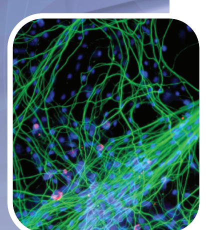



by 12 nations, including South Africa, in 1959 and enforced in 1961. By 2009, 48 nations have signed the Treaty. The purpose of the Treaty is to maintain peaceful activity and to promote cooperative scientific research on the continent. An international, inter-disciplinary research committee called SCAR (Scientific Committee on Antarctic Research) is tasked with initiating, developing and coordinating high quality international scientific research in the Antarctic region.

Article III of the Treaty states "In order to promote international cooperation in scientific investigation in Antarctica, as provided for in Article II of the present Treaty, the Contracting Parties agree that, to the greatest extent feasible and practicable:

a. information regarding plans for scientific programs in Antarctica shall be exchanged to permit maximum economy of and efficiency of operations;
b. scientific personnel shall be exchanged in Antarctica between expeditions and stations;
c. scientific observations and results from Antarctica shall be exchanged and made freely available."

This article requires that scientifc information in Antarctica be shared and freely available to all, a unique ideal. When it comes to the possibilities of bioprospecting in Antarctica in particular, this raises new questions about how bioprospecting, particularly with investment from private companies, will impact on freedom of scientific research and the unique ideal of international co-operation in Antarctica. There is a lack of specific policy when it comes to bioprospecting, which is currently being addressed. This poses questions when it comes to patenting of materials and ownership of information which have been agreed to be "shared".

Such concerns over legal issues around ownership, which still need to be resolved, create obstacles to the investment by private companies for bioprospecting and harvesting the genetic potential in the Antarctic. With bioprospecting being expensive and requiring a long-term effort, private companies will be more likely to concentrate their funds and effort elsewhere.

South Africa's presence in Antarctica

South Africa has maintained an Antarctic base for scientific purposes since 1960. South Africa also maintains its presence at the Southern Ocean Prince Edward Islands (Marion and Prince Edward) and Gough island. SANAE IV (71° 40' S 2° 51' W) is the fourth national base. The Department of Environmental affairs and Tourism is responsible for the logistics and administration of the base. Scientific work is planned by the South African Committee for Antarctic Research (SACAR). South African research activities in the Antarctic and Southern Ocean Islands are performed by university based researchers and researchers from several National Facilities of the National Research Foundation and are endorsed by the Department of Science and Technology, the South African National Antarctic Program (SANAP) and the National Research Foundation.

SANAP's mission is to increase understanding of the natural environment and life in the Antarctic and Southern Ocean. It has five main research strategies, namely

- Antarctica: a Window into Geospace;
- Climate Variability: Past, Present and Future;
- Biodiversity Responses to Earth System Variability;
- Engineering Sustainable Presence in Antarctica; and lastly the
- History, Sociology and Politics of Antarctic Research and Exploration.

The objectives in the Biodiversity research strategy are to understand the changes that occur in biodiversity over time and space, to understand biological responses to the environment, on an individual level as well as the ecosystems as a whole, and to understand and identify the differences between the effects of natural and human influences on biodiversity in the Antarctica.

For more information on SANAP activities, visit **www.sanap.ac.za.**
(http://www.sanap.ac.za/sanap_research/sanap_research.html).

The PUB programme is an initiative of the Department of Science and Technology and is implemented by SAASTA. The mandate of PUB is to promote a clear, balanced understanding of the potential of biotechnology and to ensure broad public awareness, dialogue and debate about biotechnology and its current and potential applications.
For more information visit **www.pub.ac.za** or contact **info@pub.ac.za,** Tel: 012 392 9300 or Fax: 012 320 7803.

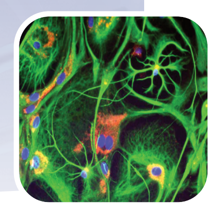
PROMOTING A CLEAR, BALANCED UNDERSTANDING OF BIOTECHNOLOGY

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

BIOTECHNOLOGY RESEARCH IN THE ANTARCTIC REGION







Antarctica is the coldest place on Earth and is almost entirely covered in ice. About 80% of the world's fresh water lies frozen in the Antarctic. Average winter temperatures are in the range of -50°C, with a record temperature of -89°C having been recorded. It also has the lowest average humidity. This makes Antartica a unique environment, with a unique natural and biological constitution, and offers unique opportunities for research and biotechnology applications, with its own set of challenges.

Biotechnology is one of the most research-intensive industries in the world. Increased understanding of biological processes and advancement of biotechnology are allowing scientists to utilise the natural world to achieve advances in areas such as drug development, bioprocessing and bioremediation.

Bioprospecting is the term used to describe exploring living things and biological material to see how they can be of commercial value to humans (see Bioprospecting fact sheet for further information). When looking to nature to find solutions, undiscovered and undescribed genetic resources provide the potential to discover new and valuable products.

Therefore scientists focus their search in areas of high biodiversity (i.e. where a lot of biological and genetic variation exists) or areas of extreme environments where adaptation in order to survive the environment will have altered key biological processes in those organisms, making their genetic and biochemical makeup unique to that particular environment.

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

The information presented here is endorsed by SAASTA. For more information on the Scientific Editorial Process followed, visit **www.saasta.ac.za**

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Antarctica is an environment of extreme cold, of arid and salty conditions. Organisms which have evolved unique characteristics to survive hostile environments like Antarctica are called "extremophiles", i.e. liking (phile) extremes (extremo). More specifically, those organisms adpated to survive in the extreme cold are called "psychrophiles" i.e. liking (phile) cold (psychro). Antarctica is an area of untapped genetic potential. Scientists are working to discover organisms with genetic and biochemical properties that make survival possible in these extreme conditions. This may lead to the development of new cancer drugs, antibiotics and industrial compounds.

Pharmaceuticals

Molecules derived from natural products, particularly plants and microorgansims, have an excellent record of providing pharmaceuticals. For example, aspirin (acetylsalicilic acid) from willow bark or penicillin from the fungus *Pencillum* are both important pharmaceuticals. Micro-organisms have gained particular interest due to their biochemical diversity and presence in all environments including extreme environments. Micro-organisms represent the largest source of undescribed, untapped biodiversity and hence possess the greatest potential for discovering new products.

- **Antibiotics**
  The Antarctic environment (the terrestrial environment and sea ice) is a rich source of novel bacterial species and of rare Actinobacteria. Actinobacteria are a group of bacteria with high commercial interest, many having produced pharmaceutical compounds. Seventy per cent of antibiotics come from species of Actinobacteria. Some of the recently discovered Actinobacteria species in Antarctica belong to groups that have shown much promise in the discovery of pharmaceuticals. Antarctica Actinobacteria may be a source of new antibiotics.

- **Polyunsaturated fatty acids (PUFAs)**
  The bacteria that inhabit the Antarctic ice produce polyunsaturated fatty acids (PUFAs). This allows them to maintain fluidity in their membranes at such extreme low temperatures. The health benefits of PUFAs to humans are well-known. For example, Omega-3 from fish oils and Omega-6 from plant oils are well-known for their benefits to cardiovascular health. PUFAs are converted in the body into certain hormones which mediate cardiovascular health, as well as being essential for development of retinal and nerve tissue in animals. PUFAs are difficult to synthesise in industry and therefore are required to be harvested from their natural sources. They also cannot be synthesised by the human body and need to be incorporated into the diet. Psychrophilic bacteria from the Antarctica have been shown to produce PUFAs such as EPA (eicosapentoic acid) and DHA (docosahexaenoic acid), which are currently sourced largely from fish, as well as algae. However, fish supplies are declining and algal supplies require a high investment of technology and money, making bacterial supplies potentially more promising. Another advantage is that bacteria produce a single PUFA, not a complex mix like fish and algal sources and therefore do not require complex purification. It may be possible in the future to use the genes responsible for the PUFA production in these Antarctic bacteria as transgenes and incorporate them into other genetically modified species.

Industrial applications

- **Cold-active enzymes:**
  Antarctic bacteria produce cold-active enzymes, which are capable of normal function at extreme low temperatures. There may be applications for these enzymes in cleaning agents, leather processing, food processing, and others.

- **Anti-freeze proteins**
  Scientists have discovered fish that survive Antarctic waters by producing their own "anti-freeze". The molecules responsible, called anti-freeze glycoproteins (AFGPs), have various potential applications. They could be used commercially to protect frozen food and increase its shelf-life, or keep ice cream soft in freezers. They have potential in medical applications to protect tissues during cryosurgery or protect tissues for transplant at low temperatures. Various patents involving the use of these anti-freeze proteins have been issued.

  Anti-freeze proteins, labelled ice-structuring molecules, have been approved by the US Food and Drug Administration (FDA) and have been shown to be safe for human consumption, and are being incorporated into ice-cream and yoghurt products.

Other examples
The cosmetics manufacturer Clarins incorporates the Antarctic algae, *Durvillea antarctica*, in its Extra Firming Day Cream.

The New Zealand biotechnology company ZyGEM uses an enzyme derived from a thermophilic (heat-loving) microorganism found in a volcanic vent in Antarctica for its products called forensicGEM, phytoGEM , and prepGEM, which are used to extract human DNA from crime scene samples. ZyGEM Corporation claims their new reagent extracts DNA from smaller samples three times faster and at greatly lower cost than other existing extraction methods.

Bioremediation

Bioremediation can be defined as any process that uses microorganisms, fungi, green plants or their enzymes to return the natural environment altered by contaminants to its original condition. Strains of bacteria isolated from Antarctica have been shown to degrade hydrocarbons. Hydrocarbon contamination may result from the fuel used to drive the human activities in Antarctica. These bacteria not only provide potential development for bioremediation technology in extreme areas, but also for the decontamination of Antarctica from human activity in line with the conservation ideals of the Antarctic Treaty.

Genetic diversity

Knowledge of the genetic diversity (i.e. how many different variations of genes exist) within a species in the Antarctica has various applications, including understanding the evolution of the species in Antarctica and how the species respond to climate and environmental change, as well as understanding the effects of human existence and intervention in the Antarctic on the species. Determining the genetic diversity of species requires various molecular and biotechnology tools.

One of the five key scientific research projects of SCAR (Scientific Committee on Antarctic Research) is *Evolution and Biodiversity in the Antarctic: the response of life to change*. This project an international multidisciplinary programme running from 2006 to 2013. The aim of the programme is to understand evolution and diversity of life in Antarctica and how it influences the properties and dynamics of ecosystems in the Antarctic. Scientists also aim to predict how organisms and ecosystems will respond to environmental and climate changes.

South African research

The Centre of Excellence for Invasion Biology (CIB) at the University of Stellenbosch, in collaboration with the British Antarctic survey, is studying the genetic variation in micro arthropods in the Antarctic to determine the role of humans as vectors for transport of organisms in the region. The Institute for Microbial Biotechnology and Metagenomics [IMBM] at the University of the Western Cape is involved in research into microbial diversity and biotechnology in Antarctica. IMBM reserchers collaborate with New Zealand and American scientists.

What makes research in Antarctica unique?

The Antarctic Treaty System has created a research environment unique to Antarctica. The Antarctic Treaty System refers to the arrangements for the regulation of nations active in Antarctica, a continent with no native population, no citizenship and no government. At its core is the Antarctic Treaty, signed originally