do you most admire?
"My supervisor Professor Muthoni Masinde, she is the best!"

ROBOTICS & ARTIFICIAL INTELLIGENCE

Robotics and Artificial Intelligence or AI are buzzwords we hear when talking about the future of work. Some people are fearful that robotics and AI will reduce work opportunities especially here in South Africa where we already have a high unemployment rate. Others are excited about the possibilities these innovations hold to improve the standard of living for humankind. So what is the future of robotics and how will it affect your job one day?

Robotics is a branch of engineering that deals with the design, construction, operation, and application of robots. A Robot is any man-made machine that can perform work or other actions normally performed by humans. Up until quite recently, industrial robots could only be programmed to carry out a repetitive series of movements, i.e pick up and place an object. An artificially intelligent robot is more advanced, because it will self-learn. An AI robot uses cameras and a specialized vision program to recognize the different types of objects. An AI robot learns to detect and select between various objects; it can also place the object in a different location depending on the type of object. (https://blog.robotiq.com).

Robotics together with AI are advancing rapidly replacing all of the tasks that humans are bad at, such as searching through databases, performing repetitive and monotonous tasks, concentrating for long periods of time. Robots can do these tasks better and quicker.

Agriculture – The "lettuce bot"

New technologies are being developed to plant, fertilise, spray, pick, pack and test all kinds of food produce.

The Lettuce Bot can be towed behind a regular tractor, and uses cameras and "deep learning" to differentiate between different plants, for example between a weed and a lettuce. If the bot detects a weed it will drop a pesticide; if it detects a crop, it will drop fertilizer. Agribots can save "up to 90 percent" of the volume of chemicals being sprayed, while also reducing labour costs. (https://www.theverge.com).

The Retail Industry – An example from Amazon

A new generation of self-driving manufacturing robots has been developed. These intelligent robots are able to carry heavy loads and can navigate the most optimal paths around the factory floor and automatically avoid possible collisions. (https://blog.robotiq.com/self-driving-vehicles-quick-to-replace-agvs In the future)

As soon as you hit "confirm purchase" on amazon.com, a robot joins the line to find your product. Amazon is also considering using drones to make deliveries door-to-door.

Medical Science – A Bionic Hand with AI

Biomedical researchers from Newcastle University have developed a prototype prosthetic limb with an AI-powered camera mounted on top. The hand uses computer vision and deep learning to identify objects and which adapts the grip depending on the object, just like a real hand. The next step in development is for scientists to add more sensors to prosthetics so they can detect things like temperature and pressure.

In time, prosthetic limbs will become more and more like organic limbs. (https://www.theverge.com/2017/5/4/15544118/prosthetic-bionic-hand-arm-ai-object-recognition)

The bionic hand is able to pick up objects such as a coin using a pinching motion or use a vertical grip to grab a can of cold drink.

The Transport Sector– Self-driving trucks

Many experts believe that the first autonomously driven vehicles will be self-driving trucks. The reason for this is that long-haul trucking is confined to the highway. Swedish start up, Einride recently unveiled a prototype of a self-driving truck called the T-pod, an all-electric truck which completely lacks a steering wheel, pedals and cab. The T-pod can be controlled remotely by a human operator, or can operate autonomously without human intervention. The company aims to deliver "a complete transport system between Gothenburg-Helsingborg" by 2020. (https://www.theverge.com/2017/7/5/15923232/einride-tpod-self-driving-truck-sweden-logan).

Einride prototype of a self-driving truck, called the T-pod

The Rise of the Cobots

Another new type of robot called a cobot has limbs of its own and can be programmed to work alongside humans. Collaborative robots, or cobots, are specifically designed to interact with people. Cobots learn new tasks from humans by imitation.

For example, by moving the robot's arm, an employee can train it within minutes, and you don't need a programmer: just move the robots hands, press record, repeat and then the machine can do it autonomously. Cobots are small, light, flexible and mobile. They also don't take breaks or get sick. (https://www.azorobotics.com/News.aspx?newsID=7819).

Here the Kuka beverage cobot works side by side with its human colleagues, it fetches the beverage, opens it, picks up a glass, rinses the glass, and pours it in, and to end it all off, it washes up!

Will this affect jobs?

In South Africa's automotive manufacturing sector some commentators are worried about increasing automation leading to job losses. Low-skill jobs which are routine and monotonous face the most risk of being replaced by automation; even complicated jobs that are fairly routine are also at risk.

What is clear is that we need to equip our learners with the skills to interface with these new technologies. To enable learners to do this, there should be emphasis on stem subjects, namely; science, technology, engineering and maths.

On a positive note, the rise of robotics and AI is creating greater opportunities for the disabled. For example, through Intelligent Assist Devices (IAD), operators manipulate a robot as though it were one of their own limbs. These machines have increased reach and strength which allows people with disabilities to participate in the workforce.

The late Professor Stephen Hawking was a world-renowned physicist. He had motor neurone disease, but was able to communicate by using a small sensor which was activated by a muscle in his cheek. He used this sensor to 'type' characters and numbers on his keyboard. It allowed him to operate his whole computer, including email, internet and to write his lectures.
<https://www.biography.com/news/stephen-hawking-biography-facts>

MEDICAL & VETERINARY SCIENCES

There are endless career opportunities in the medical and veterinary sciences of which being a medical doctor is only one.

The field of medicine has been around since pre-historic times when plants were used for medicinal purposes. Throughout history people have continually looked to improve the level of medical care provided. As human-kind became more civilised, so did the nature of medical care. Inventions such as the microscope, x-ray machine and so forth, led to major advances in medicine and, as a result, also led to many variations in medical research. It was inventions such as these that contributed towards specialisations and took us to where modern medicine is today.

The medical sciences can be differentiated into medical practise and medical research. The practise of medicine is most often guided by the research that is done.

Medical practitioners may specialise in areas such as surgery, pulmonology, dermatology and many others. Even these specialisations have sub-specialisations, for example paediatric pulmonology and maxilla surgery.

Medical research has been a major contributor to extending people's life span and to improving the quality of people's lives. Over the past few years, developments such as bionic eyes which can be transplanted into people, kidneys grown in vitro, the development of artificial livers, and babies cured of HIV Aids, show the broad span of research opportunities that exist in the medical sciences.

Nowadays medical research is interdisciplinary, which means that medical researchers will work with engineers, computer programmers, physicists, and other scientists as determined by the field of research.

People who enter into the medical sciences are curious and like to find solutions to problems, especially when such problems may cause death or lower the quality of life of people or animals. Medical scientists are usually very good at mathematics and science and if one can enter into these fields, there is an abundance of postgraduate research opportunities available.

Veterinary surgeons play a vital role, taking care of farm animals, wild animals and pets.

MEDICAL AND VETERINARY SCIENCES STUDY PATHS

National Senior Certificate:
With Mathematics
and Physical Science

Each education institution has its own unique entry requirements for each of its programmes. It is important to check the entry requirements for the programme with the institution of your choice before you apply.

University
Bachelor of Science Degree

Majors in:
Anatomy
Biochemistry
Bionumeracy
Cell Signalling
Chemistry
Defence and Disease
DNA and Genomics
Genetics
Mathematics
Microbiology
Metabolism
Physiology
Protein Structure and Function
or any other related subject offered by the university.

University of Technology
National Diploma

Diploma in:
Biomedical and Clinical Technology
Chiropractic
Homeopathy
Medical Orthotics and Prosthetics
Pharmacy
Radiography
Somatology
Sport and Exercise Technology
or any other related qualification offered by the university of technology.

Internship / Workplace Experience

Workplace experience is a requirement for the completion of a national diploma at a university of technology.

Postgrad

A postgraduate degree or diploma is needed in order to specialise. Each institution will have specific areas that they will promote. With regard to the medical sciences these specialisation areas may include:

Chiropractic Paediatrics
Indigenous Medicine
Parasitology
Serology
Coagulation
Protein Trafficking
Genetic Engineering and Cloning
and many more.

University of technology students who intend doing postgraduate studies at university will first need to check the acceptance requirements with the university concerned. Students studying a national diploma will need to complete a Bachelor of Technology Diploma and / or a Master of Technology degree as a requirement for entry.

DIAGNOSTIC MEDICAL SONOGRAPHER

Diagnostic medical sonographers are medical assistants trained to operate special imaging equipment which projects ultrasound sound waves into patients' bodies to assess and diagnose various medical conditions. .

A transducer (skin probe), which is placed directly on the patient's skin, emits pulses of sound that bounce back and are processed and displayed as images. High-frequency sound waves are transmitted from the probe through a gel into the body. The computer then uses those sound waves to create an image. The record of images may be displayed on television monitors or computer which can be used for diagnostic purposes for disease or injury on soft tissue.

The transducer is used to help diagnose the causes of pain, swelling and infection in the body's internal organs and to examine a foetus in pregnant women and the brain and hips in infants. It is also used to help guide biopsies, diagnose heart conditions, and assess damage after a heart attack.

The beauty of ultrasound is that it is safe, non-invasive, and does not use ionizing radiation so there is no radiation exposure to the patient. Because ultrasound images are captured in real-time, they can show the structure and movement of the body's internal organs, as well as blood flowing through blood vessels.

Diagnostic medical sonographers work in comfortable offices or clinics, but they may need to spend long hours on their feet, greeting patients, operating ultrasound machinery and fetching the radiologist or other resident physician to make interpretations and diagnoses.

Some responsibilities of a diagnostic medical sonographer include:

- taking a patient's history; receiving the patient and answering any questions about the procedure
- preparing and maintaining imaging equipment
- operating equipment to get diagnostic images of areas in the patient's body
- recognizing the difference between normal and abnormal images
- analysing results to check for quality and adequate coverage of the area needed for diagnosis
- recording findings and keeping track of patients' records

The sonographic equipment can be used for the diagnosis of various types of soft tissue and internal organs including: liver, gallbladder, spleen, pancreas, kidneys, bladder, uterus, ovaries, and unborn child (foetus) in pregnant patients, eyes, thyroid, scrotum (testicles), brain, hips and spines in infants.

Recent advancements in ultrasound technology include three-dimensional (3-D) ultrasound that interprets the sound wave data as 3-D images.

This technology provides the patient with a three dimensional image of their baby. The best time to perform the scan is between 26 – 32 weeks of pregnancy in the context of a medical ultrasound scan. < http://3d4dstudio.com/the-evolution-of-ultrasounds-2d-3d-4d-5d-compared >

A Doppler ultrasound is a special ultrasound technique that allows the physician to see and evaluate blood flow through arteries and veins in body and organs. An echocardiogram or ultrasound of the heart is also widely used together with this technique to check for valve problems and congestive heart failure, and to assess damage after a heart attack.
The Doppler images can help the physician to see and evaluate blockages to blood flow such as clots and the narrowing of vessels, reduced or absent blood flow to various organs.

Woman undergoing a Doppler ultrasound (angiodynography) scan of the legs to study blood flow and explore potential deep vein issues. < http://www.alamy.com/stock-photo-woman-undergoing-a-doppler-ultrasound-angiodynography-scan-of-the-72433930.html >

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects:
Mathematics, Physical Sciences.
Recommended Subjects:
Life Sciences.

Sonographer doing a sonogram on a patient

Further Training

Although sonography is becoming a specialisation and recognised field on its own, in South Africa, sonography is studied under the radiography degree and it caters for the four main disciplines of radiography – Diagnostic (D), Nuclear Medicine (NM), Radiotherapy (T) and Ultrasound (US).

Degree: NDip and BTech Diagnostic Sonography are offered at the Durban University of Technology (DUT).
Bachelor degrees:
A Bachelor of Radiography in Diagnostics: Central University of Technology (CUT) and Cape Peninsula University of Technology (CPUT).
A Bachelor of Diagnostic Radiography: University of Johannesburg.
A Bachelor of Radiography: Nelson Mandela University (NMMU), the University of Limpopo (UL) and the University of Pretoria (UP).

The first year is a general one, and from the second year students may specialise in one of the following fields: Diagnostics, Radiation Therapy or Nuclear Medicine.

Registration with the Health Professions Council of South Africa (HPCSA) is mandatory for this occupation. Consult the HPCSA website for the most up-to-date information relating to accredited qualifications and registration requirements. This information can be found in the relevant sections under the Professional Board for Radiography & Clinical Technology.

Postgraduate: An MTech degree is offered at DUT, NMMU and UJ. An honours degree in Radiography is offered at UP. A masters degree is also available at UP.

Employment

There is a high demand for diagnostic medical sonographers and this demand is set to increase as a large segment of the population ages and the health care industry grows. This is because developments in medical imaging technology will make procedures less expensive and invasive. Work may be sought in provincial and private institutions in South Africa, as well as in most countries abroad. Radiographers may also open their own practices in accordance with the requirements of the Health Professions Council of South Africa (HPCSA).

Diagnostic medical sonographers are medical professionals who can specialize in a variety of different areas of the body. Becoming one requires at least the completion of a degree or certificate programme in the field, clinical experience, and the completion of certification.

- hospitals and clinics (private as well as government controlled)
- Department of Health
- Chamber of Mines
- South African Defence Force
- municipalities
- SANTA
- private radiological practices
- universities and universities of technology
- self-employment, after registration can go into private practice or partnership

Further Information

The Society of Radiographers of South Africa
P O Box 6014
Roggebaai, 8012
Tel: (021) 419-4857 Fax: (021) 421-2566
www.sorsa.org.za

Health Professions Council of South Africa (HPCSA)
P O Box 205, Pretoria, 0001
Tel: (012) 338-9300
Fax: (012) 328-5120
E-mail: hpcsa@hpcsa.co.za
www.hpcsa.co.za

Some Related Careers

Medical Clinical Technologist, Radiation Therapist, Nuclear Medicine Technologist, EEG Technician, MRI, CT or PET Scan Technician.

EPIDEMIOLOGIST

Epidemiology is a fairly new discipline. Epidemiologists are health researchers who study the health of a population by gathering and analysing statistics to identify the cause of ill health in the population and how it can be prevented. For example, it was epidemiological research that first proved that smoking was associated with an increased risk of cancer and many other diseases.

Epidemiologists look at medical, social, environmental and economic factors when determining the causes of problems. There are many different aspects that epidemiologists can study, for example:

- Environmental epidemiologists study the links between environmental exposure and disease, such as between radon gas and lung cancer
- Public health epidemiologists work on issues ranging from alcohol and drug abuse, to communicable diseases and mental health
- Infectious disease epidemiologists deal with the factors which cause disease in the population.

Epidemiologists spend most of their time researching statistics and "crunching" numbers to conduct statistical analysis of their data. They must have an interest in and knowledge of a wide range of topics, as everything from environmental to social factors influences their work.

Epidemiologists carry out or oversee professional, epidemiological investigative work by assisting in the design, conducting and analysis of epidemiological investigations for disease surveillance and special studies.

The purpose of their work is to identify causative agents or conditions that have an adverse effect on health, provide data and information concerning corrective actions or programmes to alleviate such adverse health effects, and also to propose practices or policies based on findings that will maintain and promote public health.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.
Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences, Information Technology.

Further Training

Degree: Most epidemiologists start out first qualifying in medicine, nursing or a related health field and then study epidemiology or health statistics at a graduate level. Many epidemiologists specialise in a particular area of research; for example, communicable diseases or alcoholism.

Postgraduate: **at least a master's degree in epidemiology or health statistics. Although it is not essential, some epidemiologists go on to complete PhDs.**

Employment

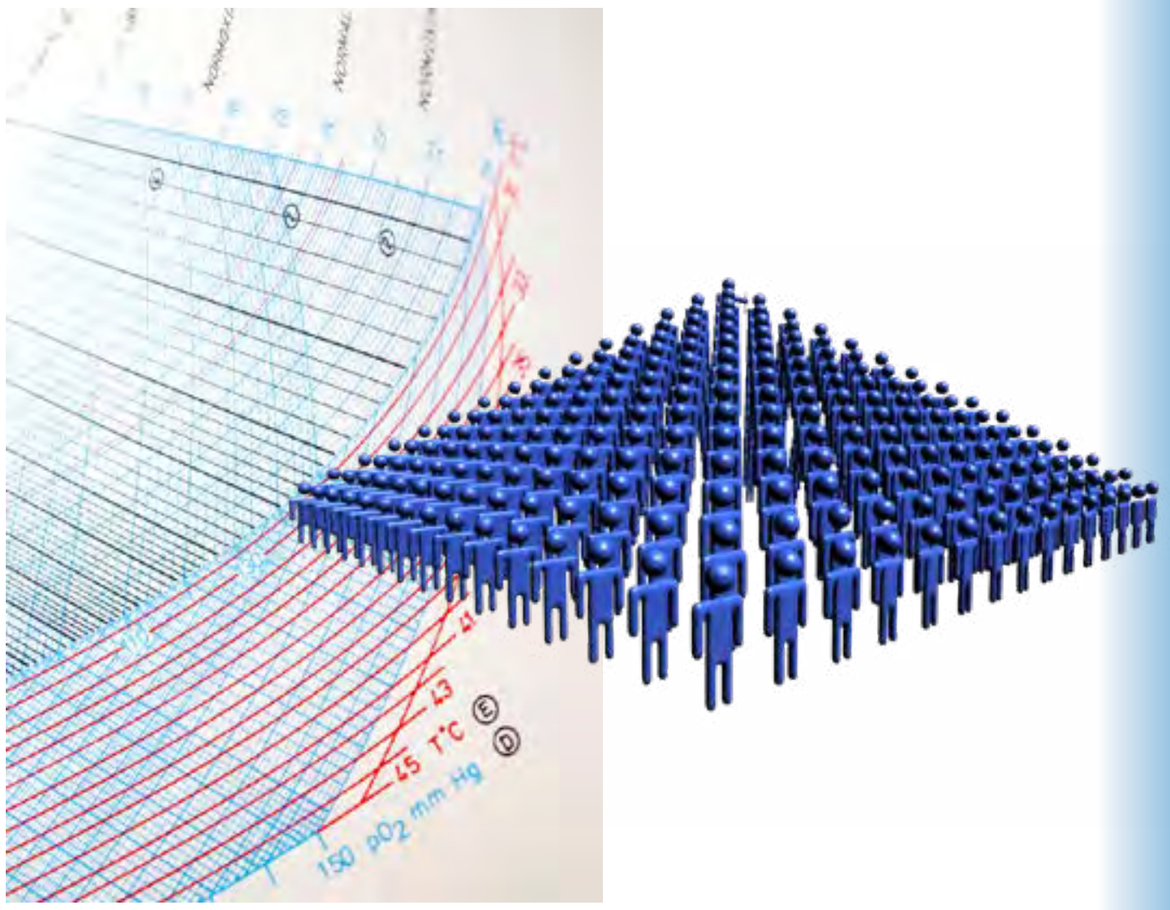
- public health
- government and environmental agencies
- hospitals
- some private research organisations
- universities, lecturing to students
- hospitals, clinics and other health care facilities
- private practice

Further Information

The Epidemiology Society of South Africa
34 Essex Terrace
Westville, 3630
P O Box 808
Durban, 4000
Tel: (031) 266-9090 Fax: (031) 266-9199
www.phasa.org.za

Some Related Careers

Health Inspector, Immunologist, Parasitologist, Pathologist, Statistician.



Statistics forms the foundation of an epidemiologist's work.

Epidemiologists look at medical, social, environmental and economic factors when determining the causes of problems.

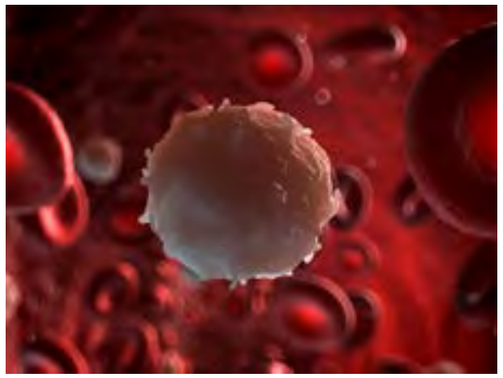
IMMUNOLOGIST

Immunologists study the processes and substances associated with the resistance of human beings and animals to infections and diseases. They study immune reactions and try to work out ways to boost the immune system to enable it to resist harmful micro-organisms more efficiently.

The task of the human immune system is to protect the body against viruses, bacteria and other disease-causing agents such as influenza, meningitis and HIV/AIDS. However, due to a number of factors, people are not always resistant to specific strains of micro-organisms which cause disease and infection.

Immunology is the study of our protection from foreign molecules or invading organisms and our responses to them. These invaders include viruses, bacteria, protozoa or even larger parasites. In addition, we develop immune responses against our own proteins in autoimmunity.

Human beings have two lines of defence against foreign organisms: outer barrier tissues and the inner, adaptive immune system. The barrier tissues, such as the skin, stop the entry of organisms into our bodies. If these barrier layers are penetrated, through a bite, for example, the body contains cells that respond rapidly to the presence of the invader. However, the adaptive immune system may take days to respond to a primary invasion. The body produces antibodies (proteins that bind to foreign antigens) in which specific cells recognise foreign pathogens and destroy them. If neither of these immune defence mechanisms functions properly in the person or animal, then alternative remedial approaches must be taken. Usually this is in the form of antibiotics or another form of sophisticated, strong medical treatment.



White blood cells, or leukocytes (also spelled "leucocytes"), are cells of the immune system involved in defending the human body.

Immunologists help scientists and physicians in the diagnosis, prevention and treatment of infections in animals and people by investigating how organisms cause disease, and their role in attacking the immune system. Work in immunology is often interdisciplinary, so immunologists may work closely with chemists, biochemists, geneticists, genetic engineers, pathologists and other physicians, environmentalists, civil engineers, veterinarians and geologists.

Immunologists use a variety of specialised equipment, such as gas chromatographs and high-pressure liquid chromatographs, electrophoresis units, thermocyclers, fluorescence activated cell sorters and phosphorimagers. They may also use computers in conducting experiments. It is common to find an immunologist using a microscope or performing experiments in a laboratory. However, the nature of the work may vary considerably with each assignment.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Note: Competition to enter medical studies is stiff and there are usually many applicants with excellent grades who would naturally be given preference. So make sure your marks/ symbols are good.

Further Training

Immunologists need at least a bachelor's degree in a biological field.

Postgraduate: **For an independent research immunologist, the minimum education requirement is a PhD in immunology.**

Medical immunologists preparing to work in hospitals usually obtain a medical degree and then specialise in immunology. Medical immunologists are usually expected to spend several years in a post-doctoral laboratory position before they get permanent jobs.

Employment

- universities and colleges
- research organisations
- hospitals, clinics and other health care facilities
- private practice or group practice

Further Information

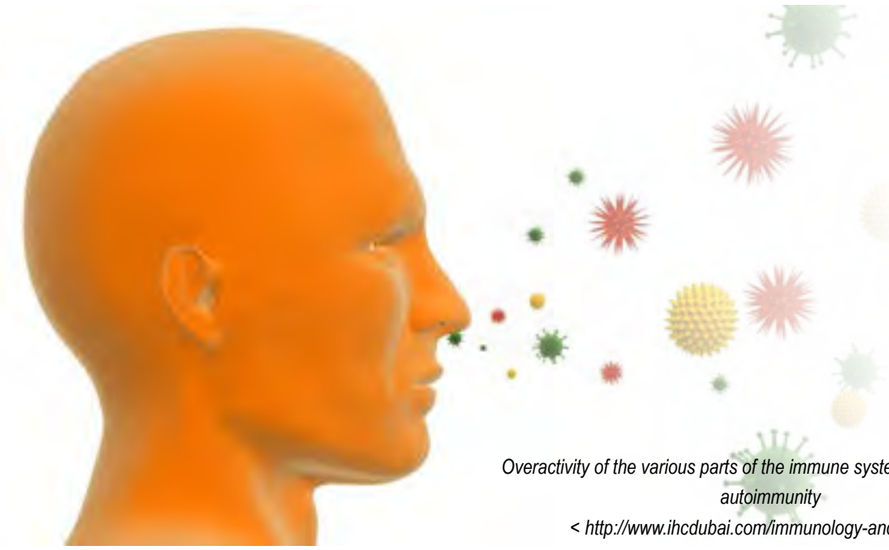
South African Immunological Society
ICGEB, Wernher and Beit Building (South)
UCT Campus, IIDMM
Anzio Road
Observatory 7925
Tel: (021) 406-6616
saimmunology.org.za

Some Related Careers

Endocrinologist, Gastroenterologist, Immuno-haemotologist, Internist, Medical Doctor.

Immunologists have expressed concern about the "dangerous" work of scientists in China who created a hybrid bird flu virus that can spread in the air between guinea pigs, and that now lives in a laboratory freezer.
< http://africa.widmi.com/index.php/south-africa/city-press/top-stories?start=400>

Right: Laboratory work in immunology aimed at providing an insight into how to work with immunological problems, usually with techniques such as cytotoxicity tests, flow cytometry, immuno-histochemistry, molecular biology and immunofluorescence.
< http://www.photo-dictionary.com/photofiles/list/608/1012laboratory.jpg >



Overactivity of the various parts of the immune system leads allergy and autoimmunity
< http://www.ihcdubai.com/immunology-and-allergy/ >

NUCLEAR MEDICINE TECHNOLOGIST

Nuclear medicine technologists prepare, administer and measure radioactive isotopes (similar atoms) in therapeutic, diagnostic and tracer studies. **They gather information on patients' illnesses and medical history to guide the choice of diagnostic procedures for therapy.** They explain test procedures and safety precautions to the patients and provide them with assistance during test procedures. They administer radiopharmaceuticals or radiation to detect or treat diseases, using radioisotope equipment, under the direction of a physician.

Nuclear medicine technologists then produce a computer-generated or film image for interpretation by a physician, process cardiac function studies, using a computer, and record and process the results of the procedures.

Other tasks are to prepare stock radiopharmaceuticals, adhering to safety standards that minimise radiation exposure to workers and patients, maintain and calibrate radioisotope and laboratory equipment, and make sure that legal requirements concerning the handling and disposing of radioactive materials are met.

They assign workers to prepare radiopharmaceuticals, perform nuclear medicine studies and conduct laboratory tests. They are equipped to write computer protocols for new and revised procedures and they train departmental workers in the overall operation of the equipment.

They generally work indoors, in well-equipped laboratories, clinics and hospitals, usually working with state-of-the-art machinery and equipment. Working conditions are very good and professional attitudes prevail.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

There are two main routes to qualification as a nuclear medicine technologist:

One is via a BSc in Clinical Technology with specialisation in Nuclear Medicine. This is combined with training based upon formal practical experience in nuclear medicine, covering the competencies listed in the Training Prospectus for Nuclear Medicine. This would take four years (part-time degree).

Another route is to take a BSc in Radiography, which takes three years, and then specialise in Nuclear Medicine, after first qualifying as a Radiographer. Practical experience can be obtained by working in a nuclear medicine department with the option of taking a postgraduate qualification, an additional minimum of two years.

Degree: BSc . This can be followed by a BSc Hons.

Diploma: NDip: Diagnostic / Nuclear Medicine / Therapy. This 3 year diploma can be followed by a BTech degree after two additional years - these courses are available at some universites of technology.

The Health Professionals Council of South Africa and the National Department of Health strictly control the training, in line with international requirements.

Postgraduate: **MSc Nuclear Medicine.**

Nuclear medicine technologists can advance to supervisory positions such as chief technologist or department administrator. Some technologists advance through specialisation, such as nuclear cardiology, or move on to work in research laboratories. Those technologists with advanced degrees may become teachers in nuclear medicine technology programmes.

Employment

- hospitals
- clinics
- Department of Health
- local authorities
- private radiological practices

Further Information

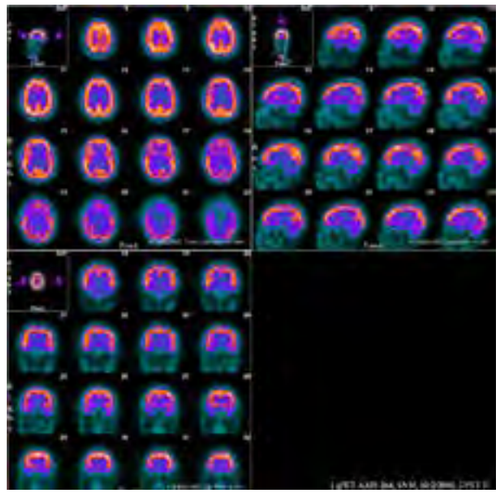
South African Society of Nuclear Medicine (SASNM)
PO Box 70980
De WillgersT, 0041
Pretoria, 0041
Tel: 083-279-7593
www.sasnm.com

Society of Radiographers (SORSA)
Unit A28
Pinelands Business Park
New Mill Road
Pinelands, 7405
P O Box 505
Howard Place, 7450
Tel: (021) 531-1231 Fax: (021) 531-1233
www.sorsa.org.za

Some Related Careers

Medical Technologist, Nurse, Physicist, Radiologist, Radiotherapist, Radiographer

Steve Biko Academic Hospital/University of Pretoria is the first in South Africa to treat liver tumours with SIR-Spheres microspheres. SIR-Spheres microspheres are a medical device used in Selective Internal Radiation Therapy (SIRT) for liver tumors.
< http://web.up.ac.za/default.asp?ipkCategoryID=809 >



Left: Nuclear imaging is a technique that uses radioisotopes, which emit gamma rays from within the body. To make a radiopharmaceutical, a radioisotope is attached to a pharmaceutical that is taken up by a specific organ, or diseased tissues. The radiopharmaceutical is given orally, injected or inhaled, and is detected by a gamma camera which is used to create a computer-enhanced image that can be viewed by the physician.
< http://www2.ansto.gov.au/discovering_ansto/publications_audio_video_and_images >

Right:
ANSTO produces more than 80% of Australia's nuclear medicines. This image shows radiopharmaceutical hot cells in action. (Photo by Nick Cubbin).
< http://www2.ansto.gov.au/discovering_ansto/publications_audio_video_and_images/images_of_ansto/medical_research >

PHARMACOLOGIST

Pharmacologists study the effect that drugs and others substances have on organs, tissues and the bodily functions of humans and animals. Their experiments include establishing the effect drugs have on individual cells; determining how drugs are taken up by the body and how drug concentrations change in the body over a period of time; and testing the safety, activity and possible use of newly discovered or manufactured substances.

Pharmacologists can specialise in drugs that relate to specific parts of the human body; for example neuro-pharmacologists focus on drugs related to the nervous system; cardiovascular pharmacologists specialise in drugs that effect the cardiovascular or circulatory systems; and endocrine pharmacologists study drug effects on hormonal balances.

Other activities of pharmacologists may include the supervision of laboratory technicians and students, the preparation of reports and papers for publication, and teaching students in lecture halls. Pharmacologists are sometimes asked to work with coroners, pathologists or other people involved in solving causes of death.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: There is a wide range of degree courses available. Pharmacology can be studied as a single honours degree or combined with subjects such as physiology, chemistry or toxicology. Alternatively, it is quite common to take a general science degree and a postgraduate qualification in pharmacology.

Postgraduate: Postgraduate specialisation, such as MSc or PhD in Pharmacology is required for a pure research post; available at many universities.

MSc (Med) (Pharmcotherapy), is a course open to pharmacists.

A short course in Pharmacology may be offered to graduates of BPharm or an equivalent qualification.

A medical practitioner trained in clinical pharmacology is known as a clinical pharmacologist.

Employment

- pharmaceutical manufacturers
- hospitals and clinics
- government departments
- provincial administrations
- Department of Health
- SANDF
- research institutes
- universities and laboratories
- self-employment; with enough experience and capital, one can start one's own business, such as manufacturing pharmaceutical products.

Further Information

South African Pharmacy Council
Building 591, Belvedere Street
Arcadia, 0083
Tel: 0861 727 200 Fax: (012) 321-1492
www.pharmcouncil.co.za

Pharmaceutical Society of South Africa
P O Box 75769
Lynwood RidgeA, 0040
Tel: (012) 470-9550
www.pssa.org.za

Some Related Careers

Biochemist, Botanist, Chemist, Dentist, Forensic Scientist, Herbalist, Medical Practitioner, Microbiologist, Pharmacist, Physicist, Zoologist.

FDA pharmacologists viewing data from food samples to identify and detect the presence of heavy metals, such as mercury, in food products such as milk, dietary supplements, juices, herbs, tea, and fish. (Photo by Black Star/Michael Falco for FDA). < http://www.fda.gov/Food/GuidanceRegulation/FoodProtectionPlan2007/ucm132713.htm >

An FDA research pharmacologist is shown developing tests designed to detect certain proteins in cattle feed. The proteins, which are prohibited in cattle feed, may carry a risk for mad cow disease. (Photo by Black Star/Dennis Brack for FDA). < http://www.fda.gov/Food/GuidanceRegulation/FoodProtectionPlan2007/ucm132713.htm>

Laboratory research being undertaken on various pharmaceutical products.

SURGEON

The surgeon is a doctor who specializes in performing surgery to prevent the spread of disease, to correct deformities, to repair injuries and to improve body functions. Patients are referred to a surgeon by general practitioners (medical doctors) and other specialists.

Surgeons diagnose bodily disorders and orthopaedic conditions and provide treatments, such as medicines and surgeries, in clinics, hospital wards and operating rooms. They operate on patients to correct deformities, repair injuries, prevent and treat diseases or to improve or restore patients' functions.

The surgeon examines each patient thoroughly to obtain information on their medical condition and the surgical risk, reviews the medical history, medication allergies, physical condition and examination results to verify the operation's necessity and to determine the best procedure. They usually consult with other doctors to be certain that an operation is necessary. The procedure is explained to the patient and/or the family. They prescribe preoperative and postoperative treatments and procedures, such as sedatives, diets, antibiotics and preparation and treatment of the patient's operative area. They direct and coordinate the activities of nurses, assistants, specialists and other staff.

Before surgery, the surgeon checks the equipment, instruments and surgical setup to be sure that everything needed is present and sterile. After surgery the patient's condition is monitored until they have completely recovered from the operation. Surgeons provide consultation and surgical assistance to other physicians and surgeons, and refer the patient to other medical specialists or practitioners when necessary. They need to manage surgery services, including planning, scheduling and coordination, determination of procedures, and procurement of supplies and equipment.

Surgeons also conduct research to develop and test surgical techniques that can improve operating procedures and outcomes.
Surgeons work indoors in consulting rooms, in hospitals and in operating rooms that must be sterile and temperature-controlled. At times they may visit patients in their wards or in recovery rooms.
In addition, some surgeons may lecture at universities.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: Degree: Bachelor of Medicine and Surgery at the following Institutions: UFS, US, Wits, UP, UCT, UKZN, WSU and Sefako Makgatho Health Sciences University.

Internship: The internship has to be completed at an accredited hospital and under the guidance of qualified clinicians.

Medical Community Service: 12 months of medical community service is required.

Medical Practitioner Designation: After successful completion of the above steps, the Health Professions Council of South Africa (HPCSA) awards the Medical Practitioner designation.

Postgraduate: **Postgraduate specialisation, Master in Medicine (Surgery) (MBChB) at UCT, Wits, UKZN, UP, UFS, WSU and Sefako Makgatho Health Sciences University**

Registration: On successful completion of the examination to qualify as a specialist, the candidate must register with the HPCSA as a surgeon

Employment

- private practice
- hospitals and other health-care facilities
- medical schools
- government departments

Further Information

Association of Surgeons of South Africa ASSA
Room 9S07A, level 9
Wits Medical School
York Road
Parktown, 2193
Tel: (011) 717 2601
www.surgeon.co.za

Health Professions Council of South Africa (HPCSA)
P O Box 205
Pretoria, 0001
Tel: (012) 338-9301
www.hpcsa.co.za

Some Related Careers

Gynaecologist and Obstetrician, Cardiologist, Plastic Surgeon, Surgeon, Orthopaedic Surgeon, Urologist, Neurologist, Nose and Throat Specialist, Plastic and Reconstructive Surgeon, Paediatric Surgeon.

In robotic surgery, the surgeon is controlling every aspect of the surgery with the assistance of the da Vinci ® robotic platform. First, the surgeon makes small incisions (1-2 centimeters; the size of a dime) in the patient's abdomen. These incisions are used to introduce small instruments and a high-definition 3D camera. The surgeon then sits at the da Vinci ® console, where he or she operates the robot and views a magnified, high-resolution 3D image of the area being operated.

State-of-the-art robotic and computer technologies translate a surgeon's hand movements at the console into precise micro-movements of the da Vinci ® instruments, which work like forceps. The system cannot be programmed or make decisions on its own.
< http://obgyn.med.miami.edu/migs/about-the-da-vinci-robot >

On September 26th, 2017
a robot performs first dental surgery without human assistance
A woman in China has had two teeth implanted in a dental surgery completed by a robot without human assistance.
< https://www.today.com/video/robot-performs-first-dental-surgery-without-human-assistance-1055059523839>

Surgical instruments

When Dr Mehran Anvari picks up a surgical instrument and cuts into somebody's flesh, he doesn't use his own hands. In fact, he's not even in the room. He operates on patients that are 400 kilometres away.
From a console in St Joseph's Hospital in Hamilton, Canada, he controls a robot surgeon in an entirely different part of the country, slicing, stitching and removing bits of the body. He's carried out more than 20 operations so far, including colon operations and hernia repairs.
< http://www.bbc.com/future/story/20140516-i-operate-on-people-400km-away >

VETERINARIAN / VETERINARY SURGEON

Veterinary surgeons diagnose and treat sickness and injury in animals. Surgery on animals and the inoculation of animals against infectious diseases are also part of their work. The type of work performed depends on the area in which they have specialised.

Veterinary surgeons who are in private practice, mainly treat sick domestic animals. Some veterinary surgeons test dairy herds for tuberculosis and brucellosis, and inoculate animals against diseases. They perform autopsies to determine causes of death, inspect animals intended for human consumption, both before and after slaughtering. They also give advice on the care and breeding of animals. Large animal practitioners are primarily concerned with the diagnosis and prevention of diseases in large and small stock, with the main aim being the improvement in production of meat, milk and wool.

Although specialisation in an aspect of practice (for example, horses) is becoming more common, many veterinary surgeons in rural areas work with both farm animals and pets. Other areas of specialisation include poultry, dairy cattle, pigs, wildlife and exotic birds.

Veterinarians in general practice may treat various animal species or may specialise in pets in general or in a single species. Those employed by pharmaceutical companies are usually involved in the research and development of many products used in animal health care and with the registration of these products.

With the increase in the number of game farms, the veterinary profession plays an important role in the capture and care of wild animals.

Veterinarian examining a rabbit

Research and development, consultation, teaching, technical writing, the prevention and control of animal diseases, agricultural education, community development, the sale or production of commercial products, or the rendering of technical services for commercial firms, are all fields in which the veterinary surgeon may be involved.

In South Africa, research into diseases affecting livestock is carried out by veterinary surgeons at various institutes, including the Veterinary Research Institute at Onderstepoort. Veterinary surgeons are employed by universities to lecture, but are also expected to conduct research in their chosen fields.

State veterinarians are employed to prevent and control animal diseases that threaten the livestock herds of the country, for example, foot and mouth disease. They are also involved in agricultural education and community development.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BVSc - at Onderstepoort, near Pretoria. This is a six-year degree course.

This degree of the University of Pretoria is recognised by the South African Veterinary Council and is also recognised by the registering authorities in the United Kingdom, Australasia and Malaysia.

Students of veterinary science are required to register with the SA Veterinary Council before the 1st of June of the year in which they first enrol.

Postgraduate: **Research and postgraduate studies, MSc (Animal / Human / Ecosystem Health), or MSc (Veterinary Science) – research, followed by a PhD, can be undertaken at UP in the Veterinary Faculty.**

Employment

- veterinary research institutes
- large stock farms
- zoos
- agriculture
- colleges and universities
- pharmaceutical companies
- CSIR and SA Medical Research Council
- self-employment, in partnership or private practice

Right: Veterinary surgeon examining xrays of a cat's leg before operating.

Further Information

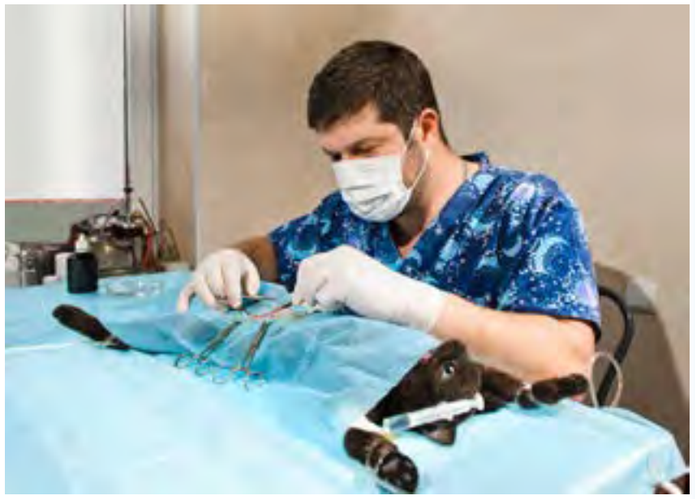
Faculty of Veterinary Science
University of Pretoria
Onderstepoort, 0110
Tel: (012) 529-8132 Fax: (012) 529-8446
www.up.ac.za

SA Veterinary Council
P O Box 60114
Pierre van Ryneveld, 0045
Tel: (012) 345-6360 Fax: (012) 342-4354
www.savc.co.za

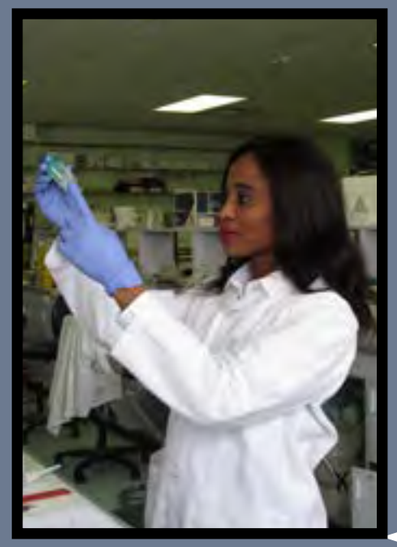
Some Related Careers

Farmer, Fish Farmer, Game Rancher, Game Ranger, Herpetologist, Ichthyologist, Medical Doctor, Medical Technologist, Pathologist, Pharmacologist, Surgeon, Veterinary Nurse, Veterinary Technologist, Zoologist.

Veterinary Laboratory Research.



Veterinary surgeon operating on a cat.



Caroline Pule

Caroline Pule is a doctoral student in the Department of Molecular Biology and Human Genetics, Stellenbosch University. Her research focuses on a very serious medical problem that we have today, to find ways of preventing and treating the drug-resistant Tuberculosis (TB). Her research findings may lead to the development of novel drug targets to combat the spread of drug-resistant TB.

Amongst her numerous academic achievements and awards, Caroline, won the prestigious Bill and Melinda Gates Foundation Global Health Travel Award to attend the Keystone conference on Tuberculosis in Canada. She was recently invited to conduct TB research at the University of Cambridge, in the UK.

Over and above all else Caroline is a devout believer who has known from a young age that she wanted to live a purposeful life and help others. Caroline's career in medical science was born from her desire to help.

We asked Caroline about her work and what had been her motivation to achieve the things she has done:

What factors influenced your choice of career?
"When I was doing my undergrad degree I was saddened by how many lives are lost because of TB, something that used to be so easily treated. Seeing people dying really got to me and I wanted to do something about it. I thought that maybe I could contribute to public health by understanding what causes drug resistant TB and figuring out how to cure it".

Meet a PhD Student in Molecular Biology

What were some of the challenges that you faced growing up?
"Some of my peers (at school) thought I had an unrealistic dream when I told them I wanted to be a scientist, most used to think I was just dreaming … my grand mom used to tell me I could be everything I want to be in the world".

"Always remember that deep within you there is that powerful inner voice that keeps saying, 'you can do it, you've got what it takes to do it', so believe that voice and keep dreaming big."

What advice would you give to a young person wanting to study in the field of science?
"Always remember that deep within you there is that powerful inner voice that keep saying, 'you can do it, you've got what it takes to do it', so believe it and take charge and keep dreaming big".

Did you ever feel like giving up?
"To be honest I have never wanted to give up … always imagining myself in a red gown, getting my PhD, walking the walk of fame and knowing that I MADE IT!".

What is your belief or motto in life?
"You need to believe in yourself as an aspiring woman scientist, hard work pays off, we as women can also achieve excellence in science, never be scared to dream big but allow curiosity and passion to drive you towards achieving your goals".

What is your goal?
To continue doing TB research as post-doctoral researcher and enrol for my MBA degree part-time which will equip me more for my ultimate goal of working for the World Health Organisation, (WHO), finding solutions for pressing public health issues such as TB and HIV/AIDS etc.

Who do you most admire?
"My grandmother … Wow this woman! True Gold! She taught me so much about living a purposeful life, the power of generosity, humility and hard work". "Nelson Mandela, I love how he turned a lemon into a lemonade, something so sour into something so tasteful, preferring to choose forgiveness and freedom for our country".

Vhonani Netshandama

Prof. Vhonani Olive Netshandama is the Director of Community Engagement at the University of Venda (UniVen). She started her career as a nurse, practising at several hospitals in Limpopo and Gauteng. In 1995, she joined Unisa as one of two new black female junior lecturers in what is now the Department of Health Studies.

Vhonani completed her doctoral degree in nursing education at the University of Johannesburg in 2003. For many years she worked as a nurse educator, at the interface between the university and the community, exploring community-based science education models.

She is living proof that a person can define their own career path by rising through the ranks within the medical field.

Vhonani is both an academic and a practitioner who works closely with the community as well as with students and academics from different disciplines in order to create better health outcomes. Among other achievements, she was instrumental in the inception and diversification of a collaborative project with the University of Virginia's Centre for Global Health. Through the project, entitled "Water and Health in Limpopo", more than 100 undergraduate students from both UniVen and the University of Virginia and a significant number of postgraduate students (master's and doctoral) received degrees.

She is passionate about using science for the community and was the initial facilitator in the establishment of Mukondeni Filter Factory, a water filter factory.

Meet a Director of Community Engagement

Mukondeni Filter Factory was a spin-off of a collaborative project between the University of Virginia, UniVen and Mukondeni Pottery near Elim in Limpopo, where the potters were trained to make ceramic water filters.

We asked Vhonani about her work and what had been her motivation to achieve the things she has done. This is what she said:

"Going the longer route as I did, is not the end of the world. If your first choice doesn't work out well for one or other reason, take up the next option available, and get the most out of it"

What factors influenced your choice of career / study?
"For me, it was really about the next possible thing to do. I did not have the liberty to choose per se."
"I could not go to varsity directly from matric. So I took up nursing knowing I would get a stipend as a student".

What were some of the challenges that you faced growing up?
"My mother, a teacher, raised the 5 of us relatively alone because my father passed on when I was 6 years old. By the time I had completed my matric, she could not send me to the university because she was already paying for my first-born brother there".

What advice would you give to a young person wanting to study in the field of science?
"It is still largely a privilege for a few matriculants, particularly in the poor universities. Going the longer route as I did, is not the end of the world. If your first choice doesn't work out well for one or other reason, take up the next option available, and get the most out of it".

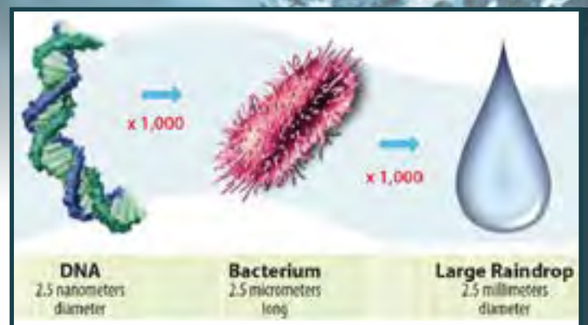
What is your belief or motto in life?
"Opportunities do not arrive in sessions and ceremonies, they are always there. It depends on how you perceive them".

Who do you most admire?
"Young ones who despite their background have so much desire to learn that they light up the room when they enter a place of learning".

NANOSCIENCE

THE SCIENCE OF THE VERY SMALL

What is nanoscience and how are scientists and engineers using it to solve problems in energy, medicine, information storage, computing & more?



National Nanotechnology Initiative NNI: Lawrence Berkeley Lab, US. Department of Energy. (www.nano.gov)

Think small, think smaller than anything you can see under a microscope and start thinking of atoms and molecules. You are now down to nanoscales. A nanometer is a billionth of a meter, or a millionth of a milimetre. Put into perspective, a sheet of paper is 100 000 nanometers thick and a 2.5 milimeter raindrop = 2 500 000 nanometers.

Nanoscience is the study of nano-materials and their properties at an incredibly small scale (between 1-100 nanometers). Nanotechnology is about applying nanoscience to create and improve new products.

Because nanostructures are so small scientists have had to come up with innovative methods to manufacture objects in this size range. Scientists use beams of electrons or ions to cut nanostructures into metal, silicon and carbon-based materials for different purposes. They can form nanostructures by reacting chemicals in liquids and gases to generate nanofibers, nanocrystals and quantum dots, some as small as one nanometer wide.

Scientists are even learning how to build three-dimensional structures at the nanoscale, called nano-electro-mechanical systems, or NEMS. These devices might one day be used like microscopic robots to carry out tasks too small for humans to do themselves. For example, NEMS could carry out surgery on a single cell or act as mechanical actuators to move around individual molecules (http://tremblinguterus.blogspot.co.za).

The discovery of carbon nanotubes in 1991 led scientists to develop hundreds of "functionalisations" for nanotube openings. Most of these can be useful as molecular gates. By creating a series of gateway sheets that perform different functions. Some examples of things that the molecular gateways could be useful for are; the removal of carbon dioxide from the atmosphere; desalination; purification of drinking water; programmable drug delivery, through patches or implantable device; to name just a few. (https://www.mattershift.com/technology/)

Illustration of antibody targeted nanospheres travelling through blood vessels to deliver therapeutic drugs to a cancerous tumor

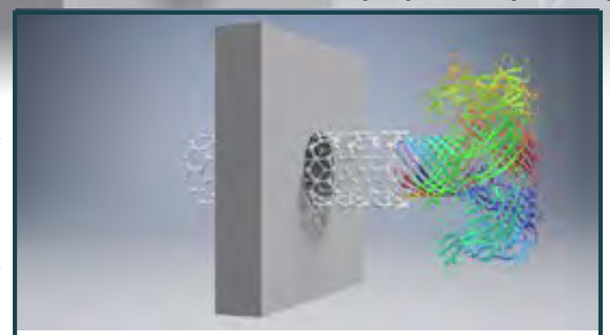
HOW IS NANOSCIENCE APPLIED

MEDICINE

One application currently being developed involves the use of nanoparticles to deliver drugs and heat to cancer cells. Nanoparticles are engineered so that they are attracted to cancer cells and this allows direct treatment to the site affected. Because this treatment is non-invasive it reduces the damage to healthy cells in the body and only the required drug dose is used so the side-effects are lowered significantly. This highly selective approach can reduce costs and pain to the patients. Clinical trials are underway to treat cancer patients, and look at vaccines. http://www.understandingnano.com/medicine.html

ELECTRONICS

Nano electronics means using nanotechnology in electronic components for electronic and computer applications, providing smaller, faster and more portable systems. These systems can manage and store more and more information. Think of your cell phone today and power and storage it has is ever increasing due to nanotechnology. Todays computer microprocessors have less than 100 nanometers (nm) features. The smaller sizes mean a significant increase in speed and more processing capability. These advances will undoubtedly help achieve better computers increasing the capabilities of electronics devices while reducing their weight and power consumption. (www.brighthubengineering.com)



An example of a catalyst gateway with a Nano Electro Mechanical System (NEMS)

The gateways are called "programmable" because a great variety of gates can be added to their openings, allowing them to manipulate molecules in specific ways, so that complex chemical synthesis can be achieved in compact, inexpensive devices. <https://www.mattershift.com/technology/>

TRANSPORTATION

Nanomaterials used to build cars and aeroplanes are lighter and stronger, so therefore use less fuel and fewer metals. Nanotechnologies may not only lighten the aircraft to produce fuel savings, but also do so by adding nanoparticles to the fuel of a conventional jet. This significantly increases its efficiency. Graphene, for example, is a carbon sheet the thickness of a single atom, yet it is stronger than traditional products such as steel and alloys used in traditional vehicle production.

In addition graphene possesses a huge range of useful properties, such as electrical conductivity, absorption of white light, and tolerance to temperature and pH change. (http://www.pauley.co.uk/blog/nanotechnology-in-transport).

RENEWABLE ENERGY

One of the major challenges of our time is replacing fossil fuels such as oil, coal and gas with renewable energy sources such as solar and wind power. Nano structured cells will only use about 1% of the materials used by traditional solar cells suggesting that nano-engineered solar cells could be significantly cheaper to produce and more efficient. They are also a lot more efficient at converting radiation into electrical energy thereby creating a sustainable solution for the use of solar energy and waste heat and lighting, and solve global energy problems. Nanotechnology is being used in a range of energy areas: to improve the efficiency and cost-effectiveness of solar panels; to create new kinds of batteries; to improve the efficiency of fuel production using better catalysis; and to create better lighting systems. Nanotechnology can help in developing new eco-friendly and green technologies that can minimize undesirable pollution.

EVERY DAY USE

Nanoparticles or nanofibers in fabrics can enhance stain resistance, water resistance, and flame resistance of the clothes we wear every day. A tennis racket made with carbon nanotubes bends less during impact, and increases the force and accuracy of the delivery. Nanoparticle-treated tennis balls can keep bouncing twice as long as standard tennis balls. Most sunscreens today are made from nanoparticles that effectively absorb light, including the more dangerous ultraviolet range. Coatings on the surface of vehicles turbine blades and mechanical components stop dirt, scratches, bacteria, rain and mist from settling.

Nanoscience is all about the ultra-small, but it has the potential to have an enormous impact on our lives.

LIFE SCIENCES

Life sciences contribute to sustainable food security and to the maintenance of the world's ecosystems. Life sciences focus on the knowledge, care and development required to maintain and enhance these resources into the future.

The field of Plant Science is the branch of biology dealing with the study of plants and how they interact with other plants, animals and people. Botanists, or plant scientists, perform various types of research on plants, some plant scientists use microscopes to examine the internal structure of plants, some identify plants in the field and others in laboratories working with plant DNA. Plant science also explores the evolution of plants.

The biotechnology revolution has significantly changed the agriculture industry through the use of genetically engineered crops. Biotechnology is one of the fastest growing global industries.

The field of Animal Science is the branch of biology dealing with the understanding of how animals function and the principles of livestock production and animal products.

Animal Science applies the principles of the biological, physical, and social sciences to the problems associated with livestock production and management.

In addition, Animal Science is concerned with the welfare of companion animals such as cats, dogs, horses and others. Animal production is one of the major sectors in South African agriculture and contributes substantially to the economy of the country.

There is a growing need for professionals trained within the plant and animal sciences as a result of the growing world population with changing patterns of diet requirements.

The study of plants and animals is an applied and practical science and looks at some of the biggest challenges facing our planet, including sustainable energy and food production, climate change and the conservation of threatened species.

LIFE SCIENCES STUDY PATHS

National Senior Certificate:
With Mathematics
and Physical Science

Each education institution has its own unique entry requirements for each of its programmes. It is important to check the entry requirements for the programme with the institution of your choice before you apply.

University

Bachelor of Science Degree

Majors in:
Environmental Sciences
Biological Diversity
Cell Biology
Chemistry
Ecology & Evolution
Ecosystems
Genetics
Marine Life & Diversity
Veterinary Science
Zoology
or any other related subject offered by the university.

University of Technology

National Diploma

Diploma in:
Agriculture
Biotechnology
Equine Sciences
Environmental Health
Environmental Management
Fisheries
Horticulture
Nature Conservation
Oceanography
Veterinary Technology
or any other related qualification offered by the university of technology.

Internship / Workplace Experience

Workplace experience is a requirement for the completion of a national diploma at a university of technology.

Postgrad

A postgraduate degree or diploma is needed in order to specialise. Each institution will have specific areas that they will promote. With regard to the plant and animal sciences these specialisation areas may include:

Biodiversity
Agroecosystems
Animal Nutrition
Oceanography
Pasture Nutrition
Parasitology
Veterinary Science
Wildlife Sciences
and many more.

University of technology students who intend doing postgraduate studies at university will first need to check the acceptance requirements with the university concerned. Students studying a national diploma will need to complete a Bachelor of Technology Diploma and / or a Master of Technology degree as a requirement for entry.

AGRONOMIST

Agronomy is the science of the successful growing of certain land crops, whether it is under dry land conditions or irrigation. Crops include corn, maize, grain sorghum, peanuts, sunflower, cotton, sugarcane, forage crops and fruit.

Agronomists develop and implement production systems so that economical production is maximised without harming the environment. They investigate field-crop problems and develop new and improved growing methods for higher yields or better quality. They advise farmers about the best crops and cultivars, crop rotation, fertilisers, field drainage, irrigation and harvesting techniques, and provide information on plant diseases, weed killers and the biological control of insect pests.

Aspects such as the choice of crop and cultivar, preparation of soil, planting of crops, irrigation, protection of the harvests and the harvesting and grading of all agricultural crops are all studied by agronomists. The aim is to manipulate the interaction between plant and environment through the use of correct management practices.

Soil is cultivated and fertilised according to the conditions each crop demands of the soil. Agronomists take climatic conditions of specific regions into consideration as this determines which cultivar should be planted, as well as the planting time and planting techniques that should be used.

Plants need to be protected against weeds, diseases and insects. If crops are irrigated, the right amount of water at the right stage of development needs to flow. Finally, crops need to be harvested at the right stage with the correct harvesting techniques to ensure the best quality.

Some agronomists become representatives of manufacturers and show farmers the most effective uses for new products. Some travel to neighbouring countries to help the people increase their food production by means of new techniques.

Other agronomists work on developing new types of grain, legumes and grasses using techniques that will increase and improve food production and help replenish the soil.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the degree requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Science.
Recommended Subjects: Life Sciences, Geography, Agricultural Sciences.

Further Training

Degree: The minimum requirement is a four-year BSc (Agric) degree with agronomy or plant production as a major subject. Other subjects that may be taken are plant physiology, soil science, plant diseases and meteorology.

Postgraduate: **A MSc Agric, PhD – the research component of postgraduate study focuses on five main scientific disciplines: agronomy, horticulture, pasture science, soil science and forestry.**

Employment

- Department of Agriculture
- Department of Water Affairs and Forestry
- manufacturers of fertilisers, weed killers, pesticides and agricultural implements
- seed and plant producers
- harvest insurers
- universities and agricultural colleges
- agricultural cooperatives
- self-employment, as a consultant

Career possibilities include research, agricultural extension, education and training, as well as the management of agricultural projects.

Further Information

Agricultural Research Council
P O Box 8783
Pretoria, 0001
Tel: (012) 427-9700 Fax: (012) 342-3948
www.arc.agric.za

Department of Agriculture
Private Bag X250
Pretoria, 0001
Tel: (012) 319-6000 Fax: (012) 319-0000
www.daff.gov.za

Agri SA
Private Bag X180
Centurion, 0046
Pretoria, 0001
Tel: (012) 643-3400 Fax: (012) 663-3178
www.agrisa.co.za

Some Related Careers

Agricultural Engineer, Agricultural Economist, Agricultural Inspector, Agriculturalist, Botanist, Environmental Scientist, Farmer, Forester, Horticulturalist, Oenologist, Viticulturalist.

Agronomist looking at wheat quality with the farmer

One of the 700 Nestlé agronomists who specialise in cocoa plant science, resulting in improved production quality, output and efficiency. Abidjan R&D centre, Côte d'Ivoire
<www.flickr.com/photos/nestle/sets/72157622637724298/detail/ >

ANIMAL HUSBANDRY SPECIALIST

Animal husbandry is the science of looking after and breeding animals — specifically those that are used in agriculture, to provide products for research purposes or as domestic pets.

Agriculture has been practised for thousands of years, and involved, at an early stage, the keeping of animals for meat, milk and clothing. Humans learned which animal species could be domesticated for maximum productivity. They studied their habits, protected them from predators, assisted with births, and learned how to treat or prevent many ailments.

Assisting rural farmers to increase their milk production
<http://indigotrust.files.wordpress.com>

In South Africa, until the end of the 19th century, cattle were kept mainly for draft purposes and bred for strength and endurance; meat and fat needs were provided by sheep. The cattle gave little milk and yielded poor-quality meat, while the sheep gave only fat mutton and no wool. The introduction of foreign breeds and crossbreeding gradually improved the stock, eventually providing excellent meat, wool of fairly good quality and good milk yields.

Animal breeding is a specialisation in animal science, dealing with the breeding of livestock and other species, with the aim of genetically improving and/or conserving a population (e.g. a breed or herd) of animals. This is done through the selection and mating of those animals that have the desired traits, according to the breeding objectives decided upon for that population.

The animal breeder plays the role of a "genetic engineer" in the development of future generations.

Unfortunately, the results of an animal breeding programme can usually only be seen after some years, because the generation interval of most livestock species is long - for cattle it is about five years.

Animal husbandry covers a wide range of activities, including care and grooming, livestock farming, accommodation and hygiene. The field also overlaps with many other disciplines, such as agriculture, veterinary science and genetics. Not all people involved in husbandry will necessarily take part in all these activities or require knowledge of other disciplines. In many parts of the world, people are essentially practising animal husbandry through being farmers, ranchers, sheepherders, or simply through taking care of large groups of livestock.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course, where appropriate.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Life Sciences.
Recommended Subjects: Physical Sciences.

Further Training

Degree: Animal husbandry specialists or animal scientists are trained in many South African universities, where a four-year BSc.degree in animal science is offered. Animal anatomy and physiology, monogastric (pigs, poultry, dogs and cats) and ruminant (cattle, sheep and wildlife) nutrition, breeding and management are studied at graduate level.

Specialisation in a specific discipline is often required to ensure employment opportunities as an animal husbandry specialist, especially for senior positions in research and education.

Postgraduate: A MSc and/or PhD degree requires an in-depth study of a specific subject in one of the disciplines (e.g. nutrition, breeding or physiology) of animal science. Training in business management will always be an asset when applying for a management position.

Employment

- Agricultural Research Council
- Department of Agriculture
- breeding organisations
- companies involved in farming
- agricultural colleges and universities

Further Information

South African Society for Animal Science
P O Box 13884
Hatfield, 0028
Tel: (012) 420-6017 / 084 404 4725
Fax: (012) 420-3290
www.sasas.co.za

SA Association for Professional Animal Scientists
P O Box 13884
Hatfield, 0028
Tel: (012) 420-3268 Fax: (012) 420-3290
www.sasas.co.za

Giraffe eating mineral supplement
<http://www.sasas.co.za>

Some Related Careers

Geneticist, Livestock Farmer, Microbiologist, Zoologist.

AQUACULTURIST

Aquaculturists specialise in large-scale aquaculture and fishery products as cash crops. Aquaculturists catch and harvest, raise and culture, fish and shellfish such as shrimps, clams, lobsters or oysters under controlled conditions for release into fresh or saltwater.

Many Aquaculturists are involved in commercial fish farms and specialise in either freshwater or marine animals. They stock ponds, feed fish, monitor water quality, check for diseases, harvest fish and maintain equipment.

Reticulation Systems
<http://www.akvagroup.com/products/land-based-aquaculture>

Tasks include:

- conducting and organising aquaculture or fishery stock examinations to identify diseases or parasites
- arranging the sale of produce and catches with buyers
- contracting with fishing skippers or owners of vessels and aquaculture farms for fishing and aquaculture operations, or for management or production
- coordinating the selection and maintenance of brood stock
- devising and coordinating activities to improve fish hatching and growth rates, and to prevent disease in hatcheries
- directing and monitoring the transfer of mature fish to lakes, ponds, streams or commercial tanks
- directing and monitoring trapping and spawning of fish, egg incubation and fry-rearing, applying knowledge of management and fish culturing techniques
- establishing and managing budgets, monitoring production output and costs, recording information such as fisheries, management practices, and preparing financial and operational reports
- monitoring aquaculture and fishery market activity and planning production and fishing activities to meet contract requirements and market demand
- monitoring environments to maintain or improve conditions for aquatic life
- overseeing the selection, training and performance of aquaculture or fishery workers and contractors
- purchasing machinery, equipment and supplies such as vessels and nets.

Aquaculture has been identified as a critical industry, due to the popularity of its produce and the declining yields world-wide. In South Africa, Aquaculture has been identified as part of the key industries for promotion in line with the country's Industrial Policy Action Plan II (IPAP II). The Department of Agriculture, Forestry and Fisheries is also lending its support to the sector and encouraging collaboration with stakeholders across the sector.

How to Enter This Occupation:

Level of Schooling & School Subjects

National Senior Certificate meeting requirements for a degree course, where appropriate.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Life Science, Physical Sciences.

Further Training

Degree: BSc Aquaculture courses, Aquaculture Distance Education Programme.
Once in possession of a degree, it is usual to work as a trainee or technician to gain practical experience. It can then be possible to progress to positions such as manager in small fisheries or hatcheries, assistant manager in larger ones, or staff biologist.

Postgraduate: Aquaculture research.
A master's degree is usually needed for managerial positions at larger facilities, senior scientist positions at large fisheries, or on research projects.

With experience, aquaculture workers can qualify for positions as consultants in private firms or as senior scientists. Aquaculturists with PhDs can also lead research projects.

Employment

- aquaculture farms or businesses
- Department of Environmental Affairs and Tourism
- Department of Agriculture
- hatcheries
- private firms

Further Information

Aquaculture Association of Southern Africa
P O Box 71894
The Willows
Pretoria, 0041
Tel: (012) 803-5208 Fax: 086 232 9677
www.aasa-aqua.co.za

South African Institute for Aquatic Biodiversity (SAIAB)
Private Bag 1015
Grahamstown, 6140
Tel: (046) 603-5800 Fax: (046) 622-2403
www.saiab.ac.za

Sea Fisheries Research Institute
Foretrust Building
Martin Hammerschlag Way
Foreshore, 8001
Tel: (021) 402-3173

Department of Science and Technology (DST)
www.dst.gov.za

Department of Trade and industry
www.thedti.gov.za

Department of Agriculture, Fisheries and Forestry
www.daff.gov.za

AquaStel
www.sun.ac.za/kie/unistel/aquaculture/aquastel

Some Related Careers

Animal Breeder, Animal Scientist, Livestock Farmer, Marine Biologist, Oceanographer, Zoologist.

Aquaculture & Fisheries For Socio-Economic Growth
FAO and ANA developing monosex tilapia hatchery production at Richard Toll Senegal
<http://www.sarnissa.org/HomePage>

BIOCHEMIST

Biochemistry is a fundamental science that deals with the building blocks and components of living organisms, as well as their functioning and physical qualities. It is a very broad discipline with two main objectives: to identify and describe the chemical components of life, and secondly, to discover how these components act and interact in processes essential to life. This is the area where important discoveries are made in the war against cancer and HIV/AIDS, and in biotechnology (e.g. the conversion of biological material into fuel).

A biochemist working in her laboratory

Biochemists deal with phenomena that distinguish the living from the non-living in chemical and physical terms. They work with animals, plants or micro-organisms and endeavour to bridge the gap between the highly integrated activity of the living cell (a biological unit) and the properties of its individual components.

The nature of the work varies with the field of work chosen. Some biochemists research new products or ways of re-using waste materials. Others try to develop better methods for water purification, or are involved in the control and purification of foods. A few work in industries where products are manufactured through chemical processes and reactions (biotechnology). Biotechnology is used in areas as diverse as household products, cosmetics, musical instruments, preservatives, agriculture, detergents, medicines, fuels, communication media, explosives, rockets, nutrients, fertilizers, etc.

Some examples of biotechnological breakthroughs include the discovery of the Rhesus factor in blood. At the beginning of the 20th century, blood transfusions were very dangerous and even when the outcome was successful, it was a touch-and-go affair which sometimes led to fatalities. Karl Landsteiner, in 1900, identified four major blood groups and devised ways of identifying them. In 1940, he made another contribution with his discovery of the Rh (Rhesus) factor.

A second example is the discovery of vitamins. In the late 20th century, a balanced diet was taken for granted but early in the century, it was only suspected that some foods contained health-giving properties. In 1890 a Dutch medical officer observed that the incidence of beriberi was linked to diet, and that it was better to eat brown rice than white rice. He was partly correct but the right answer was found by the British biochemist, F.C. Hopkins, when he discovered vitamins.

Biochemists may be involved in the development of antibiotics and the testing of human body reactions to certain medicines. They may also work in the fields of genetics and forensic science.

To clarify the difference between biochemists and other types of chemists, the following should be useful:

- Analytical chemists determine which substances are present in a sample and in what quantities
- Biochemists study the chemical reactions in living materials
- Industrial chemists apply their chemical knowledge to the manufacturing of essential products in everyday life
- Inorganic chemists investigate the reactions of compounds other than carbon compounds
- Organic chemists study the reactions of carbon compounds and the production of new compounds
- Physical chemists investigate the fundamental aspects of chemical reactions
- Nuclear chemists use the developments made in the field of nuclear science
- Theoretical chemists attempt to refine existing theories and develop new theories.

More recently, genetic biology, which is the analysis and alteration of genetic material, has become an important field.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: A biochemist must be a BSc graduate. The course takes three years to complete full-time or four years to complete part-time. This course can be followed at any university.

Since biochemistry covers such a broad spectrum, an honours degree is recommended. Biochemistry is closely related to other fields such as microbiology, zoology, genetics, botany, physiology, physics and chemistry. Since biochemistry forms a link between the physical (exact) sciences such as chemistry and physics, and the biological sciences such as botany, zoology, physiology and microbiology, training with Biochemistry as one of the majors offers the opportunity of making a choice between careers that exist in either of these fields.

Postgraduate: Further study up to doctoral level is required for lecturing, high-level research and for advancement to management and administrative positions. One option is medical biochemistry, or honours in biochemistry, chemistry, organic chemistry or microbiology. A biochemist qualification can also lead to a career as an immunologist.

Employment

- government departments, such as Agriculture and Health
- organisations such as SABS, CSIR, SA Medical Research Council and NECSA
- universities and universities of technology (Faculties of Medicine, Science and Agriculture)
- industries that manufacture food, beverages, drugs, insecticides, cosmetics and other products
- municipalities
- large hospitals
- pharmaceutical companies
- breweries and wine corporations
- self-employment, as a consultant to industry and government, etc.

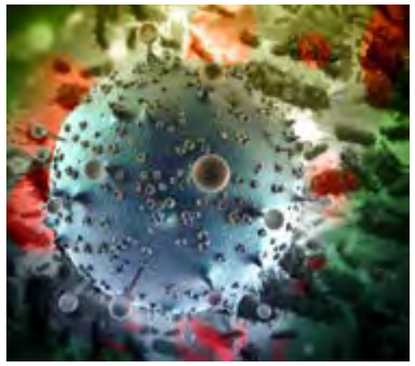
Further Information

South African Society of Biochemistry and Molecular Biology (SABMB)
Rhodes University
Grahamston, 6139
www.sasbmb.org.za

South African Chemical Institute
School of Chemistry
University of Witwatersrand
Private Bag X3, Wits, 2050
Tel: (011) 717-6705
www.saci.co.za

Some Related Careers

Agriculturist, Biologist, Botanist, Chemist, Entomologist, Horticulturist, Microbiologist, Pharmacist, Veterinary Surgeon, Zoologist.



Microscopic view of an HIV cell.

A biochemist working in a research laboratory. <http://www.wisegeek.com>

BIOTECHNOLOGIST

Biotechnologists use engineering and science to create new products from biologically-based raw materials such as vaccines or pharmaceuticals. They also develop factory processes that reduce pollution or treat waste products. Biotechnologists are also known as Bioprocess Engineers; Biochemical Engineers; Research Engineers; Process Engineers; and Fermentation Scientists / Technologists.

Biotechnologists study and examine micro-organisms such as bacteria, fungi, yeast, and their enzymes. They operate and maintain equipment used to process biological materials such as whey, foods and pharmaceuticals.

Biotechnologists develop and test methods of making new products on both small and large scales, which may involve genetic modification of organisms to make new products. They may be required to monitor production trends and data, and work out budgets and production costs.

Biotechnologists have to deal with problems when processing biologically-based materials and products. They may study the effect of waste materials on the environment; develop new waste treatment processes; and actually treat waste for safe disposal.

Biotechnologists need to have mechanical, laboratory and technical skills to perform experiments and tests. Biotechnologists need to know about biochemistry, microbiology, physics and mathematics, as well as mechanics, engineering and industrial processes. They also need budgeting and business management knowledge and skills.

They need to keep up-to-date with environmental matters, and with the technology and computer applications used in their industry. They may travel overseas to conferences and meet clients.

Equipment that biotechnologists use includes fermenters to make new substances from bacteria; centrifuges and other processing equipment to separate liquids and solids and to modify them chemically and physically; and other laboratory equipment such as microscopes, filters, pumps, and evaporators. They usually wear protective clothing, such as laboratory coats, safety glasses and gloves, as they may work in dirty, messy and noisy conditions and, in some cases, with hazardous chemicals.

How to Enter This Occupation:

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BSc majoring in biochemistry, genetics and microbiology at most universities, or courses offered at the universities of technology.
Diploma: N.Dip. Biotechnology and BTech.

Postgraduate: **A doctorate majoring in Biotechnology is the preferred qualification.**

Skills are gained on the job, and employers may provide short courses and training at tertiary institutions.

Biotechnologists can progress into fields such as agricultural biotechnology, biological forensic analysis, bioprocess engineering, conservation genetics, environmental biotechnology, immunology, medical biochemistry, microbiology or plant pathology.

Employment

- factories
- water treatment plants
- dairy, food, and meat processing plants
- pharmaceutical companies
- agricultural companies
- regional councils
- leather manufacturers
- pulp and paper processing industries
- breweries
- universities

Further Information

The Society of Medical Laboratory Technologists of South Africa
P O Box 505
Howard Place, 7450
Tel. (021) 531-1231 Fax: (021) 531-1233
www.smltsa.org.za

Some Related Careers

Biochemist, Biologist, Biomedical Engineer, Botanist, Brewer, Chemical Engineer, Food Scientist, Life Scientist, Marine Biologist, Microbiologist, Physiologist, Quality Controller.

Collecting samples to assist with a waste treatment project

Professor Himla Soodyall (left), University of the Witwatersrand, discussing DNA extraction with Ms Khanya Vokwane.
< http://www.saasta.ac.za/Media-Portal/biotech.html >

Biotechnologist Ntsane Moleleki is looking into the use of yeast to produce human therapeutic proteins.
(Photo by CSIR)
< http://www.saasta.ac.za/Media-Portal/biotech.html >

CONSERVATION SCIENTIST

Conservation scientists are responsible for implementing and carrying out programmes for the management and conservation of animal and plant populations and habitats.

Conservation scientists conduct research both outdoors in the field and indoors in a laboratory. They study relationships between organisms and their environment or habitat, how plants and animals develop, grow and die, and what the best way is to conserve them.

They investigate ecological problems and how they affect the environment and communities and they develop solutions for controlling the problems.

Rhino conservation now has two key elements – increasing numbers and the fight against poaching.
< http://westernrural.files.wordpress.com >

They conduct environmental impact studies and submit reports of their findings. Conservation scientists also conserve natural resources by managing, monitoring and restoring ecosystems. These ecosystems can include rainforests, coastal plains, mountain ranges and lakes or dams.

Conservation scientists can specialise in different areas of conservation such as wildlife, plants or birds. Some teach students and the public by running conservation education programmes at educational institutions. They also write and publish articles and research papers, deliver lectures and presentations, and arrange outreach programmes to the local communities.

Conservation scientist works closely with institutions and organisations that rely on natural resources for their operation, helping them to organise their activities in a way that least damages the environment.

Conservation scientists and foresters typically work in offices, in laboratories, and outdoors, often doing fieldwork in remote locations.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics (some institutions require Physical Sciences and / or Life Sciences).
Recommended Subjects: Physical Sciences, Life Sciences, Geography.

Further Training

Degree: BSc Ecological Science or BSc degree in environmental science, conservation ecology, natural resource management or other related field.

Diploma: NDip and BTech Nature Conservation at some universities of technology.

Additionally, a strong general knowledge of nature is required, which includes basic survival skills, as conservation scientists tend to spend a lot of time in the wild on their own without direct supervision.

Postgraduate: **Further studies in the chosen field of interest are recommended.**

Areas of specialisation

Research including field work but mainly involving studying and working in the laboratory.

Business and economics which concentrate on friendly practices or "greening" as more people become concerned for the planet.

Planning and engineering, relying on strong mathematical skills and methodical thought.

Policy and activism involves actively engaging in changing policy and these people need to be passionate and persuasive.
Education and adventure, this can be a life calling for many people.

Employment

- conservation organisations (both private and government)
- agriculture including forestry
- universities
- research organisations
- mining and the water environment (aquatic conservation ecologist)

Some may also move into environmental manager positions in large corporate companies.

Further Information

WWF South Africa
P O Box 23273
Claremont, 7735
Tel: (021) 657-6600 Fax: 086 535 9433 (national only)
Gauteng Office: Ground Floor
Presidents Place
1 Hood Avenue
Rosebank, 2196
Tel: (011) 447-1213 Fax: (011) 447-0365
www.wwf.org.za

The South African Agency for Science and Technology Advancement (SAASTA)
P O Box 1758
Pretoria. 0001
Tel: (012) 392-9300 Fax: (012) 320-7803
www.saasta.ac.za

The South African National Biodiversity Institute (SANBI)
Private Bag X101
Pretoria, 0184
2 Cussonia Ave
Brummeria
Pretoria, 0001
Tel: (012) 843-5000 Fax: (012) 804-3211
www.sanbi.org

South African Environmental Observation Network (SAEON)
The Woods
Building C
Ground Floor
41 De Havilland Crescent
Persequor Technopark
Pretoria, 0020
Tel: (012) 481-4321 Fax: (012) 349-7719
www.saeon.ac.za

Some Related Careers

Animal Ecologist, Conservation Officer, Ecologist.

Deforestation results in soil erosion and watershed destabilisation, and can lead to flooding or drought, which may contribute to regional and global climate imbalances. The planting of tree seedlings by individuals and conservation groups is one way of curbing this problem.
< http://www.conservation.org >

FORESTER/SILVICULTURIST

Foresters plan and manage the growing, protection and harvesting of trees and help to manage their utilisation. They can choose to enter one of the following areas of activity in forestry:

Management: The majority of foresters are placed at forests or plantations where they initially serve as assistants and later as managers. Their duties include the raising of seedlings in a nursery and the planting of trees. They also coordinate and assist with the pruning, thinning and felling of trees, the sawing of felled trees into logs, and their loading. They burn firebreaks and protect the forests against fire and damage. They may have to maintain roads, erect buildings and maintain telephone lines.

Conservation: Conservation foresters are responsible for conserving the fauna and flora, as well as the soil and water resources. They also manage and plan recreational activities such as hiking and picnicking in forest areas.

A Forester using a tape to measure the girth of a Fir tree

Research: Research foresters conduct research to ensure the preservation of trees and specialise in growth modelling, forest genetics, conservation and ecology.

Extension foresters: advise farmers and educate the public about the importance of trees.

Areas of specialisation

Silviculture involves tree breeding, forest tree seed, nursery practice, establishment and tending, forest nutrition, and management of ectomycorrhizal fungi.

Forest soil science involves soil classification, soil manipulation and site evaluation.

Forestry finance includes project selection, land and plantation valuation, optimal financial rotations and inflation economics. Other areas of specialisation include growth and yield science, forest biometrics and the modelling of plantation development.

Forest engineering is concerned with the environmental, social, physical and economic impacts of harvesting. This includes the management of the total supply chain from felling to mill delivery. The effect of harvesting methods and systems is analysed with regard to the impact on wood procurement cost and wood and fibre quality, as well as ergonomics. Other factors are access development, forest road construction and network management.

Foresters work mostly out of doors and are sometimes subject to considerable stress, especially during fast-changing climatic conditions and due to the steep and mountainous nature of many forests.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences, Economics, Agricultural Science.

Further Training

Degree: A four-year BSc Forestry degree and a course in wood science are available.

Diploma: N.Dip. Forestry. The course may take two or two and a half years, followed by theoretical training and two six-month practical semesters with a forestry estate.

Postgraduate: **A forest science postgraduate programme leading to master's and PhD.**

A postgraduate forestry degree, (BScForHons, MScFor and DSc), can be followed, or a postgraduate diploma in forestry and wood products sciences, (PGDipFor).

N.Dip. can be followed by BTech Forestry. Also offered is N.Dip. and BTech in Wood Technology, as well as a MTech and DTech Forestry or Nature Conservation.

Employment

- forestry branch of the Department of Environmental Affairs
- Institute for Commercial Forestry Research
- city councils
- timber-growing organisations
- sawmills and timber-preservation organisations
- private forestry companies
- organisations such as: SABS, SAPPI, Mondi Paper, Nampak Paper Ltd and Carlton Paper Corporation

Further Information

Faculty of AgriSciences
University of Stellenbosch
Private Bag X1
Matieland, 7602
Tel: (021) 808-3323
www.sun.ac.za/forestry

Some Related Careers

Ecologist, Farmer, Fish Breeder, Fisherman, Fruit Farmer, Game Ranger, Grassland Scientist, Horticulturist, Nature Conservationist, Professional Hunter, Silviculturist, Soil Scientist, Wood Scientist.

A forester reviewing a log pile

The South African Department of Forestry is experiencing a tough battle with a wasp that has become a serious pest in South Africa.
< http://www.timrite.co.za/www/announcements.asp >

MARINE BIOLOGIST

Marine biology is a diverse science concerned with all aspects of plant and animal life in the sea. Marine biologists study the distribution, abundance and life histories of animals and plants in the sea and the way in which these are governed by environmental factors.

A marine biologist holding a crab

The eventual aim of marine biology is to understand marine life and to ensure the production of food from the sea at a sustained level. The field of marine biology can be divided into research and technical work:

Researchers study the marine system as a whole or focus on a particular marine species.

Technical marine biologists are more involved in collecting samples, building and testing equipment, and analysing data.

Marine biologists are concerned with the effects of pollution on marine life, the effect of introducing commercially important species into the waters, identifying ecologically sensitive areas, and assisting in determining the ecological effects of projects such as the construction of harbours and piers.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BSc Oceanography or zoology and botany as major subjects, with supporting courses in physiology, geology, statistics and mathematics at most universities.

Diploma: N.Dip. Nature Conservation; or Oceanography; Maritime Studies. This provides a good background for work in the field of marine conservation.
These courses are mainly available at coastal universities.

Postgraduate: **An honours degree is the minimum qualification needed to become a researcher.**
A postgraduate qualification in ichthyology and fisheries science can be obtained, a postgraduate degree in marine studies, or a postgraduate diploma in Commerce (Maritime Studies). Also available:
Applied Marine Science Master's Degree.
BPhil, MPhil and PhD in Maritime Studies.

Employment

- universities
- museums
- CSIR
- Sea Fisheries Research Institute
- Department of Environmental Affairs and Tourism
- National Parks Board
- Oceanographic Research Institute
- commercial fishing companies
- self-employment as a consultant

Further Information

SA Association for Marine Biological Research
P O Box 10712
Marine Parade, 4056
Tel: (031) 328-8222 Fax: (031) 338-8188
E-mail: info@seaworld.org.za
www.saambr.org.za

Some Related Careers

Aquatic Scientist, Biologist, Ecologist, Environmental Scientist, Game Ranger, Geohydrologist, Hydrologist, Ichthyologist, Microbiologist, Oceanographer, Physiologist, Zoologist.

A marine biologist holding an injured turtle.

Study of intertidal rock habitats on the Indian Coastline.

Study of marine life in the Red Sea.

GENETICIST

Genetics is the biological science that studies the ways in which hereditary qualities are transferred from one generation to the next. Genetics provides an essential basis by which all living organisms, from micro-organisms to plants, animals and the human race, are studied.

Geneticists study the genetic composition of living organisms and attempt to explain how information is transferred from one cell to another and from one generation to the next.

Genetics can be divided into the following fields:

Cytogenetics: The genes that occur in the genetic material of the organism determine the characteristics of organisms. This genetic material (DNA) is packed in the cell in the form of chromosomes. The qualities of chromosomes and their behaviour form the central part of cytogenetics.

Molecular genetics: A study is made of the molecular nature and functioning of genetic material. Techniques are developed through which scientists are able to characterise, change and utilise genes for commercial use. This technology is applied in genetic engineering and biotechnology and plays an increasingly important role in the medical, agricultural and industrial fields.

Molecular geneticist setting up an experiment

Population genetics and plant and animal breeding: The study of genes on the cellular level and the behaviour of genes in groups of organisms go hand in hand. This gives rise to one of the most important fields of genetics application, namely the use of genetics to make predictions, which are then used in the breeding of plants and animals.

Human genetics: An important field of genetics is the study of genetic diseases in humans. Better knowledge of human genetics and the molecular nature of defective genes makes it easier to successfully diagnose and prevent possibly genetically associated diseases.

Other fields of application are microbe-genetics, pharmaco-genetics, cancer-genetics, immuno-genetics and the genetics of mental disabilities.

Geneticists often perform laboratory work, but also work on farms where they work on plant breeding. These are outdoor posts, but geneticists can also be office and /or laboratory bound. They do laboratory research, computer analyses, mathematical analyses in population studies and breeding, and diagnostic work in the human, plant and animal fields.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: The following degrees, which generally include the option of a course in genetics, are offered at most universities - BSc degree, BSc (Agric). The Natural Sciences and Agriculture faculties of universities can be contacted for further information.

The BSc takes three years and a BSc (Agric) four years to complete. Several job opportunities, especially in research, require postgraduate qualifications.

Today, especially in South Africa, the field of biotechnology is showing immense growth, especially in Plant Biotechnology.

Postgraduate: **Those who wish to become geneticists must undertake advanced postgraduate studies such as BSc MedSci Hons, MSc MedSci, PhD Human Genetics; BSc Hons, MSc, PhD Human Genetics; or BSc Hons, MSc (Med) Genetic Counselling.**

Employment

- universities
- hospitals
- research institutes such as CSIR, the Medical Research Institute and the Veterinary Research Institute
- agricultural research institutes
- National Botanical Gardens
- private institutions, such as AECI
- plant breeding companies
- animal breeding companies
- forensic laboratories
- self-employment; plant and animal breeders can start their own businesses

Further Information

The Southern African Society for Human Genetics (SASHG)
University of the Witwatersrand
P O Box 1038
Johannesburg, 2000
Tel: (011) 489-9211/9223 Fax: (011) 489-9226
www.sashg.org

Some Related Careers

Agriculturalist, Animal Breeder, Animal Scientist, Biochemist, Botanist, Chemist, Entomologist, Genetic Engineer, Horticulturist, Microbiologist, Pharmacist, Stud Farmer, Zoologist.

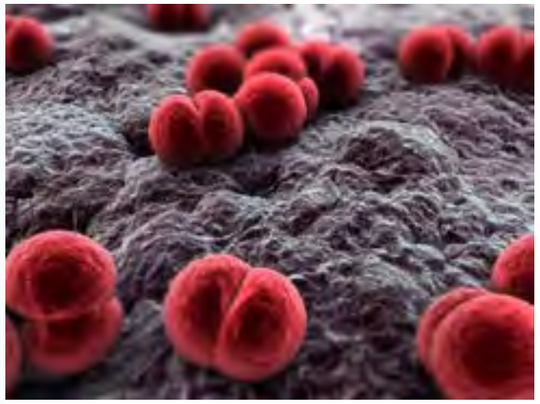
A genetic migration map of the Y chromosome in humans.
< http://www.tumblr.com/tagged/population%20genetics>

A DNA Molecule.

MICROBIOLOGIST

Microbiologists study the basic anatomy, genetics and physiology of micro-organisms, such as bacteria, fungi and viruses, as well as the vital interaction between micro-organisms and the environment.

They apply this knowledge to manipulate micro-organisms both ecologically and industrially, to improve the quality of life and to diagnose and control micro-organisms which infect human beings, animals and plants.



Microscopic view of Neisseria meningitidis, one of the most common causes of bacterial meningitis. <http://www.bioquell.com>

Micro-organisms are found everywhere, from places such as Antarctica, to the volcanic pipes on the bottom of the ocean with temperatures of 268ºC, the salt pans in Namibia, the bloodstream of animals, and swamps where the only source of food is carbon dioxide. Even though they are very small and usually invisible to the naked eye, micro-organisms play vital roles in biological activities in our environment as they interact with human beings and animals, either detrimentally or beneficially.

In the medical world, microbiologists are involved in the quick and accurate location and identification of pathogenic micro-organisms. They develop effective vaccines and methods of preventing epidemics of dangerous diseases.

Microbiologists are involved in various activities such as:

- finding solutions for fresh water pollution
- the identification of pathogenic micro-organisms
- prevention of food decay
- microbiological processes in the industry where micro-organisms are used in the manufacture of chemicals
- the control of unwanted microbe activities which can cause losses, for example the degradation of aviation fuel, the corrosion of iron tubing and the breaking down of textile products
- micro-organisms are also used in the production of antibiotics

Areas of specialisation include:

- Environmental Microbiology
- Genetics
- Immunology
- Medical Microbiology
- Mycology
- Virology
- research
- teaching
- administration
- Laboratory Direction (Supervision)
- Product and Process Control

Microbiologists work in laboratories in a wide range of employment areas. Laboratories are equipped with microscopes, dyes, stains, beakers, test tubes and other laboratory and testing equipment. Special care must be taken to keep the work areas sterile, and safety precautions must be taken when working with disease-causing organisms. Some microbiologists work in specially designed areas. Others work in areas which house laboratory equipment and animals. The actual setting depends on the size, type, location and financial resources of the employer.

How to Enter This Occupation:

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BSc Microbiology, and supporting majors such as chemistry, biochemistry, physics, biology, mathematics and statistics - most universities.

Diploma: N.Dip. Microbiology of Biotechology - universities of technology. National diplomas in related study fields, such as the N.Dip. Food Technology, are also offered. These courses take three years to complete and include theoretical as well as in-service training.

Postgraduate: **Advanced study is required for teaching posts at universities and for research and administration, for example:**
MSc (Microbiology).
MSc Medical Microbiology.

Employment

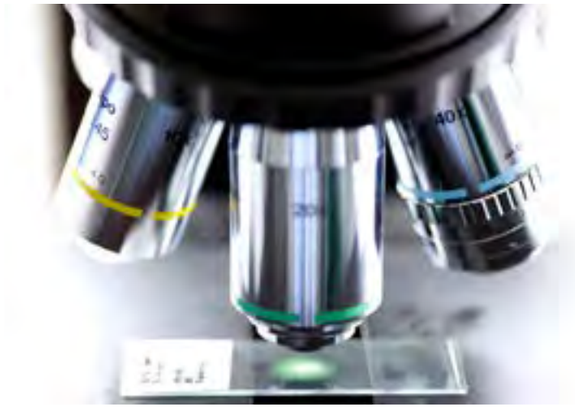
- hospitals
- clinics and other health care facilities
- medical schools
- medical research councils
- agricultural research organisations
- food, fermentation and pharmaceutical industries
- SABS
- CSIR
- Department of Agriculture
- Department of Health
- Department of Water Affairs and Forestry
- Department of Trade and Industry
- universities and universities of technology
- practising pathologists

Further Information

South African Society for Microbiology
Faculty of Natural Science
University of the Western Cape
Belville, 7535
Tel: (021) 959-2199

Some Related Careers

Botanist, Biochemist, Biologist, Chemist, Entomologist, Food Scientist, Hospital Administrator, Marine Biologist, Medical Technologist, Medical Laboratory Technician / Scientist, Pharmacist, Pharmacologist, Zoologist.



PALAEO-SCIENTIST

Palaeo-scientists study the remains of ancient life forms and some specialise in the investigation of fossils.

Analysis begins with the anatomical description, measurement and drawing of a fossil. Drawings usually illustrate a three-dimensional picture of the fossil which is placed in the physical context and dated. Dating fossils involves comparing layers of rock with the various formations of the world and comparing fossil beds of a known age. Fossils form part of the history of the earth and of living organisms. By studying the markings on stratified rocks and fossilised remnants, palaeo-scientists are able to establish, with amazing accuracy, a record of the evolution of life through geological time.

Palaeo-scientists combine their findings with those of other scientists such as geologists, geographers and meteorologists, to reconstruct a progressive history of life on earth since ancient times. Fossils are furthermore utilised to determine the relative age of rocks and are particularly important in the search for coal and oil deposits.

It is as a result of the work of palaeo-scientists that we now have some knowledge of what led to the extinction of certain species and the origin of others, and that we have a fairly accurate picture of ancient plants and of the great dinosaurs that once roamed the earth.

Paleontologist Anne Pasch digs for fossils inside a permafrost tunnel. (Photo by Kevin May).
< http://www.farnorthscience.com/2007/10/04/news-from-alaska/>

Areas of Specialisation

- palaeo-botanists study plant fossils
- invertebrate palaeo-scientists study animals without a backbone, for example insects
- vertebrate palaeo-scientists study animals with backbones, for example, fish.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences, Geography.

Further Training

Degree: BSc degree majoring in botany, zoology, microbiology, entomology with specialisation in anatomy and with supporting courses in geology, geography, environmental science or archaeology.
.
Postgraduate: **honours degree in palaeontology. Master's and PhDs can be taken in subjects of interest relevant to this career.**

Employment

- museums
- universities - teaching and research
- laboratories
- government departments
- oil companies

Further Information

University Departments of Archaeology

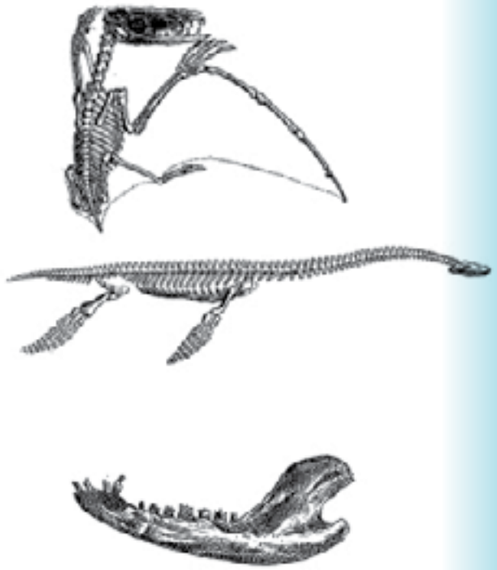
South African Heritage Resources Agency
PO Box 4637
Cape Town, 8000
Tel: (021) 462-4502
www.sahra.org.za

Palaentological Society of Southern Africa
Tel: (011) 717-6683
www.palaeontologicalsociety.co.za

Some Related Careers

Archaeologist, Botanist, Ecologist, Game Ranger, Geographer, Geologist, Geophysicist, Historian, Lecturer, Meteorologist, Zoologist.

Paleo-scientist at work extracting fossils from rocks.
< http://fossil.wikia.com/wiki/File:Paleontologist_at_work.jpg>



Jurrasic fauna drawings, showing various fossils.
Dictionary of Words and Things - Larive and Fleury - 1895.

Justin Mukanku from the Wits Institute for Human Evolution spotted a tooth in his field work in June 2012, prompting a CT scan to be taken and leading to the discovery of further fossils believed to belong to Australopithecus sediba, "Karabo" . (Photo by Witwatersrand University).
< http://www.southafrica.info/about/science/fossil-160712.htm#.UdwoakkaLIU#ixzz2YYsaLLjj >

SOIL SCIENTIST

Soil science deals with the origins, characteristics and use of soils for purposes of sustained biological production, the retention of environmental quality, and for promoting health in plants, animals and people.

For this reason, soil scientists are trained to identify and evaluate soil types for agricultural and non-agricultural uses to determine the deficiencies of various kinds of soil and how these may be rectified. The process includes aspects such as soil-cultivation methods and practices, soil fertility and fertilising, irrigation and drainage.

Soil scientist in laboratory modifing soil organisms genetically

Areas of specialisation

- soil formation - the processes whereby soil is formed
- soil classification - the classification of soil according to its properties
- soil mineralogy - the composition of the soil
- soil science - the biological, chemical and physical properties of the soil
- soil fertility - how many plant nutrients the soil can absorb and contain
- soil decay - through, for example, erosion or by becoming brackish.

Thus, their work may involve: classifying soils according to standard types; conducting experiments on farms to determine the best soil type for different plants; analysing soil to establish chemical and mineralogical relationships to plant growth; and / or investigating the effects of tillage, fertilisation, crop rotation, environmental factors and pollution on different soil types.

Soil scientists are researchers, developers and advisors. They use their knowledge to ensure that good soil planning and management are applied. They make recommendations regarding soil fertilisation and the correct use of water. Soil scientists are responsible for optimal soil utilisation. They must prevent soil decay and ensure that the natural soil fertility is maintained and improved. Farmland with good potential must be reserved for agricultural use.

Soil scientists work in the field as well as in the laboratory and use natural resource data banks, simulation models and computers. They work closely with other agricultural experts and with farmers, ensuring that available knowledge and research are utilised to improve soil-management practices.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Geography.

Further Training

Degree: The minimum requirement for a soil scientist is a four-year BSc (Agric) or a three-year BSc with Soil Science as major subject. Both degrees are offered at most South African universities.

Postgraduate: courses are offered by many universities, e.g. BScAgricHons; MScAgric; PhD (Agric) BScHons (Environmental Soil Science); MSc(Environmental Soil Science); PhD (Agronomy) (Horticulture, Pasture Science, Soil Science, Forestry Science); MSc(Agric)(Agronomy)(Horticulture, Pasture Science, Soil Science).

Soil scientists can follow a career as a Researcher, Consultant, Extension Officer, Farm Manager, Representative, Environmentalist, Technician, Farmer or Lecturer.

Employment

- Agricultural Research Council
- research institutes and organisations
- Department of Agriculture

- universities
- agricultural cooperations
- fertiliser manufacturers
- CSIR
- self-employment, one can start one's own business and practice as an analyst, soil surveyor and development consultant to the agricultural and construction industries, development cooperatives, commercial banks and landscape architects.

Further Information

The Agricultural Research Council
P O Box 8783
Pretoria, 0001
Tel: (012) 427-9700 Fax: (012) 342-3948
www.arc.agric.za

The Institute for Soil, Climate and Water
Private Bag X79
Pretoria, 0001
Tel: (012) 310-2500 Fax: (012) 323-1157
www.arc.agric.za

The Soil Science Society of South Africa
P O Box 13429
Noordstad, 9302
Tel: 083-389-0543
www.soils.org.za

Some Related Careers

Agricultural Scientist, Agronomist, Ecologist, Environmental Scientist, Farmer, Forester, Geologist, Geophysicist, Hydrologist, Silviculturist, Weed Scientist, Wood Scientist.

Sieglinde Snapp, crop and soil scientist at MSU's Kellogg Biological Station. Researching how overfertilising corn undermines ethanol. Farmers can save money on fertilizer while they improve their production of feedstock for ethanol and alleviate damage to the environment.
< http://msutoday.msu.edu/news/2011/overfertilizing-corn-undermines-ethanol/#sthash.BWhb-S8cn.dpuf>

Soil Erosion caused by water is, besides human activity, one of the main causes for global soil loss. Especially water that is moving in rills, Alexander Remke is using terrestrial photography as a method to identify sediment sources in eroding rills as an extension of the existing in-field rill experiments.
< http://gsoil.wordpress.com/category/featured-soil-scientist/ >

TOXICOLOGIST

Toxicologists plan and carry out laboratory and field studies to identify, monitor and evaluate the impact of toxic materials and radiation on humans, animals and the environment.

Toxicology can be divided into eight distinct job areas: industrial, pharmaceutical, academic, clinical, forensic, regulatory, occupational, and eco-toxicology.

Toxicologists' work typically includes isolating, identifying and quantifying toxic substances or radiation, and its effect on people, animals, plants or the whole ecosystem. They carry out and interpret laboratory and field experiments or observations of plants and animals, on in vivo or in vitro systems, using bacteria or tissue culture.

Toxicologists liaise with other scientists and technicians, evaluating statistical data and risk analyses. They write reports and scientific papers, present findings, and in the case of forensic work, give evidence in court.

They evaluate the safety of new chemicals in pharmaceutical products, toiletries, other consumer products, packaging, and industrial chemicals. Chemical, pharmaceutical, biotechnology and agro-chemical companies involve toxicologists in all stages of product development, either within their own facilities or through research organisations.

Expert analysis of radioactive water

Toxicologists' may also be required to advise people over the telephone in cases where someone has taken a dangerous drug or chemical, as well as test bodily fluids to identify and measure levels of drugs and chemicals.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BSc - subjects such as physiology, microbiology, chemistry, genetics, anatomical pathology, at most universities. A degree in biomedical science can be followed by specialisation in this field.

Postgraduate: **Possible paths to follow are MMEdVet (Tox), a speciality degree consisting of course work and research.**
Postgraduate diploma and master's with elective modules such as occupational and environmental toxicology.
Postgraduate diploma in occupational health including occupational hygiene and toxicology.

Employment

- educational institutions
- chemical and drug manufacturing industries
- government
- contract research companies
- forensic and civil laboratories
- medical research industry
- hospitals
- water research centres
- private consultancy

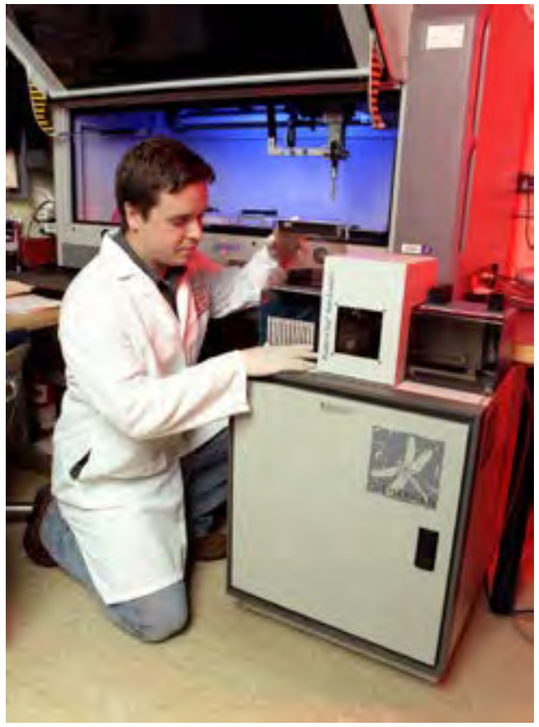
Further Information

Toxicology Society of South Africa
P O Box 4788
Johannesburg, 2000
www.toxsa.ac.za

Society of Toxicology
www.toxicology.org

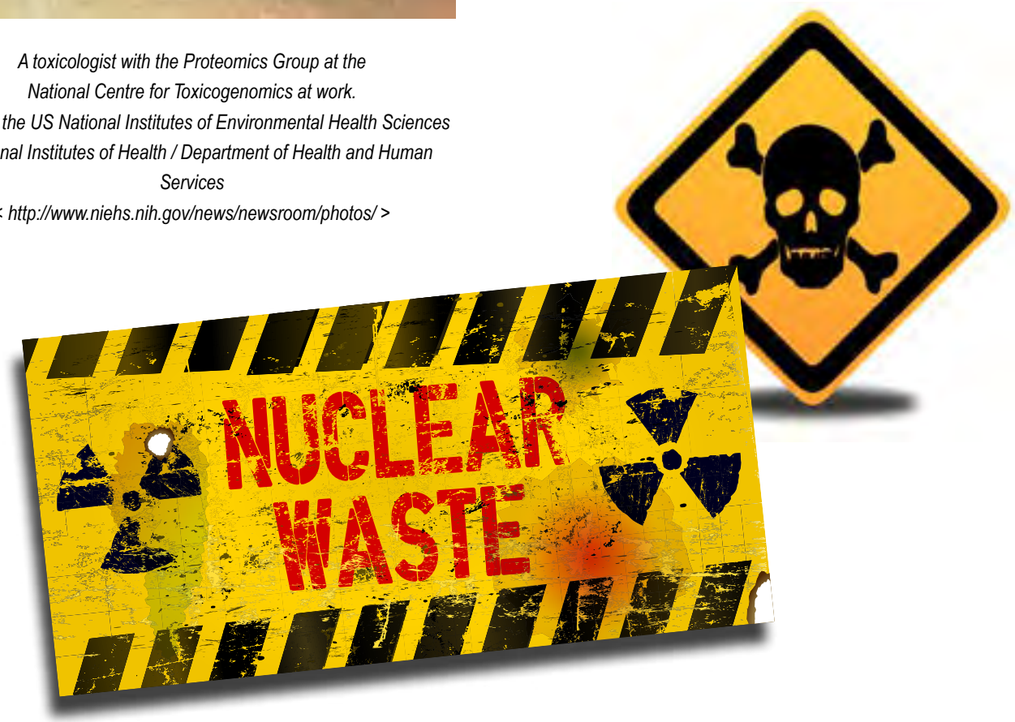
Some Related Careers

Biologist, Environmental Health Officer, Environmental Technologist, Microbiologist, Pharmacist.



A toxicologist with the Proteomics Group at the National Centre for Toxicogenomics at work.
Credit to the US National Institutes of Environmental Health Sciences / National Institutes of Health / Department of Health and Human Services
< http://www.niehs.nih.gov/news/newsroom/photos/ >

Kathrine Springman, toxicologist and assistant editor of Marine Environmental Research, collects a sediment sample from an area of Alaska's Prince William Sound affected by an oil spill.
< http://www.shfwire.com/reporters/heather-lockwood-spring-2009 >



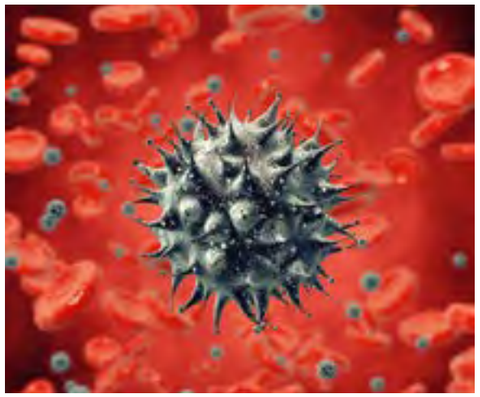
VIROLOGIST

Virologists study viral microscopic organisms that cause diseases and attempt to create new vaccines and medicines that will help cure these diseases and provide immunity to human beings.

Viruses have plagued human beings since the beginning of history. Some, more lethal than others, such as chickenpox, Ebola, HIV/AIDS, hepatitis and influenza (the flu). These are some of the viruses that virologists have been fighting against.

Virologists study how viruses are able to replicate in animal, plant and bacterial cells. To replicate, viruses take over the host cells on which they are parasites. The viral parasite causes changes in the cell, directing the host cell's metabolism to produce new virus particles. Viruses come in two basic types, having a genome of either DNA or RNA. Accordingly, viruses infect all major groups of organisms, including vertebrates, invertebrates, plants, fungi and bacteria.

Many people mistakenly believe that drugs such as antibiotics help to combat viruses. Nevertheless, there are many preventative vaccinations now available to people, such as the hepatitis B vaccine or typhus shots. These vaccines are designed to immunise people against the infections. People travelling to foreign regions where they are at risk due to various viral epidemics, are advised to get inoculated with region-specific vaccines to prevent being infected by a lethal virus.



Contaminated blood showing viruses amoungst red blood cells

The most common types of viruses are the "cold viruses" of which there are about 130 different types. Usually these infections are not very serious and may just cause a runny nose and malaise for a couple of days.

Viruses are spread by contact with infected individuals. The usual method of transmission is person-to-person contact through mucus or blood secretions. Some types of virus can be transmitted through the air. In addition, drug users who share needles can easily become infected if the needle is contaminated with HIV/AIDS or hepatitis.

Virologists who work on researching dangerous organisms such as Ebola or HIV/AIDS, must take special safety precautions, such as wearing protective suits and working in biohazard areas, access to which is restricted to these scientists only. They usually work in teams with other microbiologists such as parasitologists, immunologists and bacteriologists, performing interdisciplinary research studies. Some may also work as medical doctors, treating patients who have viral infections.

A virologist's work seems to be never ending, as new viruses continually emerge. The career can be very rewarding since virologists make discoveries that help cure our deadliest scourges. There is a great deal of research being conducted on new treatments, improved diagnostics and vaccines.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

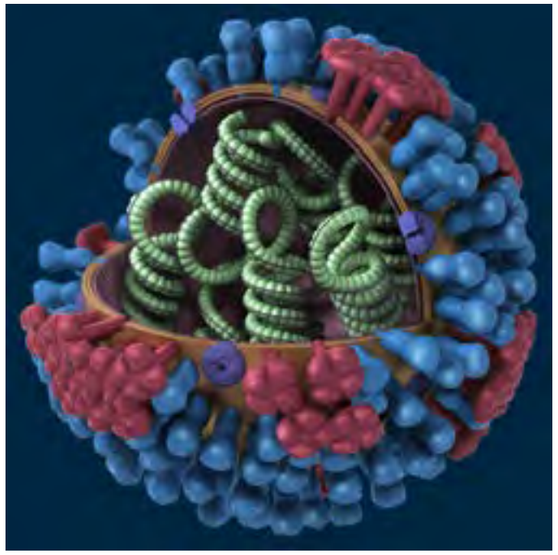
Degree: BSc - four years, in subjects such as microbiology, genetics, immunology – all universities. Those who have a bachelor's degree are qualified to work as laboratory assistants or technicians.

Postgraduate: **A master's degree or PhD is always required for senior research positions. Those who have a PhD may continue their training as post doctoral fellows and teach at the university level.**

Medical virologists preparing to work in hospitals or treat patients must take a medical degree and then specialise in virology.

Employment

- universities and colleges
- government departments
- industrial and diagnostic laboratories
- research organisations
- pharmaceutical companies
- biotechnology and bioremediation companies
- agricultural industry
- hospitals, clinics and other health care facilities
- food and beverage industry
- contract work is becoming more common, focusing on individual research projects to formulate vaccines.



This image provides a 3D graphical representation of the biology and structure of a generic influenza virus.
< http://www.cdc.gov/h1n1flu/images/3D_Influenza_blue_no_key_pieslice_med.jpg >

Further Information

National Institute for Virology (Communicalble Diseases)
Private Bag X8
Sandringham, 2131
Tel: (011) 386-6000

Department of Medical Microbiology UCT
Anzio Road, Observatory, 7925
Tel: (021) 406-6727 Fax: (021) 406-6210
www.medmicro.uct.ac.za

Related Careers

Bacteriologist, Geneticist, Immunologist, Microbiologist, Parasitologist.

CDC developed the PCR diagnostic test to detect the novel H1N1 virus.
< http://www.cdc.gov/h1n1flu/images/CDC_PCR_diagnostic_testkit_med.jpg >

The H1N1 Virus. Photo by: C. S. Goldsmith and A. Balish, CDC, [Public domain], via Wikimedia Commons
< http://www.cdc.gov/h1n1flu/images.htm?s_cid=cs_001 >

In June 2009, the World Health Organisation declared the new strain of swine-origin H1N1 as a pandemic. This strain is often called swine flu by the public media. This novel virus spread worldwide and had caused about 17 000 deaths by the start of 2010.

ZOOLOGIST

Zoologists study the origin, growth and development, structure, environment, classification, behaviour and life processes of animals. As this field is so broad, zoologists usually specialise in a particular type of animal or animal family, or in certain aspects of animal life, such as genetics or animal classification.

Tasks of zoologists are determined by their specialities and by their employers. They may study live animals in controlled or natural settings; dissect animals to study their anatomy and physiology; be involved in the identification and classification of animals; do research into the diagnosis, the prevention and the treatment of both animal and human diseases; or work as a consultant or curator for a zoo, aquarium or wildlife park.

Areas of specialisation

- Aquaculture: commercial production of aquatic animals
- Arachnology: study of spiders, scorpions, ticks and mites
- Carcinology: study of crabs, shrimps and other crustaceans
- Cell biology: study of cells
- Developmental biology: study of how animals develop from egg to adult
- Ecology: study of organisms in relation to the environment; this area could include freshwater biology, marine biology and terrestrial ecology
- Ecotoxicology: study of toxic environmental substances and their effects on animal life
- Entomology: study of insects
- Ethology: study of animal behaviour
- Evolutionary biology: study of evolution and evolutionary relationships of organisms
- Genetics: study of heredity
- Herpetology: study of amphibians and reptiles
- Ichthyology: study of fish
- Laboratory animal science: breeding of experimental animals
- Malacology: study of molluscs
- Mammalogy: study of mammals
- Morphology: study of the structure of animals
- Nature and environmental conservation: conservation of the environment
- Nematology: study of nematodes
- Ornithology: study of birds
- Palaeontology: study of fossils
- Parasitology: study of parasites
- Physiology: study of how animals function
- Protozoology: study of unicellular animals
- Systematics (taxonomy): identification and classification of animals
- Toxicology: study of toxins and venom.

The work settings of zoologists vary from pure research and laboratory work to fieldwork. Museum zoologists are involved in the preservation of valuable animal collections, research on the classification and distribution of animals and the construction of interpretive displays for the education of public visitors.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BSc degree course with zoology as a major, with a second major such as botany, chemistry, physiology, geology, biochemistry, genetics, microbiology at most universities.

Postgraduate: **An honours degree or preferably an MSc or PhD degree, is essential for the full professional development of the zoologist. Postgraduate studies involve a series of research projects chosen by the student in accordance with the area of interest. Employers prefer postgraduates.**

Employment

- schools, universities of technology and universities
- medical and industrial laboratories
- Departments of Agriculture and Water Affairs
- Department of Environmental Affairs and Tourism
- zoos and aquariums
- wildlife parks, SA National Parks
- research organisations
- Onderstepoort Veterinary Research Institute
- museums
- manufacturers of fertilizers, insecticides and livestock remedies

Further Information

The Zoological Society of Southern Africa
www.zssa.co.za

The National Parks Board
P O Box 787
Pretoria, 0001
643 Leyds Street
Muckleneuk
Tel: (012) 428-9111 Fax: (012) 426-5500
www.sanparks.org

Wildlife and Environmental Society of SA
Umgeni Valley Education Centre & Nature Reserve
P O Box 394
Howick, 3290
Tel: (033) 330-3931 Fax: (033) 330-4576
www.wessa.org.za

Some Related Careers

Animal Behaviour Consultant, Animal Breeder, Animal Trainer, Game Ranger, Guide Dog Trainer, Nature Conservator / Zoo Keeper, Taxidermist, Veterinary Nurse, Veterinary Surgeon, Zoo Manager

Simon Thomsett, born in Kenya, rehabilitates and conserves African birds of prey for the Peregrine Fund and the National Museums of Kenya.
< http://simonthomsett.wildlifedirect.org/about-us/ >

A group of cavers and zoological scientists studying a newly found bat colony in Azokh cave in Azokh, N. Karabakh.
<salajean / Shutterstock.com>

Clint Rhode

Clint Rhode hails from Stellenbosch in the Cape Winelands where he matriculated in 2003 from Stellenbosch High. After finishing school he enrolled for a BSc in Animal Biotechnology at the University of Stellenbosch, with majors in animal physiology, biochemistry and genetics. He then decided to specialise in genetics and subsequently completed his BScHons, MSc and PhD degrees at the Department of Genetics at Stellenbosch.

Currently, Clint is a lecturer, but also works as a member of the research team pioneering the the application of genetic technologies in one of South Africa's most important marine living resources, the abalone. "Our principal aim is to establish a range of genetic tools for the abalone in order to conserve the wild populations and also to facilitate a sustainable and economically viable abalone aquaculture industry".

"My curiosity is probably the major factor that spurred my interest in studying science. I have always been in awe of the plethora of life forms that exists all around us and I wanted to comprehend how these function and came to be. I also have an industrious disposition a nd often found myself asking 'how can one improve on this? or I will look upon something and think what will this be good for?'.

Clint's primary research interest is in the ever-expanding and exciting field of genetics. "I am particularly fascinated by how various factors (natural and anthropogenic) affect the genetic composition of animals from a molecular to a population level".

Meet a Research Scientist

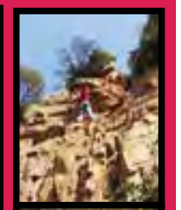
"In my research speciality, population genomics, I combine the latest technologies in genome science with sophisticated statistical models in order to understand how animals evolve. Ultimately, I also aim to use this knowledge to inform decision-makers on biodiversity conservation, the sustainable utilisation of our nation's bio-resources and the development of biotechnology and the bio-economy".

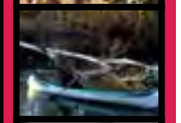
" My primary research interest is in the ever-expanding and exciting field of genetics. In my research specialty, population genomics, I combine the latest technologies in genome science with sophisticated statistical models in order to understand how animals evolve".

Clint's choice to become a research scientist is a logical extension of his scientific curiosity. "In a developing country like South Africa where we still face so many challenges, I wanted to be part of the solution. I take pleasure in sharing knowledge, moulding young minds and seeing the next generation of researchers grow into independent and free-thinking individuals".

Clint sees challenges and difficulties as a symptom of living. "What is important is that the challenges and hardships do not become who you are, but that you become who you are despite those challenges and hardships. These adversities that we encounter must be viewed as opportunities for personal growth and we must rise beyond our circumstances so as to be a better version of ourselves at the end of an ordeal. The world is often a cruel and harsh place, but with a positive and realistic outlook we can persevere, be content and successful, irrespectively".

"If you are serious about becoming a scientist, a master's degree is a necessity, but a doctorate is strongly recommended (especially if you want to be seen as an expert in your field). This means you will have to do some long-term planning as it may take an additional three years to obtain a master's degree after completing a bachelor's degree (approximately six years in total, including a year for BScHons). And if you want to go all the way to the doctorate level you may have to add another three to four years".





Dashnie Naidoo

Dashnie grew up in Durban, and went to Oceanview Primary School and Protea Secondary School in Chatsworth. After matriculating with distinction in 1996, she went to the UKZN in Durban where she completed a BSc in chemistry and applied chemistry with other subjects including physics, mathematics and cellular biology.

She continued with BSc Honours in Chemistry and an MSc degree in natural products chemistry under the supervision of brilliant Professor Dulcie Mulholland. "My research involved discovering novel compounds from plants. This work awarded me a travel grant to present at the International Symposium of the Phytochemical Society of Europe in Lausanne, Switzerland.

Dashnie comes from a humble but tight-knit family and community. "No matter what restrictions and limitations existed, we were encouraged to stay focused and concentrate on our studies and have a dream that one day we would achieve great things in this world."

As a child, Dashnie enjoyed the outdoors and explored the world around her with a curious mind. She would catch crabs and tadpoles from the stream behind her family"s house and watch them grow and transform.

As an adult, she still enjoys outdoor activities like mountain climbing, river rafting, and kissing a lion, to name a few. She loves seeing new places and learning about different cultures, becoming friends with wonderful people and seeing beyond the boundaries of nationality, race and gender.

Meet a Senior Scientist

She also enjoys photography and likes supervising students to impart knowledge and train them in skills to gain expertise and competencies to pursue a career in science.
"In 2002 I studied towards a PhD in natural products chemistry and again discovered novel compounds which allowed me the opportunity to spend time at the University of Utrecht, Netherlands. I presented this work at the International Congress on Natural Products Research in Arizona, USA, and was also awarded a travel grant to present the work at the XV National Symposium of Organic Chemistry in Buenos Aires, Argentina".

"My research involved discovering novel compounds from plants, which I named after myself and colleagues"

Another opportunity arose from this research, allowing Dashnie to do postdoctoral research at the Ghent University, Belgium, in 2004, involving medicinal chemistry where a new synthetic route was developed for the total synthesis of biologically active natural products for the pharmaceutical industry. She returned to South Africa and did further postdoctoral research and lectured chemistry at the University of KwaZulu-Natal in 2005.

Dashnie currently works at the Council for Scientific and Industrial Research (CSIR). "Currently I am a Business Area Leader and senior scientist in the Natural Products Technology Platform. I am involved with the identification of new natural active ingredients from South African biodiversity by collaborating with consortia of multi-disciplinary research teams from multi-national institutes, and development of these actives into high-quality innovative product technologies ready for commercialisation through industry partners".

"Coming from humble beginnings, my parents could only afford the basics. At school and university there was a lot of competition and people often thought I had a privileged life because I always looked happy and content. I had to work hard physically and mentally, without help from others, to achieve the most I could.

Challenges were to stay strong and think positively while going through a difficult home life. Believing in God and myself helped me get through the hardships and overcome the obstacles and achieve everything I have".

SOCIAL & HUMAN SCIENCES

If you are interested in people and how they behave, both as individuals and within society, then you may be interested in studying in the social and human sciences. In broad terms, social science is the study of society and the manner in which people behave and influence the world around us. Social science disciplines include psychology, sociology, anthropology, economics, human geography, history, education, linguistics, communications, and other disciplines which investigate human behaviour as individuals and/or groups.

Social scientists try to improve their perception of society and how it functions, so as to better understand the world in whcih we live. Other sciences very often draw on research that has been done in the social sciences in order to receive guidance on future trends and research possibilities. The lines between the social sciences and other science disciplines are often blurred. For example, anthropology, which includes subfields such as archaeology, plays an important role in creating research opportunities in disciplines such as DNA analysis, materials sciences, and many more. Other social sciences such as economics investigate the interaction between humans and wealth. Such investigations shed light on human migration patterns and trends, which in turn feed into the engineering sciences in terms of transport needs or the medical field in terms of patient care needs, and so on.

Each of the social science fields have their own specific specialisations and subfields. So within economics, one can specialise in subfields such as micro- or macro-economics or even the green economy, which places special emphasis on biodiversity and sustainable energy. Fields in linguistics with specialisations in neurolinguistics or acoustic phonetics can have far-reaching implications for medically related issues such as speech or hearing impediments.

In essence, the social sciences are multi-disciplinary and people in these fields work closely with people in other disciplines such as the natural or medical sciences. This interdisciplinary cooperation is reflected in the way university degrees are made up. Students in a Bachelor of Social Sciences degree are often encouraged to include a few subjects from the Bachelor of Sciences degree. Such combination degrees are particularly useful in generating ideas for future research.

SOCIAL AND HUMAN SCIENCES STUDY PATHS

National Senior Certificate:
With Mathematics
and Physical Science

Each education institution has its own unique entry requirements for each of its programmes. It is important to check the entry requirements for the programme with the institution of your choice before you apply.

University
Bachelor of Arts / Social Science Degree

Majors in:
Anthropology
Criminology
Education
History
Law
Psychology
Sociology
Social Development
or any other related subject offered by the university.

University of Technology
National Diploma

Diploma in:
Education
Environmental Tourism

or any other related qualification offered by the university of technology.

Internship / Workplace Experience

Workplace experience is a requirement for the completion of a national diploma at a university of technology.

Postgrad

A postgraduate degree or diploma is needed in order to specialise. Each institution will have specific areas that they will promote. With regard to the social sciences these specialisation areas may include:

Forensic Psychology
Experimental Psychology
Ethnographic Criminology
Archaeology
Biocultural Medical Anthropology
Stratification, Work and Labour Markets
Social Networks and Community,
and many more.

University of technology students who intend doing postgraduate studies at university will first need to check the acceptance requirements with the university concerned. Students studying a national diploma will need to complete a Bachelor of Technology Diploma and / or a Master of Technology degree as a requirement for entry.

CRIMINOLOGIST

Criminologists examine the systems which bring people accused of crimes, to justice. They attempt to explain the reasons for criminal behaviour and suggest ways of reducing crime. They study the ways in which certain criminal justice agencies operate, including the law courts, police services, prisons and community-based correction centres.

Criminologists analyse and interpret data received on the incidence of crime and the operation of the justice system and are thus able to provide information about crime and the ways in which people are processed by the criminal justice system.

They also catalogue information about the possible causes of crime and the crimes committed and compile crime statistics and develop ways in which crime-solving resources can be best used.

Criminologists analyse and develop crime prevention strategies and generally evaluate all aspects of crime and the criminal justice system. They research criminological issues such as those pertaining to offenders, victims of crime and sentencing.

Criminologists may specialise in organisational research, victimology, corporate crime or juvenile justice. They may work in the legal field that tries to ensure that laws keep up with changes in society. They may also work in the social / psychological fields, which study the effects of the criminal justice system or the factors that contribute to offending behaviour by individuals.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: History, Geography.

Further Training

Degree: BA, BSocWork or BSc with relevant majors, such as criminology, criminal justice, criminal law.
Other useful courses - statistics, sociology, social anthropology, etc.

Postgraduate: **Criminology Hons.**
Postgraduate courses in criminology leading to degrees in the faculties of Law and Humanities.
LLM in Criminology, BA Hons, MA in Criminology and PhD.

Possible career paths in Criminology include:
Corrections (Correctional Services), Counselling, Criminal Investigation, Diversion Programmes (organisations such as NICRO), Financial Fraud Investigation, Forensics, Insurance Fraud Investigation & Prevention, Intervention Programming, Courts, Law Enforcement (Policing), Medical Investigation, Rehabilitation programmes, Research and Policy Studies, Private Investigation.
Psychologist - Psychopathology Specialist, Retail Investigation, Teaching, Women's Studies, and Youth Programming & Counselling

Employment

- government departments
- tertiary institutions, universities as academics and researchers
- insurance companies
- banks and financial institutions
- department of justice, as research officers and
- advisers on policy, law reform, juvenile justice, crime statistics and adult correction
- police departments, courts, corrective institutions
- private welfare and investigation agencies

Further Information

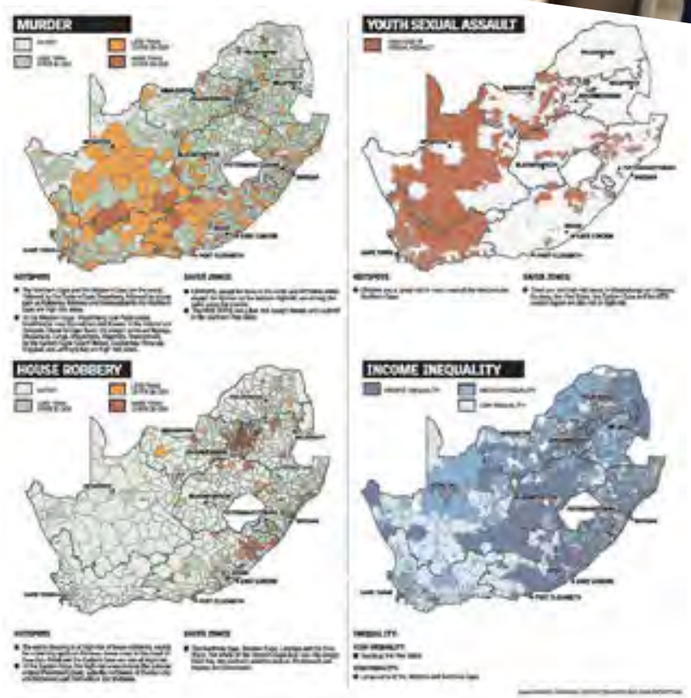
Department of Justice
Private Bag X81, Pretoria, 0001
Tel: (012) 315-1111
www.justice.gov.za

Some Related Careers

Attorney, Detective, Lawyer, Police Officer, Private Investigator, Psychologist, Social Worker, Sociologist.

Analysing evidence on a case.
<http://www.buzzle.com/articles/criminologist.html>

A criminologist analysing evidence



South Africa Crime Map. Source: Centre for Justice and Crime Prevention
< http://www.southafrica.to/people/Quotes/crime.php >

DEMOGRAPHIC ANALYST

Demographic analysis is the study of populations in a given sector. Companies often conduct demographic analysis in order to judge the relative sensitivities of a target market. This allows them to tailor their advertising and general presence to the needs of a given community. Understanding the demographics of given populations is also important for government planning and funding initiatives.

In many respects, demographic analysis is a form of scientific study. It involves sampling, statistics and probability, as well as traditional research. Analysis can be performed in a number of different settings and can usually be as general or as specific as the analyst wants.

The most straightforward demographic analysis concerns the populations of entire towns, communities or countries. These populations can be broken down by age, sex, marital status and ethnic background. From there, factors such as profession, level of education and average income can also be compiled.

There are a number of reasons why demographic analysis is important. Most governments have a vested interest in understanding the makeup of their communities. Having accurate information about the needs of certain populations can help governments ensure that the people have adequate representation from local officials and sufficient access to emergency services, for instance. Data on current student demographics can make informed decisions possible about where to build schools, libraries, and other government-funded school resources, just as demographics on elderly populations can help governments identify communities where more senior services may be needed.

Demographic analysis at a more localised level is typically of great importance to business owners. Marketing demographics often focus on the population details of a specific community where a product is to be sold or where a business is to be opened. Having demographic data helps businesses to target marketing to certain demographic areas. Sometimes, this involves the creation of a specific advertising campaign for a given community. Other times it involves choosing a community because it has a high percentage of target demographics — high numbers of school students, for instance, or stay-at-home moms.

Companies looking to break into a market might also use demographic analysis to assess a community's need for its particular services.

Analysis in this context is usually sector-specific. A banking company might perform a business demographic analysis of all bank customers in a certain area, for example, in order to understand what sort of clientele they are likely to encounter. Demographic trends concerning age and socioeconomic status might also be helpful to a business when looking ahead and projecting what a community is likely to consist of, a number of years into the future.

Population demographics do not always concern people. In biology, scientists frequently use demographic analysis to study populations of animals in the wild. This kind of analysis provides information on birth rate, migratory patterns and cause of death. Information gleaned from these demographic analyses is helpful in understanding humans' impact on animals in the wild, as well as natural phenomena such as disease and genetic mutation.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Accounting, Economics, Business Science, Geography, Computer Science.

Further Training

Degree: Bachelor's degree in marketing, finance, economics or business.
Useful course subjects would be applied economics, marketing research, statistics, survey design, geography.

Postgraduate: **Graduates should continue with honours, master's and PhD programmes to progress in this field.**

Further Information

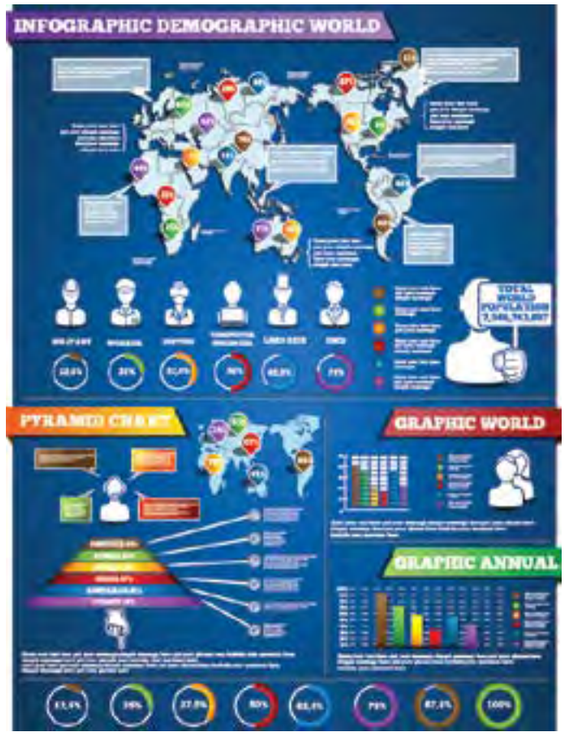
Statistics South Africa
Isibalo House, Kock Street,
Pretoria, 0002
Tel: (012) 310-8911 Fax: (012) 310-8944
Email: info@statssa.gov.za
www.statssa.gov.za

Employment

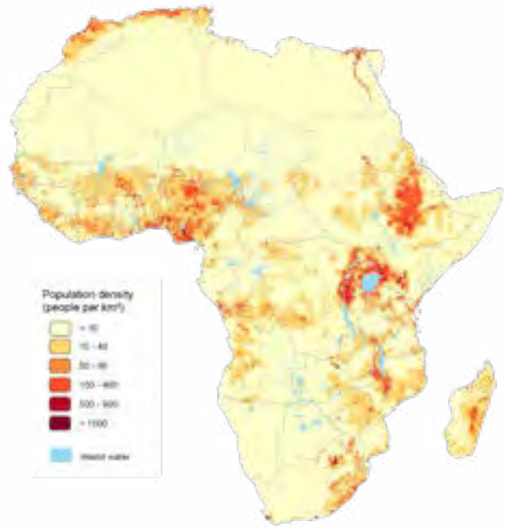
- Government
- Municipalities
- banking companies
- retail businesses

Related Careers

Energy Auditors, Job Analysis Specialists, Management Analysts, Security Management Specialists, Training and Development Specialists, Sustainability Specialists.



Above: Infographic demographic used to present collected data.



Above: AfriPop: Demography aims to supply Africa with data through the provision of detailed gridded spatial population datasets showing age composition by 5-year groupings and gender. <http://www.afripop.org>

Left: Global Dependancy Explorer is an interactive application that tracks the commercial ties between most countries across the globe. It also allows one to compare a variety of socio, demographic and economic indicators on the national level. It was developed at the University of Amsterdam and it uses data from the CIA World Factbook.
< http://www.visualcomplexity.com/vc/>

DISASTER RELIEF MANAGER

Disaster relief management is the management of resources and programmes for responding to emergency situations caused by natural events such as wars, earthquakes, floods, droughts and tornadoes. This role is often combined with emergency management resulting from man-made emergency situations such as hazardous material spills, nuclear power plant malfunctions, and terrorist attacks.

Disasters have a devastating effect on people and the environment and are accompanied by fear and great uncertainty. Disaster relief managers plan responses to disasters to minimize risk to people and property.
These measures include prevention, as well as preparation and response to disasters by means of recovery and rehabilitation of communities and the environment affected.

In planning and preparing for various types of disaster, the disaster relief managers meet with law enforcement officials, local businesses and residents to discuss and make recommendations on draft emergency response plans. They assess available resources and coordinate the sharing of emergency response resources among agencies and organizations such as fire departments, law enforcement and emergency medical services. They may request budget increases or additional resources, such as funding, from the national or provincial government.

During a disaster they lead the response and make critical decisions, such as opening public shelters or ordering evacuations. They plan emergency relief procedures and coordinate assistance to the people affected with basic supplies of food, water and medicines. They may also need to create communication campaigns to advise the public on what to do and where to go. They may visit schools, hospitals and other public spaces to educate employees and the public about the plans.

Disaster relief managers work with teams of scientists to restore and remove pollution and contaminants from the soil and water, and to address engineering issues after a disaster. In the event of environmental waste damage they may need to ensure that chemical analysis takes place and sampling of contaminants is conducted in the field. Disaster relief managers may classify damage in order to evaluate it and prioritize actions based on the resources available. In order to do this they may need to source and review maps, photo, video, GPS data and field investigation reports of the disaster area and use this to plan possible actions.

Once a disaster has occurred and plans are in place, disaster relief managers organize training for first responders, ensure that appropriate personnel are familiar with the plans, and make them available to the public. They may make arrangements for their accommodation and work with the medical, government and social service teams. After a disaster, they assess and report on the damage, and may request additional funding. They then begin the process of restoring the individuals, communities and the environment after the impact of the disaster to its normal condition through various means and involving various organisations.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Dependant on the faculty of study.
Recommended Subjects: Mathematics, Life Sciences, Physical Sciences, Geography, Economics.

Further Training

Disaster Management is an integrated multi-disciplinary field of study. For this reason there are a variety of complementary undergraduate degrees suitable for this career from different study fields:

Degree: An undergraduate degree in Social Science with Geography or Environmental Studies and Economics would be suitable, or a BSc degree in Environmental Science, Natural Resource Management, or another related field, e.g. Zoology or Botany. A BEng or BSc Eng e.g. Civil Engineering, with Environmental Engineering is offered by most universities. Alternatively, a BTech Civil Engineering is offered at all universities of technology.

Postgraduate: The University of the Free State offers a Postgraduate Diploma in Disaster Management.

Postgraduate: BEng (Hons) Environmental Engineering can follow BEng, or BSc (Hons) can be taken with an acceptable B Degree.

Postgraduate: The University of the Free State offers Masters and Doctoral (PhD) degrees in Disaster Management.

Further Information

The Disaster Management Training and Education Centre for Africa (DiMTEC)
Room 3.102, First Floor, Agriculture Building
Main Campus, University of the Free State
Nelson Mandela Road
Bloemfontein, 9300
South Africa

International Association of Emergency Managers (IAEM)
201 Park Washington Court
Falls Church, VA 22046-4527
USA
Phone: +1 (703) 538-1795
https://www.iaem.com/

Employment

Disasters can occur anywhere and are increasing in frequency due to adverse weather events resulting from climate change. This may drive job growth in the following organisations:

- government departments
- International aid agencies
- Intergovernmental agencies such as the UN
- waste management companies
- provincial administrations and municipalities
- consulting engineering firms
- chemical and petrochemical industries, e.g. Sasol
- academic and research institutes
- self-employment; with enough experience, initiative and capital, can work as a consultant.

Related Careers

Environmental Health and Safety Officer, Environmental Scientist, Project Manager, Environmental Assessment Practitioner, Air Quality Control Specialist, Air Pollution Analyst, Environmental Engineer, Environmental Restoration Planner.

Fire and rescue services managing mountain fires

Managing oil spills off the coast of South Africa

Managing flooding in informal settlements

SA Weather Services - pick up early warnings of weather issues

Risk Management in case of a disaster at Koeberg Nuclear Power Station

Above: Cape Town's Risk Management Centre is responsible for producing information and bringing the key people together to review the disaster, discuss logistics and make informed decisions. They also deploy the relevant emergency services and manage the warnings and communications around the disaster or potential disaster. This Centre has been awarded Role Model Status by the United Nations Disaster Reduction Campaign < https://www.youtube.com/watch?v=a9V0Pf7ouj4>

FORENSIC SCIENTIST

Forensic scientists or analysts apply scientific knowledge and skills to investigate crimes. The information they provide may help the police to find or eliminate a suspect in a crime. Forensic scientists usually specialise in one area of forensics, such as DNA analysis, firearms examination, or toxicology, which is the analysis of body samples for traces of drugs and poisons.

The service that forensic scientists provide is invaluable in police and legal work, and their expertise is called upon to detect traces or confirm the presence of substances such as poison, drugs and alcohol, in the human body at post-mortems. This information is then used by the police to assist in solving crimes and by the legal profession to secure convictions or to prove innocence.
Another branch of forensic analysis is in the field of preventive medicine where foods, beverages and habit-forming drugs are tested to determine their safety for human consumption.

Forensic scientists may visit crime scenes to find evidence. They analyse physical evidence such as fibres, glass, debris, firearms, bullets and marks made by tools or weapons. They also analyse biological evidence such as hair, blood and body fluids. They write reports on the results and findings. They may be required to give evidence in court. They are sometimes called to investigate civil court cases, such as fire or insurance claims. They may travel locally and around the country to attend crime scenes and court cases.

Forensic scientists need to know about using science to investigate crime. They need to understand the chemical make-up of everyday things, such as paint or textiles, as well as that of blood, body tissues and DNA. They also need to know about poisons and drugs, firearms and explosives. The knowledge required will vary, depending on their areas of specialisation.

Area of Specialisation

Fingerprinting: There are three main types of fingerprints: arches, whorls, and loops. Each of these has several subcategories. Most fingerprints have a delta (triangular formation) near their core. A visible print is patent while an invisible print is latent. Fingerprints are usually latent and can be found at just about any type of crime scene.

Document analysis: The vast majority of the crimes that take place involve paper or are committed on paper. Everything about the paper concerned is a potential clue. Document analysis includes handwriting analysis, fraud and forgery.

Firearms and ballistics: The science of ballistics allows matches to be made between firearms and their ammunition.

Explosives: This involves analysis of bomb components, that is, its power source, its initiator, and its explosive substance. If a bomb explodes, analysts examine the bomb's residue by scanning the debris for fragments of the bomb in order to piece together its composition.

Forensic anthropology: To a forensic anthropologist, truth lies embalmed in the marrow of the dead. By examining the various characteristics of a person's bones, certain deductions may be made about their age from the fusion of bones; diseases suffered, from bone erosions and anomalies; gender, from the size, characteristics and shape of bones; and race, from bone characteristics and shape.

Chemistry and toxicology: To analyse substances for chemicals, including poisons and drugs, forensic scientists use such instruments as mass spectrometers, which provide molecular "fingerprints" of unknown substances; X-rays, to detect potassium cyanide and other chemicals; dielectrometers, which send out electric impulses and record energy absorption, marking differences such as wall imperfections or different densities.

Behaviour profiling: Forensic analysts attempt to solve crimes by understanding a criminal's MO or "Modus operandi", which is the method by which a particular criminal commits a crime, including the time and place, type of crime, property involved, victim type, tools or implements used, disguises, props or associates.

Of significance are "signatures" or the psychological "calling cards" or imprints, some criminals are motivated to leave.

Blood: When a sample of blood is sent to a laboratory, as in any other science of identification, there are things that can be read from it, and others which remain elusive. Certain things about the donor can be determined from blood (excluding DNA testing), such as whether it is animal or human and the blood grouping (A, B, AB or O), besides types of genetic markers, which are specific enzymes and proteins.

Entomology: A dead body attracts flies. Forensic entomologists use the clues provided by flies to find out exactly how long the body has been dead.

DNA (deoxyribonucleic acid): DNA has been called the biological equivalent of fingerprints. As with every person, each DNA arrangement is unique, the only exception being in the case of identical twins.

Hair and fibres: Based on the theory of transfer, which states that when a person comes into contact with another person or place, there is a transference of evidence to that person and to that environment, and vice versa.

Photography: Photography, when it was first developed, quickly replaced branding as the preferred means of identifying criminals. Now standardised criminal photographs, known as "mug shots", are essential forensic tools.

Photo-identification: One of the first crime scene activities is the taking of photographs. Their value as evidence is obvious: they are visual testaments to an inaccessible point in the past; permanent records that allow other evidence to be preserved.

Surveillance: Film is an important part of surveillance, which is the secret monitoring of suspected criminals in the hopes of gaining vital information which might lead to arrests, etc. Specialised equipment is necessary for long-range photography and for hidden cameras that must operate for long periods without maintenance.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course. Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Physical Sciences.
Recommended Subjects: Life Sciences.

Further Training

Degree: BSc majoring in Chemistry, Analytical Chemistry or Pharmacology is recommended - all universities.

Diploma: Forensic Investigations.
N.Dip. Chemistry / Analytical Chemistry - universities of technology.

Many practical forensic science skills are also gained on the job. Once employed, training is given in the specific scientific techniques required in the job.

Postgraduate: Honours degree in Forensic Sciences or Forensic Anthropology.

Graduates can work as a forensic examiner and operate within a laboratory to analyse forensic evidence in order to determine its evidential value for a specific case. Qualified learners will be able to present specialised forensic evidence in support of the expert evidence in a court of law.

Employment

- Department of National Health
- South African Police
- government laboratories and offices
- private laboratories

Further Information

Forensic Engineering Association of SA
Tel: (011) 607-9500
www.forensa.org.za

Some Related Careers

Ballistics Expert, Biochemist, Chemist, Explosives Technologist, Geneticist, Industrial Chemist, Medical Practitioner, Pathologist, Pharmacist, Physiologist, Police Officer, Systems Analyst, Textile Technologist.

LECTURER

Lecturers teach tertiary level students at universities, universities of technology, FET colleges and other institutions, within a set study course in one or more fields. They also conduct research projects.

Lecturers have to prepare their lectures before they deliver them in class. They give students assignments and grade their performance accordingly. Lecturers also evaluate performances with individual students and discuss possible areas of improvement. When students do research, lecturers act in a supervisory capacity. To further research studies, lecturers usually organise excursions and field trips.

They publish findings in academic journals or books. Besides lecturing and capturing data, lecturers also need to attend meetings in connection with budgets and departmental administration. They plan courses together with other staff members, supervise and coordinate teaching assistants and arrange timetables. Most lecturers serve on committees dealing with administrative and general departmental concerns. They may also provide industries and government with consultation services.

Lecturers must present information with confidence. They also need to maintain a high academic standard. The ability to get the point or information across to students is extremely important, as well as the ability to set examination papers, and to mark them.

It is important as a lecturer to have good communication skills as the most important requirement of this career is to impart knowledge to students.

FET colleges employ lecturers in all areas of training. It is important that a lecturer be able to conduct his or her classes both from an academic and a practical angle.

Most college lecturers work in the field in which they train and are therefore able to advise their students on the practical applications of the subject, as well as being able to deliver the information required to assist students in their chosen field.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: This will depend on the field which you enter.
Recommended Subjects: Depends on the field.

Required qualifications of a lecturer would be in line with the subject matter in which they are lecturing. i.e. if the lecturer is teaching about mechanical applications it would be necessary for the lecturer or tutor to be qualified in the mechanical field.

Further Training

Degree: Any appropriate degree in the subject which is one's specialisation at all South African universities.

Diploma: Any appropriate diploma in your subject of choice at universities of technology.

Postgraduate: For TVET College lecturers, the most appropriate nationally recognised qualification at the present time which acknowledges the vocational sector as a possible target, is the National Professional Diploma in Education (NPDE) which is an in-service programme.

For lecturers, in general, progression to honours, master's and PhD in the field of expertise is highly recommended – all universities.

A new postgraduate diploma catering for the professional needs of lecturers and learning facilitators, the Postgraduate Diploma in Higher Education (Teaching and Learning), will be offered in 2014 for the first time.

Work activities vary according to individual areas of responsibility and research. Progression to managerial posts will also have an impact on work responsibilities.

Employment

- universities
- universities of technology
- FET colleges
- private tertiary institutions
- research institutions

Employment is offered to FET lecturers at all FET colleges and training institutions around the country. In order to become a lecturer at these institutions, it is necessary to prove proficiency in the chosen subject.

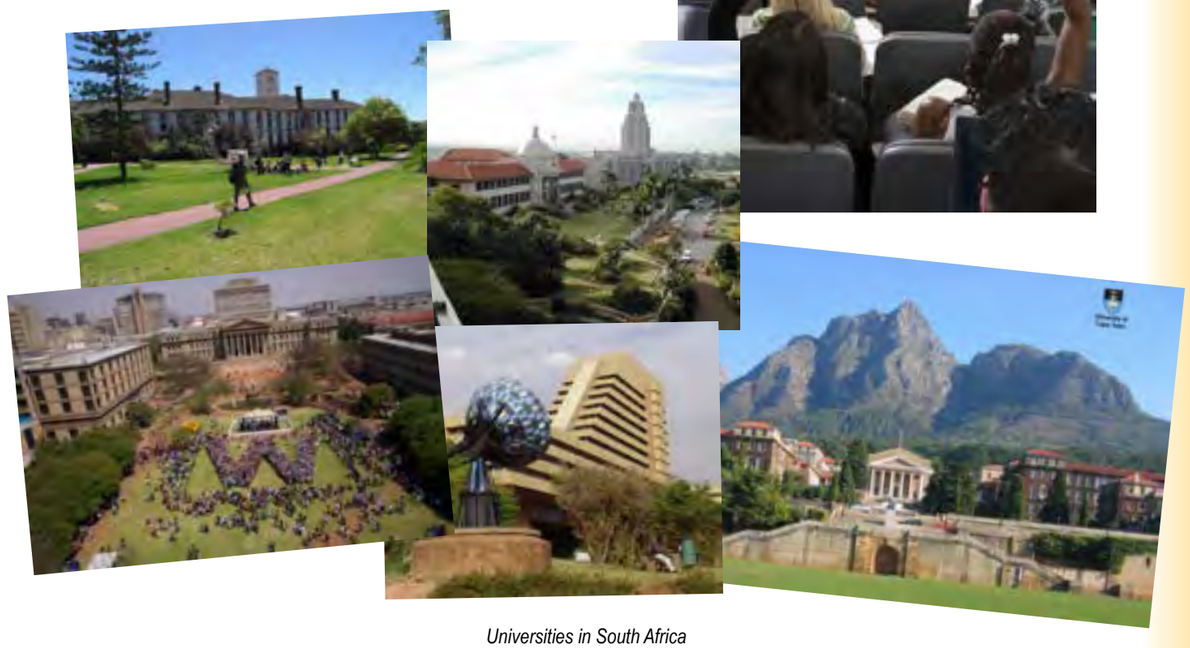
Above: Dr. Yacoob, the lecturer in Physics at UKZN, studies the interactions of fundamental particles at short scales (high energies).
< http://physicsdbn.ukzn.ac.za/Academic_Staff_Profiles/S_Yacoob.aspx >

Further Information

South African Council for Educators
240 Lenchen Ave
Centurion
Private Bag X127
Centurion, 0046
Tel: 086 1007 223 Fax: (012) 663-9238
www.sace.org.za

Some Related Careers

Secondary School Teacher, School Counsellor.



Universities in South Africa

RESEARCH PSYCHOLOGIST

Psychology is a broad field with several areas of specialisation. In experimental psychology, for example, psychologists carry out research projects to develop theories about learning, motivation, and other aspects of behaviour.

Research psychologists apply skills in statistics, research design, computing and data analysis in an attempt to answer a variety of questions.

They conduct research at centres, universities, corporations, non-profit organisations, or for the government. They look at patterns of behavior in humans or animals to learn about attention span, learning processes, effects of drugs, motivation, genetics, and neurology.

Applied psychologists utilise psychological principles and research to solve real-world problems. Examples include aviation psychologists, engineering psychologists, industrial-organisational psychologists and human factors psychologists.

Developmental psychologists research the growth and change that take place throughout life. They may concentrate on one particular stage of development, such as adolescence or old age. Other specialties include educational psychology, comparative psychology, social psychology and psychometrics.

Lecturers in psychology usually engage in research as well.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: Dependent on institution. (Mathematics is a prerequisite at some institutions).
Recommended Subjects: Mathematics, Life Sciences.

Further Training

Degree: Training consists of five years of academic training at a university, with an internship of 12 months at an accredited institution. The basic minimum qualification for registration as a psychologist is a master's degree in research psychology/ clinical psychology / educational psychology / industrial psychology and counselling psychology. Firstly, a B degree must be obtained with psychology as a major subject - all universities.

Postgraduate: **After obtaining a B.degree prospective psychologists must do an honours degree in psychology.**

After completing this degree the prospective research psychologist must apply for selection for a master's degree in the field of research psychology. The selection is a very intensive process and only a limited number of students are selected.

Master's degree in Psychology: The duration of this degree is two years. The first year is predominantly theoretical but includes supervised practical work. In the second year an internship has to be done under the supervision of a registered psychologist. A short thesis must also be submitted.

Registration: After complying with all the requirements for the master's degree and successfully completing the internship, the prospective psychologist has to apply for registration with the Health Professions Council of South Africa in one of the five recognised categories of clinical, counselling, educational, industrial or research psychology.

The Professional Board recently approved the implementation of a revised model for education and training in psychology in South Africa:

Registered Counsellors: Registration as a Registered Counsellor is contingent on completion of:

- An accredited four year BPsych or equivalent degree in Psychology and an approved minimum six-month internship in the designated practice area.

- The six-month internship included in the BPsych has to be done under the supervision of a registered Psychologist according to criteria set by the Professional Board. This internship may occur from the third year of the degree or after completion of the degree.

Employment

- universities and colleges
- government departments
- HSRC and CSIR
- consulting agencies
- private, public and psychiatric hospitals
- community and rehabilitation clinics etc.
- correctional institutions
- management institutes
- market research organisations
- self-employment, in private practice

Further Information

Psychological Society of South Africa (PSSA)
P O Box 989
Houghton, 2041
Tel: (011) 486-3322 Fax: (011) 486-3266/77
www.psyssa.co.za

Health Professions Council of South Africa (HPCSA)
P O Box 205
Pretoria, 0001
Tel: (012) 338-9301 Fax: (012) 328-5120
E-mail: info@hpcsa.co.za
www.hpcsa.co.za

Some Related Careers

HIV/AIDS Counsellor, Anthropologist, Criminologist, Counsellor, Guidance Officer, Human Resources Manager, Market Researcher, Rehabilitation Counsellor, School Counsellor, Social Worker, Sociologist, Teacher, Youth Worker.

Miss Breanne Hawes, research psychologist, NSRDEC, and Dr. Tad Brunyé, cognitive scientist, NSRDEC. Researching how people plan routes, this will help with the development of predictive navigation models. Photo by Mr. David Kamm, NSRDEC
< http://science.dodlive.mil/2011/10/24/treebeard-was-right-travelers-are-less-rational-than-theyd-like-to-believe/ >

RESEARCHER

All researchers share one primary objective: to uncover the meaning, significance, causes, and effects of whatever subject they are investigating. The work they do can have academic, commercial, political, social or scientific impact. They may be trying to advance society's understanding and appreciation of a particular subject, or develop products or practical applications based on their findings, or advocate changes in their organisation's policy.

Put simply, research may be divided into three broad research types:

- pure basic research - experimental and theoretical work, often called fundamental research, "knowledge for knowledge's sake".
- strategic basic research - experimental and theoretical, but often undertaken to acquire new knowledge and can lead to useful discoveries or to solving practical problems.
- applied research - original work to perhaps determine new ways of achieving specific objectives or developing new techniques.

Research is a broad field encompassing careers with myriad responsibilities in myriad industries:

Consumer products industry market researchers, for example, conduct focus groups and apply statistical analysis techniques to demographic data to understand consumer behaviour better.

Political researchers conduct telephone polls of voters to learn where they stand on political issues and candidates.

Pharmaceutical researchers (usually chemists) research the properties of new chemical combinations.

Aerospace researchers (usually engineers) may study how air flows around different aircraft designs.

Psychology researchers conduct studies, for instance, of depression in young children or elderly women.

Medical researchers conduct medical laboratory tests to diagnose, treat and prevent disease.

Financial analysts research companies, industries, and markets with the goal of helping their employer or their clients to make good securities investments. Careers in financial or market research emphasise analysis over discovery, and tend to be more structured than other research careers.

The requirements for an academic research position are straightforward: an excellent academic record, including an advanced degree, usually a PhD, strong written and oral communication skills and strong recommendations from other academics. Securing a tenured research position at a university is perhaps the most competitive and political venture that academics undergo in their professional lives.

During the course of their work, researchers review previously published findings, formulate hypotheses, and gather original data to support or rebut their hypotheses. In technical or scientific fields, researchers develop experiments and conduct trials to test their hypotheses and gather new data.

In scientific fields, researchers are often searching for solutions to problems that have eluded others for years, if not centuries. Although routine testing and experiments may be a large part of their day-to-day jobs, scientists also rely heavily on innovation to achieve major breakthroughs.

Science researchers usually spend time designing experiments. Usually, researchers have a particular question that they want to investigate and they try to design an experiment that can answer the question. A researcher is responsible for working out the controls necessary to validate the experiment, the materials necessary, as well as the procedure for the experiment.

Researchers now have better, broader, and faster access to more information and technology than at any other time in history, but the funds necessary to tap into these resources, and so fulfill the full promise of research, are lean and growing leaner.

All researchers, whether in science or other fields, need to write grant proposals. Grants may come from private sources, such as trusts, or from public organisations. Researchers have to write grant proposals to the administrators of the funds, and the administrators may decide to grant money based on the quality of the proposal. Grant proposals consist of a proposal of the project, including the project's goals and how it relates to the mission of the particular agency. In addition, it itemizes expenses for the proposed research project.

There are, of course, great differences between the different research disciplines. Humanities and creative arts researchers tend to work on their own or in small, highly focused groups. They often need fewer physical resources, such as research maintenance funding, than researchers in other discipline areas.

At the other end of the spectrum, large biological science groups or physical science research centres that require large amounts of research funding for both purchase and maintenance of very large research infrastructure, are probably most common.

Researchers also have to write academic papers. These papers are submitted to various journals for peer review. Usually papers get published based on their quality. Peer reviewers judge the quality of the paper based on elements such as the methods used, the quality of the results and the novelty of the results. Peer-reviewed articles usually undergo a long process before appearing in the journal.

There are many demands on the time of the researcher, for example, those working in universities also have teaching responsibilities, community service and internal administration. Researchers in research institutes or commercial companies also have a range of other responsibilities.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.
Each institution has its own entry requirements.

Compulsory Subjects: Depend on field chosen.
Recommended Subjects: Depend on field chosen.

Further Training

Degree and Postgraduate: **Following the basic bachelor or engineering degree, it is necessary to continue to honours, master's and PhD, in one's field of interest. Research is an essential part of this process. It is possible to continue one's research career on the same subject as one's PhD, or one may decide to branch out into something different. Critical choices about the paths taken need to be made in order to achieve one's research goals.**

Employment

- universities and colleges
- research institutes
- commercial companies.

Opportunities to do research are vast in almost every industry. There is a tremendous range of opportunities for people with various academic, business and technical backgrounds and interests.

Further Information

South African Marketing Research Association
The Workspace
Maxwell Drive, Sunninghill
Johannesburg, 2191
Tel: (011) 052-2808
www.samra.co.za

National Research Foundation
Meiring Naudé Road
Brummeria
P O Box 2600
Pretoria, 0001
Tel: (012) 481-4000 Fax: (012) 349-1179
www.nrf.ac.za

Council for Scientific and Industrial Research (CSIR)
Meiring Naudé Road
Brummeria
P O Box 395
Pretoria, 0001
Tel: (012) 841-2911 Fax: (012) 349-1153
www.csir.co.za

Some Related Careers

Budget Analyst, Industry Analyst, Market Analyst, Policy Analyst.

SOCIOLOGIST

Sociology is the science of human relationships, the means by which people and groups behave towards one another, as well as socio-economic developments and changes. Sociologists study the origins, growth and interactions of human groups; for example, families, tribes, communities and social institutions such as: religious, political and economic groupings, ethnic groups and social classes.

They study the behaviour and interaction of groups, trace their origin and growth and analyse the influence of group activities on individual members. Sociologists can specialise in a wide range of areas, for example: social groupings, social stratification and mobility, racial and ethnic relationships, social psychology, as well as political, economic and applied sociology.

Sociology is important in predicting people's behaviour.
< http://mattmunchsoc101.blogspot.com/ >

Other directions include research, demographics, gerontology and clinical sociology. Sociological research involves collecting information, and analysing and interpreting data that is collected through surveys, in-depth interviews, case studies and other methods.

Sociologists also study social processes and phenomena, such as social deviant behaviour, group friction and migration. They may investigate topics on a large scale such as housing conditions, recreational patterns, drinking patterns and drug abuse as it occurs in groups of people, or they may examine the effects of different styles of leadership on individuals in small groups.

The sociologist can work in a variety of fields:

- Social psychology
- Clinical sociology
- Political sociology
- Economic sociology
- Applied sociology
- Research.

Academic sociologists teach at universities; research sociologists do full-time research; administrative sociologists assist personnel sections; and planning sociologists are concerned with development and planning. Many sociologists work at universities, doing research and giving lectures. As sociology overlaps many related fields of study, sociologists may interact and cooperate with psychologists, economists and town planners and do market and consumer behaviour research.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree course.

Each institution has its own entry requirements.

Compulsory Subjects: None.
Recommended Subjects: Languages, History, Geography.

Further Training

Degree: Sociology may be taken as a major or subsidiary subject to form part of the BA degree or diploma. Sociology can be studied at all South African universities. Related fields of study in which sociology is a compulsory subject, are nursing, social work and town and regional planning.

Postgraduate: Those who wish to become sociologists require postgraduate qualifications and may be employed as academic sociologists attached to universities as lecturers, research sociologists attached to the HSRC, at research institutes, universities and other organisations; and administrative and planning sociologists (persons employed in large organisations and industries in which a sound knowledge of human relations is essential, for example liaison officers and personnel managers and persons concerned with planning and development).

At certain universities, sociology and industrial sociology are also offered for degree courses in commerce, economic sciences and administration.

Industrial Sociology is concerned, inter alia, with management / labour relations in complex industrial societies. It prepares students for careers in industrial relations, either in the field of management or in trade unions.

Employment

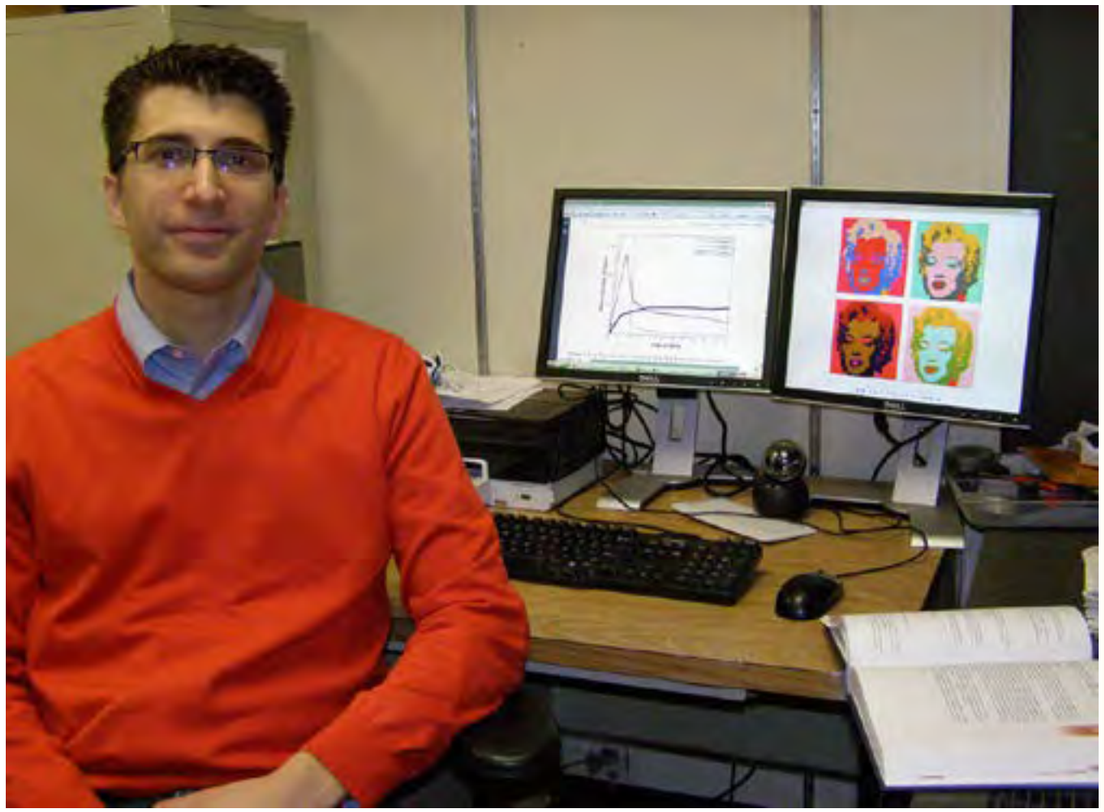
- universities
- government departments, municipalities and administration boards
- non-governmental organisations
- research institutions such as Human Sciences Research Council (HSRC)

Further Information

Human Sciences Research Council (HSRC)
Private Bag X41
Pretoria, 0001
134 Pretorius Street
Pretoria, 0002
Tel. (012) 302-2000 Fax: (012) 302-2001
www.hsrc.ac.za
Any university sociology department.

Some Related Careers

Anthropologist, Community Development Worker, Criminologist, Economist, Historian, Market Researcher, Marketing Manager, Political Scientist, Psychologist, Social Worker, Welfare Worker, Youth Worker.



Arnout van de Rijt, Assistant Professor, Department of Sociology, Stony Brook University "Only 15 Minutes? The Social Stratification of Fame in Printed Media,"
< http://www.newswise.com/articles/ >

STATISTICIAN

Statisticians are concerned with the collection, analysis, interpretation and presentation of quantitative information.

They summarise and display the data on computer, turning it into information which is useful for scientific understanding and decision- making. An important aspect of a statistical analysis is that it recognises the variability in the data and aims to understand the sources of this variation.

Statistics is a versatile discipline, and because of this, statisticians are found in a wide variety of organisations. They design and manage experiments and surveys, and deal with the initial collection of data. They process and analyse the data in context, looking for patterns to help make decisions. They advise on findings and recommend strategy. Statisticians and operations researchers are often used as problem-solvers, who together with the relevant experts and managers from the organisation, use their collective skills to generate and evaluate alternative solutions to the problem.

Areas of Specialisation

Health: in medical and pharmaceutical research where they plan and analyse experiments and clinical trials; in epidemiology they study public health issues such as the effects of smoking on cancer, and monitor and predict the spread of diseases such as AIDS; they design and analyse clinical trials to evaluate and compare the effectiveness of different drugs for treating these diseases.

Statistical Analyses is used in scientific research as well as in most areas of business.

Demographics: in the area of official statistics they design censuses and surveys and report on demographic trends and trade statistics.

Marketing: designing and analysing market surveys, opinion surveys and censuses

Environment: understanding the relationship between habitat factors and species compositions in wildlife populations: estimating biodiversity in palaeontological populations from incomplete fossil records; the design and analysis of agricultural field trials towards the improvement of crop yields and genetic stocks

Education: relating interest- and aptitude scores of school leavers to their eventual career choices

Economics: forecasting economic indicators, predicting the creditworthiness of a new customer at a bank and analysing queuing patterns at an automatic teller machine

Forensics: some forensic statisticians are employed by forensic science units specifically to analyse forensic data; at the other end, there are some researchers who specialise in carrying out statistical research on forensic matters and act as consultant forensic statisticians when required

Mining: estimating the ore reserves of a mine, planning the mining strategy for extracting the ore and monitoring the production figures

Astronomy: interpreting satellite images and analysing the frequencies of variable stars

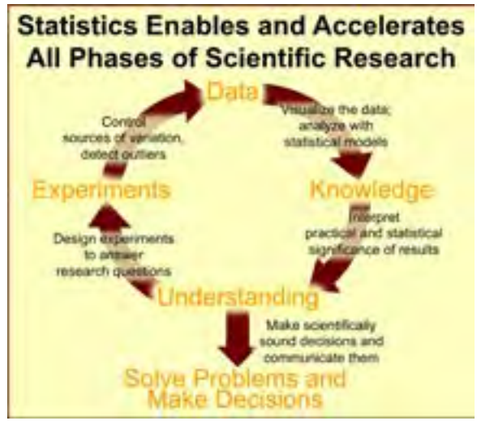
Manufacturing: establishing quality control procedures for a factory and estimating the reliability of a manufactured product: designing experiments aimed at improving the performance of manufacturing processes

Finance: analysing derivative securities and evaluating gambling systems: long and short-term insurance: the banking sector

Engineering: designing and testing new machinery.

Statisticians often work in teams, usually including professionals from other disciplines. Strong analytical and IT skills are essential, as are interpersonal and communication skills in order to share findings with colleagues and clients.
In the financial world, with its increasingly complex transactions and financial instruments which depend heavily on probabilistic modelling and statistical forecasting, new careers for statisticians are continually opening up. In order to achieve and maintain a competitive edge in modern manufacturing, companies have to apply statistical quality assurance and improvement principles to all aspects of their production processes. This is also creating career opportunities for statisticians.
Most communication with clients can be completed through email or teleconferencing, however some situations require that they be physically present, such as meetings or while gathering data. Travel may also be required to supervise and set up surveys, gather statistical data and provide advice on research projects.

Statisticians usually work a regular 40-hour work week but may need to work longer hours to meet strict deadlines.



From the Laboratory for Interdisciplinary Statistical Analysis at Virginia Tech in Blacksburg, Virginia, USA.
<http://www.lisa.stat.vt.edu/LISA2020/?q=faq>

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting degree requirements for a degree course

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, English
Recommended Subjects: Physical Sciences, Economics

Further Training

Degree: Prospective statisticians can follow a BSc or BEconSc degree in statistics or mathematical statistics. Normally this would be combined with computer science. Students must compile their courses according to university regulations. Another option for aspiring statisticians is a degree course leading to a Bachelor of Commerce (BCom). Such a choice will usually have a strong economics orientation.

Post-graduate study: Most statisticians enter the occupation with a master's degree in statistics, mathematics or survey methodology, although a bachelor's degree is sufficient for some entry-level jobs. Research and academic jobs generally require a PhD. These qualifications are available at most universities. MSc Medical Stats will lead to a career in medical statistics.

Operations Research is another career linked to Statistics, which can be followed from the honours level.

Employment

- pharmaceutical companies
- banks and other financial institutions
- insurance companies
- market research firms
- computer software companies
- mines and mining houses
- chemical industries and manufacturers
- research and consulting organisations such as CSIR, the HSRC
- management consulting firms
- universities and universities of technology
- metropolitan councils as well as state and semi-state organisations such as the Central Statistical Service, Departments of Agriculture, Water Affairs, Forestry and Fisheries, Eskom and educational bodies

Further Information

South African Statistical Association
P O Box 3341
Matieland,
7602
Tel: (012) 420-5420
www.sastat.org.za

Central Statistical Service
Isibalo House, Kock Street,
Pretoria, 0002
Tel: (012) 310-8911
www.statssa.gov.za

Related Careers

Accountant, Auditor, Business Systems Analyst, Economist, Environmental Scientist, Financial Analyst, Insurance Underwriter, Mathematician, Market Researcher, Risk Analyst, Operations Researcher, Personal Financial Advisor, Scientist.

TEACHER

Teachers are responsible for the facilitation of learning and the development of skills in children. Another vital role for teachers is to contribute to the development of the child's character and sense of responsibility.

The specific nature of teachers' work will depend on the age of the children they teach and the nature of the training they received. Prospective teachers can be trained for foundation phase or pre-primary, primary or secondary education. Specialist education includes special needs schools such as those for epileptics and for children with hearing, visual, mental or physical disabilities.

Foundation phase school teachers play a vital role in the early development of children. What children learn and experience during their early years can shape their views of themselves and the world and determine their later success or failure.

Pre-primary teachers lead children in activities which are designed to facilitate their language development, develop their physical abilities, communication skills and to interpersonal relationships. They need to be acutely aware of the emotional development of small children and organise and supervise activities and games that promote self-confidence and social interaction with other children. They try to keep a balance of activities while also ensuring that children have adequate rest periods. At times, they need to attend to sick children and those in need of first-aid; comfort children who are hurt or distressed and assist children with their toilet training and other personal matters. They teach from Grade R (reception) through to Grade 3. They usually teach all of the subjects in the curriculum to the learners.

Intermediate Phase – Grades 4 to 6: teachers give pupils the basic concepts of mathematics, languages and sciences. It is their responsibility to pave the way forward, encouraging young learners to enjoy the learning phase of their lives.

Senior phase – Grades 7 to 9: These teachers have versatile tasks which include, amongst others, the facilitating of learning, supplying information regarding many other choices children have to make, giving supportive counselling when necessary and setting an example regarding correct manners and behaviour.

At senior school level, teachers have usually graduated in a specific field and follow the syllabus laid down by the relevant department and curriculum in order to prepare students for examinations. Besides the formal education given in the classroom, the teacher is also expected to plan and organise extracurricular activities such as sporting events, cultural activities, tours, weekend camps and outings to places of interest. Through involvement with the child on this level the teacher gets to know the child better, and values such as a sense of responsibility, punctuality, respect, friendship and trust are nurtured. Teachers are also required to do administrative work which includes tasks such as setting examination papers, marking answer sheets, marking homework, the completion of registers, drawing up of schedules and the writing of reports.

FET: Those students who continue through Grades 10 to 12 are then prepared for this final phase of schooling. This, therefore, is a very important phase of their schooling and requires learners to make mature decisions - most importantly, to have properly trained teachers who will be able to guide them through this process.

Special Education: The teacher working in the field of special education works with children with speech and hearing disabilities, learning disabilities, blindness, deafness, hardness of hearing, weak-sightedness, epilepsy and mental and physical handicaps. These children require specialised attention and are taught through specially developed apparatus and techniques. The teacher works as part of a multi-professional team consisting of physiotherapists, occupational therapists, occupational counsellors, psychologists and medical personnel.

Teachers' working hours may be irregular and depend on factors such as the amount of special classes they arrange, administrative work, and the number of extramural activities they are involved in.

How to Enter This Occupation

Level of Schooling & School Subjects

Compulsory Subjects: English or Afrikaans
Recommended Subjects: Depend on field of interest.

Further Training

National Senior Certificate meeting the requirements for a degree or diploma course.
Each institution has its own entry requirements.

Degree: there are different ways of obtaining a teaching degree:

One of the more flexible options is to first complete a bachelor degree at a university of either 3 or 4 years, depending on the course concerned, followed by a one year PGCE (Post Graduate Certificate in Education) for Grades 7 to 12. The bachelor degree must include as major subject(s), those that you wish to teach, (a major subject is a subject taken for the full term of the degree programme).

Note: Every institution will have its own subject requirements to qualify for acceptance. It is advisable to contact the institution at which you wish to study before making a final choice of subjects.

A second means of obtaining a teaching degree is via the Bachelor of Education (BEd) degree, a 4-year programme that integrates academic and professional training, intended for prospective teachers and those wishing to enter other educationally-related fields, which is offered by universities and universities of technology. Students may choose one of the following school-phase endorsements (each having a particular combination of core and phase-specific modules):

- Intermediate & Senior phases (grades 4-6 & 7-9)
- Senior phase & Further Education & Training: FET (grades 7-9 & 10-12)

For a Senior phase and FET endorsement, specialisation is offered in:

- Services
- Engineering and Technology
- Business & Management Studies
- Science (including Mathematics, Physical Sciences and Life Sciences).

Qualifications in Education may be obtained at all universities. Most universities offer a one-year full-time or a two-year part-time course in remedial education.

Diploma: diploma courses in teaching provide a practical and focused teaching qualification targeted at specific levels of education, i.e. Foundation phase (Grades R-3), Intermediate, Senior phases and FET. The teaching diploma is offered by a number of universities and universities of technology. A diploma can be upgraded to a degree at a later stage.

Postgraduate: Advanced Certificate in Education (ACE) courses are offered by most universities. These Certificates are, in particular, available for teachers of Grade 12 life sciences, english, mathematics and physical sciences. This training focuses on upgrading the subject knowledge and teaching skills of teachers.

A South African teaching qualification is highly regarded in most other Commonwealth countries. It also provides an excellent foundation for entry into other career paths outside the education industry. South Africa is planning to reopen three former teacher training colleges.

All educators need to register with the South African Council of Educators (SACE). You cannot be hired as an educator if you are not registered.

Employment

- government schools
- private schools or colleges
- nursery schools
- to earn an extra income teachers can give extra or part-time classes, for example in Mathematics or Adult-education.

Further Information

National Professional Teachers' Organisation of South Africa
P O Box 572
Pretoria, 0001
Tel: (012) 324-1365 Fax: (012) 324-1366
www.naptosa.org.za

Some Related Careers

Child Care Worker, Counsellor, Day Care Mother, Educarer, Lecturer, Psychologist, Speech Therapist and Audiologist, Youth Worker.

TRANSPORT ANALYST

Transportation analysts are responsible for improving transportation safety and efficiency while reducing costs and minimising environmental impact.

In general, analysts collect and analyse transportation statistics and information relating to, for example, traffic flow, crash statistics, highway infrastructure and air quality. They use mathematical modelling to interpret the information and help to make decisions about whether future projects meet the transportation objectives, including their effects on social, economic and ecological factors. They then have to prepare reports of their findings.

Transportation analysts also evaluate current projects, such as repaving highways, to determine their impact on social, environmental and economic factors. Analysts might devise more efficient systems and methods of transportation and use GPS and traffic modelling programs to predict future transportation needs. They commonly work in project management positions.

Safety planning may be another responsibility of a transportation analyst. His or her duties may include developing and marking evacuation routes, or ensuring that infrastructure remains capable of handling loads safely. Some transportation analysts focus on developing strategies for reducing traffic jams. This may include reprogramming traffic lights so that backups during daily commutes do not occur and traffic moves in a smoother flow.

Some transportation analysts work in supply chain management and are often expected to be familiar with the shipping regulations and customs that impact the transportation of goods. They may also work with IT professionals, engineers, or shipping companies to oversee the different transport systems.
Sometimes transportation analyst duties may involve working with public transport systems. If this is the case, the task of the analyst generally involves designing safe, dependable, and appealing modes of transport for commuters. Such systems often combine different models, as a commuter may drive to a train station, then travel by train from one city to another, and finally use a bus or taxi to complete the journey. The analyst is usually expected to develop strategies that keep the system flowing. Assessing the number of commuters and matching that with the appropriate scheduling of train arrivals and departures, for example, would be a typical task for a transportation analyst in a major metropolitan area.

Transportation analysts at a private company might interact with customers as well as identify ways to save money in the company's supply and transportation network. Analysts working for a municipality or province usually develop analysis methods and interpret transportation statistics for a given region. Analysis might focus on a particular aspect of transportation such as rail transport or the effectiveness of current transportation security methods.

Transportation analysts need superior organisation, communication and computer skills, as well as an attention to detail.

A new public transport system is being planned which will become operational in the next couple of years (RRT). The different professionals involved include transport planning consultants, lawyers, engineers and other experts.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics.
Recommended Subjects: Information Technology, Engineering and Graphic Design.

Further Training

Degree: BEng Civil Engineering, BCom Transport Economics, BCom Logistics Management.

Diploma: N.Dip. Logistics, Transportation Management.

Postgraduate: **One can complete postsecondary degrees in fields such as transportation and civil engineering. BTech Logistics, Transportation Management, BCom Hons Logistics Management / Transport Economics, master's and PhD in Logistics and Transport. BLogistics Hons, MLog and PhDLog. MPhil and PhD Transport and Logistics Studies. Civil Engineering research and postgraduate studies in the field of Transport Planning.**

Employment

- Department of Transport
- municipalities
- transport companies
- private companies
- consulting firms

Further Information

Department of Transport
Head Office (Pretoria)
Privaate Bag X 193
Pretoria, 0001
Tel: (012) 309-3000 Fax: (012) 328-3194
www.transport.gov.za

Institute of Road Transport Engineers
South African Branch
Tel: (011) 681-3300
www.irte.za

Road Freight Association (RFA)
Block E1
Isando Business Park
Gewel St
Isando
P O Box 511
Isando, 1600
Tel: (011) 974-4399 Fax: (011) 974-4903
www.rfa.co.za

South African Allied Transport Employers' Association
Tel: (012) 567-7657
www.saatea.org

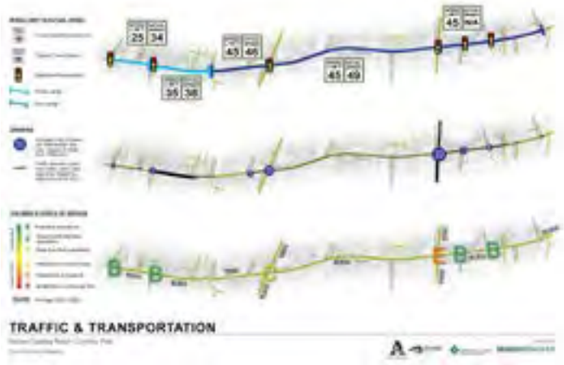
Federation of East and Southern African Road Transport Associations (FESARTA)
96 Main Road (R55)
Crowthorne
Midrand, 1682
P O Box 70202
Bryanston, 2021
Tel: (011) 468-5277
www.fesarta.com

Contact the local City Planning Department at the City Council
The South African Planning Institute
Eastgate Ofiice Park
South Boulevard Road
Bruma, 2198
Tel: (011) 558-7135
www.sapi.org.za

City Planning Department
City Council of Pretoria
P O Box 6338
Pretoria, 0001
Tel: (012) 358-2111
www.tshwane.gov.za

Some Related Careers

Logistics Analyst, Logistics Manager, Transportation Logistics Manager.



Above: Infographics were completed to convey transportation analyses data easily during public outreach meetings.
< http://foresitegroup.blogspot.com/2013/03/project-showcase-renew-opelika-road.html>

Above: Transportation Forecasting - predictive analytics for cost modeling and forecasting.
< http://www.simafore.com >

URBAN AND REGIONAL PLANNER

Urban and regional planners develop, from regional to neighbourhood level, programmes for the most advantageous and purposeful development of towns, cities and rural areas.

Urban and regional planners focus on improving the living conditions of people. They estimate future needs for housing, business and industrial sites, community facilities and open spaces to meet the needs of expansion and renewal.

The work also entails further investigating the nature and extent of problems concerning prospective development such as projecting future needs in traffic and transportation. They need to keep up with legal issues involving community development and changes in housing and building codes.

The growing South African population and quick urbanisation offers town and regional planners the opportunity to play a role in the development of affordable housing and effective infrastructure. The need to conserve historical and natural environments has also become an important development issue. Most of the work is done in an office but it is also necessary to go out on site to see whether everything is done according to proposed development plans. Urban and regional planners work closely with architects, engineers, economists, sociologists, administrators and management on matters concerning public interest and industry.

How to Enter This Occupation

Level of Schooling & School Subjects

National Senior Certificate meeting the requirements for a degree or diploma course.

Each institution has its own entry requirements.

Compulsory Subjects: Mathematics, Science.
Recommended Subjects: Geography, Economics, Business Science, Life Sciences, Engineering and Graphic Design.

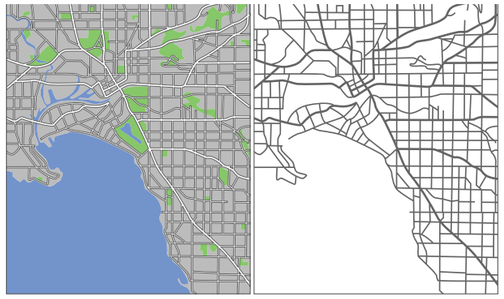
Further Training

Degree: Town and Regional Planning.
Diploma: N.Dip. Town and Regional Planning. With this qualification the candidates are known as town and regional planning technicians. This can be followed by a BTech Town and Regional Planning.

Postgraduate: Qualifications can be obtained at the above universities. In these cases students have to be in possession of an approved degree (not necessarily in town and regional planning), for example, a BEng (Civil), BSc or B degree in architecture or surveying.

Most of the master's degrees are 2 years in duration. BEng civil engineering research or postgraduate studies in urban engineering and management. A master's programme, leading to an MPhil in urban infrastructure design and management, is aimed at building capacity amongst those in government and the private sector who are committed to the future of African cities and to the servicing of particularly poorer inhabitants.

All graduate town and regional planners may register at the South African Council for Town and Regional Planners after completion of at least three years of approved postgraduate practical experience.



Layered Vector Map - Graphical representations of geographic databases that create the displayed map with lines, or "vectors."

Employment

- municipalities
- provincial planning departments
- property developers
- private consultants
- universities, universities of technology and research institutes
- self-employment, as a consultant

Further Information

Contact the local City Planning Department at the City Council

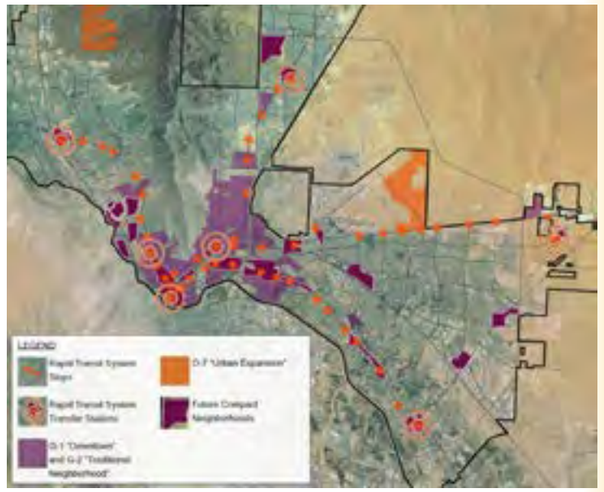
South African Council for Planners
Corner of Brooklyn Rd and First St
Menlo Park, 0083
P O Box 36086
Menlo Park, 0102
Tel: (012) 362-1741 Fax: (012) 362-0983
www.saacpp.org.za

The South African Planning Institute
Eastgate Ofiice Park
South Boulevard Road
Bruma, 2198
Tel: (011) 558-7135
www.sapi.org.za

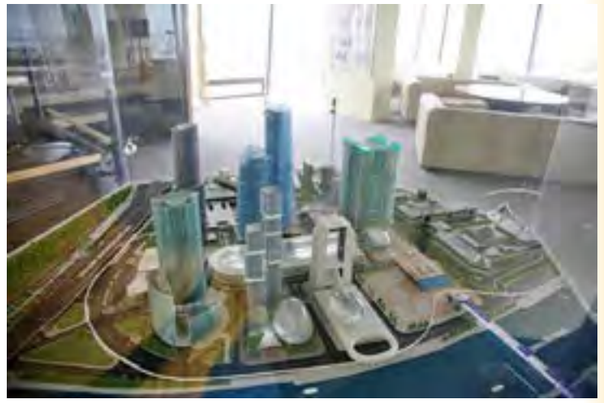
City Planning Department
City Council of Pretoria
P O Box 6338
Pretoria, 0001
Tel: (012) 358-2111
www.tshwane.gov.za

Some Related Careers

Architect, Cartographer, Civil Engineer, Environmental Health Inspector, Geologist, Interior Designer, Land Surveyor, Landscape Architect, Property Developer.



El-Paso, Texas . The agency said it is a "comprehensive, transit-orientated development plan (that) will help link neighbourhoods to greater economic opportunity and to one another, creating new homes and jobs."



A model of a region based on the regional planner's design.

Hotels, shops, restaurants and businesses on every corner and houses built on every square inch of land.

FORENSIC SCIENCE

Popular crime TV series, like CSI have created a great deal of interest among young people wanting to study forensics. In reality however, forensic science is not as dramatic, fast paced and exciting as it is portrayed on TV, but there are some similarities. Physical evidence collected and analysed using forensic science is playing an increasingly vital role in the prosecution of criminals and with the advancement in science, forensic science is becoming a lot more specialised and much of the work is laboratory based.

Forensic science involves a variety of fields: they may assist investigators to understand how blood spatter patterns occur (physics), learn the composition and source of evidence such as drugs and trace materials (chemistry), determine the identity of an unknown suspect or victim (biology), determine the trajectory of a bullet (engineering) or reconstruct the profile of body (computer science).

During an investigation, evidence is collected at a crime scene or from a person, analyzed in a crime laboratory and then the results presented in court. Evidence such as computer data, photographs, DNA and blood can all be put through forensic testing. Each crime scene is unique, and each case presents its own challenges.

The field of forensics can be divided into various areas of specialisation, which include:

FINGERPRINTING

Fingerprint identification is used forensically to identify victims of crimes and place suspects at crime scenes. In both TV crime dramas and real-life courtrooms, fingerprints are often the lynchpin connecting a criminal to a crime.

<http://www.sciencemag.org/news/2015/06/fingerprints-change-over-time-not-enough-foil-forensics>

DOCUMENT ANALYSIS

The vast majority of the crimes that take place involve paper or are committed on paper. Document analysis includes handwriting analysis, fraud and forgery. Questioned material may consist of identification cards, contracts, wills, titles and deeds, seals, stamps, bank checks, handwritten correspondence, currency and electronic documents. In some circumstances, graffiti and digital signatures may be examined; however, the client should be aware that the examination of these types of evidence can be problematic.

Example of alterations on a Deed

7 typed over 5 5 typed over 1 0 typed over ,

<https://quality9.com/a-fraudulent-deed-was-filed/>

FIREARMS, BALLISTICS AND EXPLOSIVES

The science of ballistics allows matches to be made between firearms and their ammunition. Explosives involves the analysis of bomb components, that is, its power source, its initiator, and its explosive substance.

Investigators identify a weapon used which will be matched with the bullets found at the crime scene.
linked to http://diaiz.co/forensic-ballistics-expert/155292727-forensic-ballistics-expert-coloring-3f/

FORENSIC ANTHROPOLOGY

To a forensic anthropologist, truth lies embalmed in the marrow of the dead. By examining the various characteristics of a person's bones, certain deductions may be made about their age from the fusion of bones; diseases suffered, from bone erosions and anomalies; gender, from the size, characteristics and shape of bones; and race, from bone characteristics and shape.

Exhumation of political prisoners at Rebecca Cemetery, Pretoria. The identification of remains allows relatives a chance to get closure and to provide a proper ancestral burial.
<http://www.digitaljournal.com/news/world/exhumed-bodies-reveal-s-africa-s-deep-apartheid-wounds/article/481805>

DNA

DNA (deoxyribonucleic acid) has been called the biological equivalent of fingerprints. As with every person, each DNA arrangement is unique, the only exception being in the case of identical twins.

Hair and fibres: Based on the theory of transfer, which states that when a person comes into contact with another person or place, there is a transference of evidence to that person and to that environment, and vice versa. DNA methylation patterns can be used to build accurate prediction tools in various forensically relevant body fluids, such as in blood, saliva and semen.
<https://forensiccoe.org/webinar/webinar-dna-methylation-based-age-prediction-body-fluid-id-live/>

The forensic scientist often get to follow their cases, including the analysis of evidence in the laboratory and the interpretation of the analytical findings in a courtroom. It is satisfying to see one's work having a direct impact that clearly serves society.
<http://www.sciencemag.org/careers/2002/06/forensic-science-fact-and-fiction>

CHEMISTRY AND TOXICOLOGY

To analyse substances for chemicals, including poisons and drugs, forensic scientists use such instruments as mass spectrometers, which provide molecular "fingerprints" of unknown substances; X-rays, to detect potassium cyanide and other chemical; dielectrometers, which send out electric impulses and record energy absorption, marking differences such as wall imperfections or different densities.

Scientists and researchers continue to improve and discover new means of separating, analyzing, and identifying chemical substances.
<https://www.nlm.nih.gov/visible-proofs/media/detailed>

BLOOD

When a sample of blood is sent to a lab, as in any other science of identification, certain things about the donor can be determined from blood (excluding DNA testing) such as whether it is animal or human and the blood grouping (A, B, AB & O), besides types of genetic markers, which are specific enzymes and proteins.
<http://www.forensicsciencesimplified.org/dna/how.html>

ENTOMOLOGY

A dead body attracts flies. Forensic entomologists use the clues provided by flies to find out exactly how long the body has been dead.

An Old World screw-worm fly Chrysomya albiceps, feeding on decaying matter. The Chrysomya, like other blow-flies are an important tool in Forensic science and Forensic entomology.

<https://en.wikipedia.org/wiki/Wikipedia:Featured_picture_candidates/Greenbottle_fly_eating>

Nicole De Wet

Dr Nicole De Wet is a senior lecturer in Demography and Population Studies at Wits University. Her research focus is on adolescent health in South Africa and in identifying risk factors and the causes of death in adolescents.

In her short career, Nicole has received wide recognition for her work: She spent a four-month residency at the University of Michigan as part of the African Presidential Scholars' Fellowship; she also completed a three-month fellowship in Berlin. Her work has identified the leading causes of death among adolescents as HIV/AIDS, self-harm and transport injuries. Her research shows that factors like poverty and average community income levels are determinants of risky sexual behaviours and illicit drug use among adolescents, placing them at higher risk of disease and mortality.

Nicole is passionate about developing and encouraging young researchers in her field. She has successfully supervised over 25 postgraduate students, most of them African and female. She has single-handedly secured funding from the NRF to host conferences and bring professionals in the field from around the world to train students in her programme.

Nicole has published 31 articles in internationally recognised and peer-reviewed journals, written four chapters of a book and given 34 presentations on her research.
She serves as a peer-reviewer for eight social science and population-related journals. She is a member of several international population research associations and serves on four committees in the Wits School of Social Sciences.

Meet a Senior Lecturer in Demography

We asked Nicole about her work and what had been her motivation to achieve the things she has done. Here is what she said:

What were some of the challenges you faced growing up (at home, school or University)?
"My family are not wealthy, so growing up there were financial challenges. Particularly when I got to University and wanted to do my post-graduate degree in Demography and my parents could not afford it. To overcome this, I studied really hard to secure a scholarship and worked on weekends at a furniture store to be able to obtain my Honours and Master's degrees".

" The process of learning is challenging and time-consuming, but in order for you to be successful and achieve your goals, make the sacrifices now and later on these will pay off".

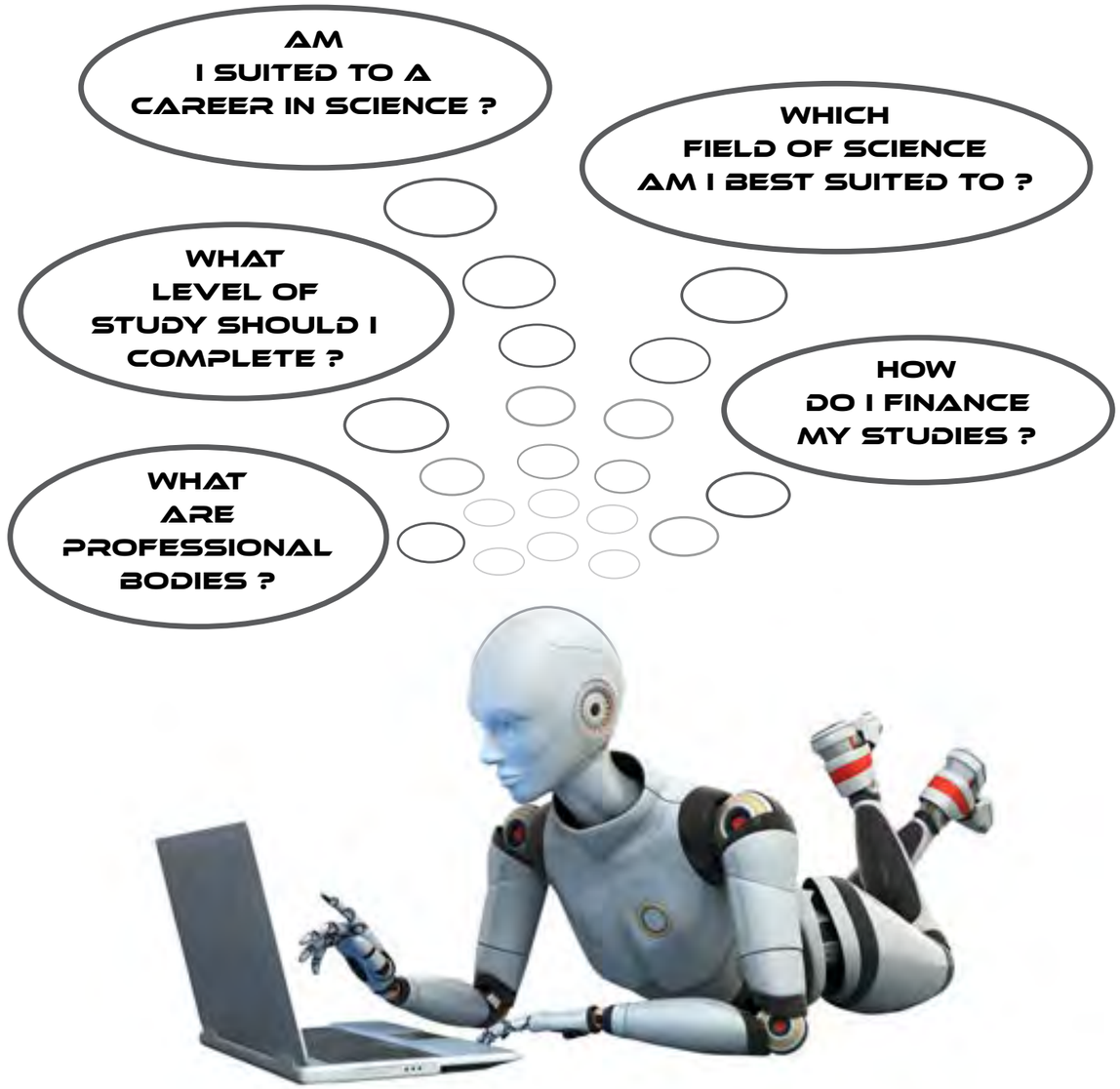
What advice would you give a young person wanting to study in the field of science?
"Be prepared to make short-term sacrifices in order to achieve your long-term goals. The process of learning is challenging and time-consuming, but in order for you to be successful and achieve your goals, make the sacrifices now and later on these will pay off".

Did you ever feel like giving up? What made you carry on?
"Yes! Especially during the Master's and PhD research process where you feel alone and frustrated at the pace. I was also concerned about finances and was worried that I was giving up positions where I could earn a stable salary".

What is your goal?
"My goal is to become a full Professor and to contribute to improving the health and development of adolescents in Southern Africa".

Who do you most admire?
"I most admire my parents who made so many sacrifices for my education and development. From them I have learnt so many lessons in my professional and personal life. They taught me to be respectful, to work hard in my career and in my relationships, to be kind and understanding and to never give up".

Self-Help Guide to my future career in Science, Engineering & Technology



science & innovation
Department: Science and Innovation
REPUBLIC OF SOUTH AFRICA
NRF SAASTA
NDP 2030

1. Self Assessment Questionnaire - "Who am I ?"

Which fields of Science are you best suited too?

Complete the career questionnaire below to help you to choose a field of science best suited to you.

Read through each statement and tick ✓ the ones that you like the most. Leave blank the ones that you do not like. There are 35 statements in all. Once you have finished, add up the total for each row and write the total out of 5 in the right hand column at the bottom of each set of questions. See example below:

EXAMPLE

	Tick ✓
Designing mechanical equipment	✓
Using geometry to design various products	
Using science to develop new products	✓
Managing construction projects	
Manufacturing and maintaining electrical equipment	✓
Total:	*3*

A

Designing mechanical equipment	
Using geometry to design various products	
Using science to develop or design new products	
Managing construction projects	
Manufacturing and maintaining electrical equipment	
Total:	

B

One of my best subjects at school is Physical Science	
Studying Chemistry	
Conducting experiments in a lab	
Solving complex mathematical problems	
Researching scientific problems	
Total:	

C

Studying the earth and its atmosphere	
Studying the earth, from earthquakes to raindrops, and from floods to fossils	
Studying other planets	
Collecting rocks, soil and water to conduct experiments	
Doing geography	
Total:	

D

	Tick ✓
Solving problems with the help of computers	
Writing computer programmes	
Designing and installing computer equipment	
Researching the latest computer technology	
Using mathematical models to design computers	
Total:	

E

Studying human anatomy	
Doing biology	
Studying physics and chemistry as part of a medical degree	
Treating people or animals with who are sick or injured	
Studying the causes of diseases	
Total:	

F

Studying chemical interactions that occur within a living cell	
Studying animal behaviour	
Studying organisms and microorganisms	
Doing environmental science projects at school	
Studying the processes of how an organism forms, from zygote to full structure	
Total:	

G

Studying the behaviour of individuals and groups	
Analysing political issues in a country	
Studying the culture and lifestyle of people	
Conducting public opinion surveys	
Reading books on people and events from the past	
Total:	

Add up your scores for each of the Science Fields and plot them on the Table on the next page.

2. Highest Scoring Fields - Bar Chart

Record your results!

Once you have added up your scores, colour in the bars for your scores from A - G, then identify the field(s) with your highest score. There may be some fields where your scores are the same. Choose the field(s) which you like best of all! Then read up on/ research the types of careers that are related to the field(s) you like in the Science, Engineering & Technology Publication.

	FIELD	1	2	3	4	5
A	**Engineering Sciences**					
B	**Physical & Chemical Sciences**					
C	**Earth Sciences**					
D	**Computer Sciences**					
E	**Medical Sciences**					
F	**Life Sciences**					
G	**Social Sciences**					

Which were your highest fields?

1. _____

2. _____

3. _____

3. Find out more information on Careers

Choose your favourite career. Do some research on this career. Use the Internet and the Science Engineering & Technology Careers Publication to assist you in your research.

CAREER 1

1. Career Name: _____

1.1. What will I do in this career? _____

_____

1.2. What tools or equipment will I use? _____

1.3. Work Environment – tick (✔) in the relevant blocks.

Work outdoors ☐ Work indoors ☐ Work in an office ☐

Work in a laboratory ☐ Work in a classroom ☐ Work in consulting rooms ☐

1.4. What are the personality requirements?_____

1.5. What are the subjects I need to take at school?

Compulsory Subjects	Recommended Subjects

1.6. Where can I study this career? Tick (✔) in the relevant block(s).

University ☐ University of Technology ☐

TVET College ☐ Private College ☐ Other ☐

1.7. Who are the possible employers for this career?

_____

1.8. Name careers that are related or similar to this career.

_____

1.9. What can I do to get started? (Make a list of things to do and people to contact)

_____

_____

_____

Choose a second career that interests you and research it. Use the Internet or the Science Engineering & Technology Careers Publication to assist you in your research.

CAREER 2

2. Career Name: _____

2.1. What will I do in this career? _____

_____

2.2. What tools or equipment will I use? _____

2.3. Work Environment – tick (✔) in the relevant blocks.

Work outdoors ☐ Work indoors ☐ Work in an office ☐

Work in a laboratory ☐ Work in a classroom ☐ Work in consulting rooms ☐

2.4. What are the personality requirements?_____

2.5. What are the subjects I need to take at school?

Compulsory Subjects	Recommended Subjects

2.6. Where can I study this career? Tick (✔) in the relevant block(s).

University ☐ University of Technology ☐

TVET College ☐ Private College ☐ Other ☐

2.7. Who are the possible employers for this career?

_____

2.8. Name careers that are related or similar to this career.

_____

2.9. What can I do to get started? (Make a list of things to do and people to contact)

_____

_____

_____

Choose a third career that interests you and research it. Use the Internet or the Science Engineering & Technology Careers Publication to assist you in your research.

CAREER 3

3. Career Name: _____

3.1. What will I do in this career? _____

_____

3.2. What tools or equipment will I use? _____

3.3. Work Environment – tick (✔) in the relevant blocks.

Work outdoors ☐ Work indoors ☐ Work in an office ☐

Work in a laboratory ☐ Work in a classroom ☐ Work in consulting rooms ☐

3.4. What are the personality requirements?_____

3.5. What are the subjects I need to take at school?

Compulsory Subjects	Recommended Subjects

3.6. Where can I study this career? Tick (✔) in the relevant block(s).

University ☐ University of Technology ☐

TVET College ☐ Private College ☐ Other ☐

3.7. Who are the possible employers for this career?

_____

3.8. Name careers that are related or similar to this career.

_____

3.9. What can I do to get started? (Make a list of things to do and people to contact)

_____

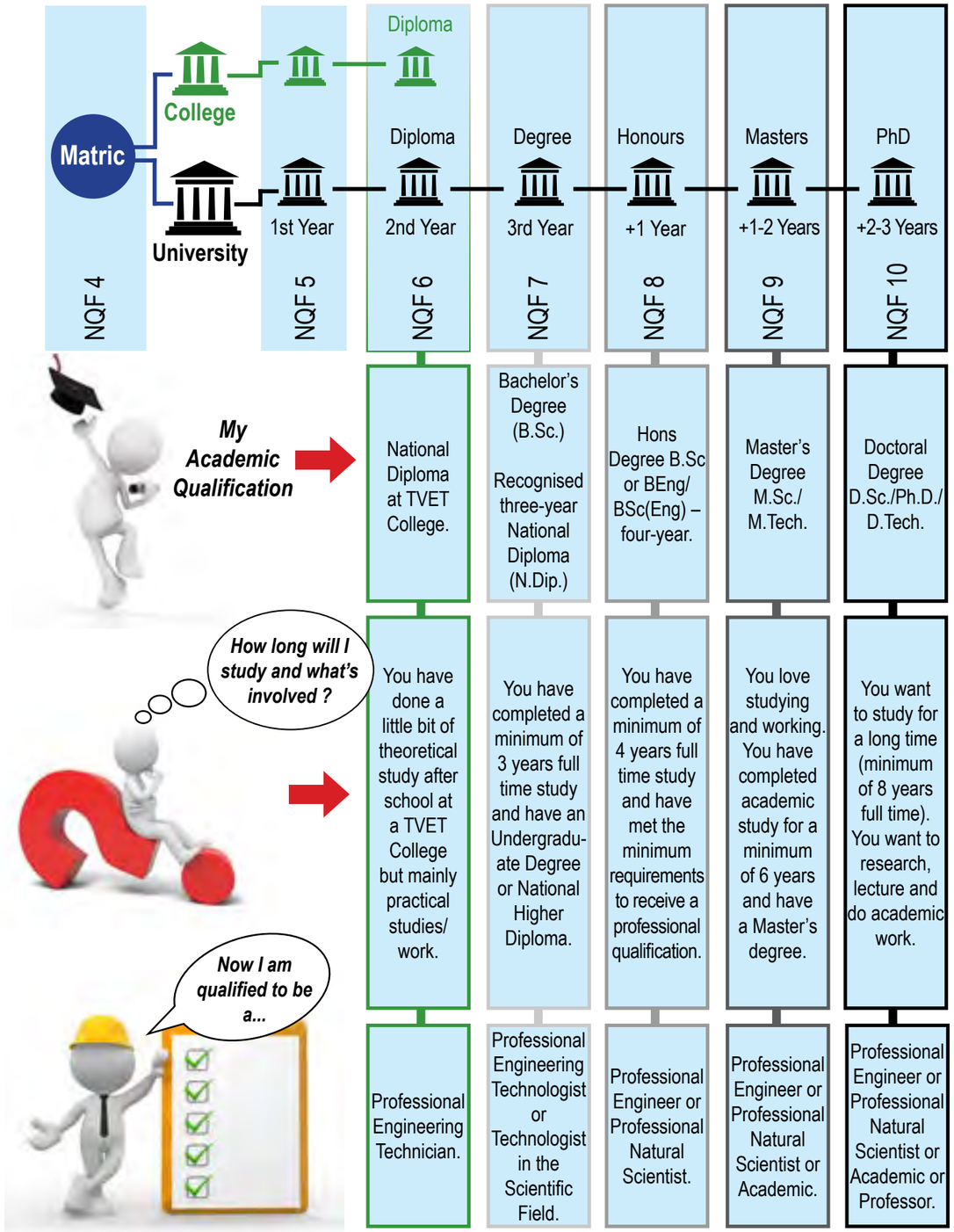
_____

_____

4. Levels of Study

The National Qualification Framework (NQF) consists of 10 levels. All qualifications are graded according to the NQF levels each level signifying a specific standard of intellectual and academic skills. As a general rule of thumb the higher the NQF level, the more academic knowledge required. ***So, what level suites you best?***

The diagram below indicates the levels of study available within the Engineering and Scientific Fields:



5. What Level of Profession do I want to achieve?

What is a Profession?

We all rely on professionals in our everyday lives, from doctors to engineers, from pharmacists to scientists. Professionals in the fields of engineering, science or medicine are required to study an accredited qualification and practical internship before going into independent practice. All professionals are regulated and registered with a Professional Body which set the standards for practice.

In order to practice as an engineer, scientist or medical practitioner, it is compulsory for you to be registered to practice by a professional body or an association representing your discipline. A statutory body means a body or association formed through an act of the Parliament or the State Legislation. Standards and codes of conduct are regulated by law and these are supervised by professional bodies or councils for each field or discipline.

ENGINEERING

To become an Engineer, you need to be registered with the Engineering Council of South Africa (ECSA)
The Engineering Council of South Africa (ECSA) is responsible setting the educational and professional development standards and registering professional engineers. This is done in accordance with the Engineering Profession Act, 2000 (Act No 46 of 2000).

The Engineering Council of South Africa (ECSA) recognises 4 categories of engineer:

- Professional Engineering Technician (Pr Eng Techni)
- Professional Engineering Technologist (Pr Tech Eng)
- Professional Certificated Engineer (Pr Cert Eng)
- Professional Engineering (Pr Eng)

Engineering	Engineering Council of South Africa (ECSA)	www.ecsa.co.za	011 607 9500

NATURAL SCIENCES

In order to practice as a Natural Scientist, it is mandatory to be registered with South African Council for Scientific Professions (SACNASP). This is done in accordance with the Natural Scientific Professions Act, 2003 (Act No. 27 of 2003) (Sections 18 (1) and 20(2)(a).

SACNASP recognises 3 categories of natural scientist:

- Certificated Natural Scientist
- Candidate Natural Scientist
- Professional Natural Scientist

Natural Sciences	South African Council for Natural Scientific Professions (SACNASP)	www.sacnasp.org.za	012 748 6500

MEDICAL & VETERINARY SCIENCES

All medical practitioners working in their respective fields of practice are mandated to register with the HPCSA as a pre-requisite for professional practice. Qualifying in any of the health care professions is an important personal responsibility and, as a practitioner, there are several legal obligations. There is a detailed reference guide for the registration requirements for each of the 12 Professional Boards:

Medical Sciences	Health Professions Council of South Africa (HPCSA)	www.hpcsa.co.za	012 338 9300

NEED FINANCIAL AID?

One of the biggest factors affecting the career choice of young people today is funding for study.

The good news is that the gates of learning are not closed to financially needy students! This is especially true if you have achieved good marks in maths and science at school. Financial aid is provided in different forms by way of bursaries, scholarships or incentive schemes. Read through the options below and check whether you may be eligible for financial aid.

Bursaries:
A bursary is an amount of money granted to a student for the purposes of study. Bursaries are granted on the basis of academic performance, financial need and other requirements. They are usually not paid directly to the student but are administered by a trust or body set up for this purpose. The terms of the bursary will vary from bursary to bursary. Contract bursaries require that the student "pay" for the bursary by working for the bursary provider on completion of studies.

Scholarships:
A scholarship is an amount of money granted to a learner on the basis of outstanding academic or other achievement in a defined field of study. A scholarship is therefore a type of bursary. The word scholarship is often used when referring to international study.

University Discounts & Incentives:
Many institutions offer incentive schemes in order to attract learners with high academic, sporting and leadership potential. Academic incentives are provided on the basis of school marks. To find out more about incentives contact the financial aid bureau of the institution to which you are applying.

Student Loans:
Most young people do not qualify for a bursary and need funding by way of a loan to pay for their studies. Student loans are offered by banking or other institutions for the purpose of paying for studies. Student loans must be repaid once you have graduated. Most banks require you to pay back your student loan over the same number of years that it took to complete your studies and loans must be paid back with interest. Most banks will require some form of surety or security before they grant a student loan. This means that a relative, friend or sponsor must guarantee to repay the loan if you do not. Some banks will also require the person who signs surety for your loan to pay the interest on your loan while you are studying.

The National Student Financial Aid Scheme (NSFAS)

There is a perception that people from poor homes will never be able to study after school. This is not true! The National Student Financial Aid Scheme of South Africa (NSFAS) is financial aid system that enables academically deserving and financially needy students to study.

The student receiving a loan from NSFAS must pay back the capital and interest on the loan. However, interest charged is less than that charged by the commercial banks. To find out more about incentives contact the financial aid bureau of the institution to which you are applying.

The first step in the process is for the student to apply to and be accepted by a university, university of technology or TVET college. Applications must be made via the institution's Financial Aid Office or Student Support Centre. Visit, www.nsfas.org.za for more information.

SO, HOW DID THEY FINANCE IT?

Self-Help to my future career in Science, Engineering & Technology

AM LUCKY TO A CAREER IN SCIENCE

WHAT LEVEL OF STUDY SHOULD I COMPLETE ?

WHICH FIELD OF SCIENCE WILL BEST SUITES ?

HOW

Funding for post-graduate studies

"My family are not wealthy, so growing up there were financial challenges. Particularly when I got to University and wanted to do my post-graduate degree in Demography and my parents could not afford it. To overcome this, I studied really hard to secure a scholarship and worked on weekends at a furniture store to be able to study my Honours and Masters degrees. Thankfully the funding I received from the Consortium for Advanced Research and Training in Africa (CARTA) in my PhD was sufficient and I did not need the weekend job anymore. My advice to young people is: be prepared to make short-term sacrifices in order to achieve your long-term goals. The process of learning is challenging and time-consuming, but in order for you to be successful and achieve your goals, make the sacrifices now and later on these will pay off. ***Nicole de Wet***

Big dreams, hard work and lots of family support

Thakane experienced many financial challenges while studying: "I got financially excluded after my first year and was home for the first month of second year. Towards the end of that month, my mother took my results to the Department of Environmental affairs in Free State and asked them to assist with my fees. I will forever be grateful to her and to the MEC. I did not have additional resources such as laptop and smartphone so I spent more time on campus doing more work than my peers with such resources. Throughout my postgraduate degree, I was a recipient of a bursary from Inkaba ye Afrika. The Inkaba ye Afrika bursary was co-funded by NRF, SA and BMBF Germany. During the last few years of my research, the same Inkaba ye Afrika bursary was funded solely by NRF". ***Thakane Ntholi***

Get a part-time Job!

In order to pay for her studies, Vhonani managed to get a student loan and she had 3 part-time jobs to make ends meet.
"There are many challenges which face students today. Students have to learn to do things for themselves and not rely on entitlement". Apply for funding, look out for opportunities, ask questions … show up and just be where things are happening instead of sitting and complaining about that which is not working all the time. Its all about having the right attitude and taking the opportunities that come up". ***Vhonani Netshendama***

With freedom comes responsibility

Nndwelenil matriculated at Ithuteng Secondary school in 2012, top of his class. He received a bursary from GCRA to study BSc Mathematical Sciences at UJ.
The bursary was worth R50 000 at the time, it covered tuition fees, books, food and accommodation.
"I chose BSc Mathematical Sciences because of the love for mathematics and science. I started my first year away from home, the new environment came with the luxury of independence. I had to adapt and learn to be a responsible grown man. In 2015, I had my first fail academically, it was heart breaking. I lost my bursary and through support of family and friends I managed to complete my studies."
Nndweleni Wayne Sithagu

6. Draw up a Financial Plan

It is **VERY IMPORTANT** to **REMEMBER** that paying for your studies should **NEVER** be an obstacle.
You must investigate all options and plan how you are going to achieve your goal.

Financing your studies

How do you plan to finance your studies? Make a cross in the relevant block. **X**

Parents		**Study Loan**		**Bursary**		**Other**	

Example of cost options for some study programmes and accommodation

Institution	**Study Programme**	**Cost Of Study**	**Cost Of Accommodation (If Required)**	**Total**
Wits	BSc	R47 920	R49 872	R97 792
University of Pretoria	BEng (Civil Eng)	R48 000	R49 000	R97 000
UWC	BPharm	R35 700	R25 910 (excl meals)	R61 610
UKZN	B Agriculture	R40 200	R49 872	R90 072

These figures are estimated costs in order to illustrate that costs structures differ among institutions and cities/towns

Financial Aid

Investigate bursary and study loan opportunities by referring to the Financial Aid Guide (only to be completed if you meet the entry requirements). Note: Most bursaries require high marks, especially in Maths and Science.

Bursaries

Study field		**Requirements of bursary**	
Bursary name		**Duration of bursary**	
Value of bursary		**Who Can Apply?**	
Where to study (Institution)		**Closing date**	
Service Contract with company (if applicable)		**Do I qualify?**	
Address			

Investigate study loans

List three institutions (banks or other) where you can obtain student loans. List their contact number and the documents you require when you apply for a loan.

Institution Name	**Contact Number**	**I Have The Required Documentation To Apply**	
1		YES	NO
2		YES	NO
3		YES	NO

Applications

Have you applied for a bursary	YES	NO

7. Draw up an Action Plan

Complete the Action Plan below, use the following questions as a guide:

1. What is your career goal?
2. At which institution do you plan to study?
3. Do you meet the entry requirements ?
4. What level do you plan to complete, eg Diploma, Degree, Honours, Masters or PhD?
5. How are you going to finance your studies?

EXAMPLE of an Action Plan

Goal	*Action*	*Due Date*	*Completed*
I want to become a Geologist	*Check requirements for BSc at UWC* *C in Maths* *B in Physical Science*	*Use June Matric marks*	✓
	Apply to UWC	*30 Sept*	
	Study to BSc Honours level		
	Bursary and Student Loan	*Applications to Study Trust (bursary) (30 Sept)* *Anglo Platinum (15 May)* *Department of Mineral Resources (30 Oct)*	

YOUR ACTION PLAN

Goal	**Action**	**Due Date**	**Completed**

NSFAS

National Student Financial Aid Scheme

If you were to picture your future, how would it look like? What is that big dream that you have? What are the opportunities available to make that dream possible?

At the National Student Financial Aid Scheme (NSFAS) we know that due to financial reasons, it's not possible for most young people to study further than their matric. And that is why government set up a scheme to provide them with financial assistance to further their studies and realise their dreams, thus helping South Africa grow its economy.

What is NSFAS?

NSFAS is a scheme established by the South African Government in terms of the National Student Financial Aid Scheme Act 56 of 1999, with the main aim of helping students whose financial circumstances would not make it possible for them to study further than Grade 12.

Who has benefited from NSFAS since 1999?

In 2016 NSFAS celebrated 25 years in existence and looked back on its proud history, where it has paid more than R60 billion in loans and bursaries to over 1, 7 million young people from poor backgrounds across all nine provinces in South Africa.

NSFAS' beneficiaries have done well in various careers and most of them hold important positions. Among them are medical doctors, lawyers, engineers and chartered accountants.

What do we do?

NSFAS provides financial assistance in the form of bursaries to eligible students at 26 public universities and 50 Technical and Vocational Education and Training (TVET) Colleges throughout the country. We have helped hundreds of young people who are now working for both the private and public sectors.

dream

Who qualifies for a NSFAS bursary?

You qualify to apply for a bursary if:

- You are registering for the first-time for an under graduate qualification at a public university or you are registered at a public TVET College for one of the National Certificate Vocational or report 191 programme;
- You are a South African citizen;
- Your combined annual household income does not exceed R350 000 per annum;
- You are applying to study at a public university or TVET College for a qualification;
- You are a SASSA grant recipient;
- You are an already registered university student with an annual household income of less than R122 000 per year;
- You need to have passed Grade 9 & 10 to receive NSFAS funding to study at a TVET College;
- You need to have passed Grade 12 to receive NSFAS funding to study at a university.

Who should not apply?

- Students that have completed a previous qualification.
- Students with a combined annual household income of more than R350 000 per annum.
- Students who have already applied, qualified and received funding. They are automatically funded for the duration of their studies provided they pass their modules and meet the academic requirements.
- Foreign students (any student who is not a South African citizen).

What is a combined annual household income?

This is the total annual income earned by the student's family (spouse, mother, father or legal guardian) in the form of wages, salaries, pensions or other sources of income, including rental or business income. NSFAS funding threshold is R350 000 per annum for first time entrants and R122 000 for students currently registered at university. Eligible students will be expected to provide proof of income of their parents or guardians in order to be assisted.

study

what?

What does a NSFAS bursary cover?

- Registration fees
- Tuition fee (total cost of study)
- Prescribed learning materials to a maximum set by NSFAS
- Subsidised accommodation to a maximum set by NSFAS
- Subsidised meal and book allowances
- Subsidised transport allowance

Documents needed for application

- Your South African green bar-coded or smart ID or birth certificate (preferably unabridged)
- IDs of parents and/or guardian (or death certificate where applicable)
- IDs of all people staying in your household
- Pay advice/letter of employment or pension advice (not older than three months)
- Complete disability questionnaire available at the NSFAS website

when?

Applying for NSFAS study assistance

Before you approach us, you need to apply for admission to study at a university, technikon or TVET college. This application process is completed with the institution of your choice directly. Financial assistance is only considered for students who have been accepted at a higher learning institution and meet all the requirements to study towards higher education.

Learners can also apply for both NSFAS funding and university or TVET college admission through the Central Applications Clearing House (CACH).This applies to students whose applications have been rejected at Universities. Most of the places available at universities through CACH will require good performance in subjects such as Maths, Physical Sciences and Life Sciences. Learners are encouraged to apply on time

When can I apply?

NSFAS will announce application period or dates every year before they open.These dates are usually communicated well in advance during the year before the one you are requesting funding for.

Other Bursaries provided through NSFAS

Social Worker
Apply via www.dsd.gov.za or at the Financial Aid Office of the University you want to study.

Students with Disabilities
Apply at www.nsfas.org.za.

Teaching
Funza Lushaka Bursary Programme.
Apply at www.funzalushaka.doe.gov.za.

Sector Education and Training Authorities (SETAs)
Apply at the relevant SETA.

NSFAS manages a number of different bursaries from different SETAs. You can apply for these bursaries through NSFAS or Financial Aid Office of the University or TVET College you wish to study.

achieve

NSFAS Contact details

For more information on NSFAS funding visit www.nsfas.org.za or contact us at info@nsfas.org.za or 086 006 7327

Follow us on Twitter @myNSFAS or Facebook at National Student Financial Aid Scheme

EVALUATION SHEET

Tell us your thoughts about this career book

Your responses will help us to improve future editions of the publication.

Please tick the most appropriate choice for the following:

1. At the time of reading and using this career booklet, you were a ...
   - ☐ Teacher ☐ Learner ☐ Parent ☐ Student (tertiary)
   - ☐ Professional Career Counsellor
   - ☐ Other _____ (state your professional status)

2. Please rate how USER-FRIENDLY this career booklet is?
   - ☐ Very user-friendly ☐ User-friendly ☐ Not user-friendly ☐ Unusable

3. How useful did you find this publication?
   - ☐ Very useful ☐ Useful ☐ Not useful ☐ Don't know

4. Please provide us with any suggestions to IMPROVE the quality and content of the publication

   _____
   _____
   _____
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   _____

Please copy and return the completed EVALUATION SHEET to the Science Promotion Unit, Department of Science and Technology, Private Bag X 894, Pretoria, 0001;
or Fax to 086 6810 129

Thank you for taking time to complete this evaluation sheet

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