Biotechnology and Environmental Sustainability: Tools for a cleaner, greener planet

Sustainability is vital as we progress into the future. As limited natural resources are in decline and as we are faced with consequences of climate change, the preservation and sustainability of the environment is recognised globally at the highest levels of leadership to be an issue requiring critical attention. To ensure environmental sustainability, key areas of focus include the management and preservation of non-renewable and environmental resources, the management of waste, the prevention and treatment of pollution, and the preservation of biodiversity.

Biotechnology uses living organisms and their biological processes to produce valuable products. It has widespread applications across many sectors, including agriculture, industry and medicine. Biotechnology, by its nature, uses biological systems and its processes are potentially "greener" compared to many traditional technologies involving chemical processes. It has the potential to play a role in the above key focus areas and be an important tool to promote environmental sustainability. Biotechnology applications can reduce the use of fossil fuels, reduce greenhouse gas (GHG) emissions, allow more energy efficient production in industry, produce biodegradable products, manage waste and treat pollution.

Biofuels are being developed as a more environmentally friendly, alternative energy resource to alleviate our dependency on limited fossil fuels. The production of biofuels is being refined to reduce the input of fossil fuel in the manufacturing process to reduce its impact on the environment. Biofuels made from cellulose in wood, grasses and non-edible parts of plants can significantly reduce GHG emission in comparison to fossil fuels. Newer sources of biomass such as algae can be transformed into a variety of renewable fuels. Visit www.pub.ac.za to download fact sheets on biofuels.

Agricultural (Green) Biotechnology and Genetically Modified (GM) Crops can reduce the impact of farming on the environment caused by the effects of fertilisers, pesticides, tilling (ploughing), exhaustion of soils and loss of biodiversity. With the increase in food production to feed the growing population, the environment comes under more severe threat. Biotechnology allows farmers to produce more food on existing farmland and allows crops to be grown on marginal land. It allows farmers to use less water (drought-resistant crops), to use less pesticide (insect-resistant crops), and to plough less (herbicide-resistant crops) thereby reducing soil erosion, water pollution caused by run-off, and the use of fossil fuels, therefore reducing GHG emissions. GM crops can lead to greater farmland biodiversity and reduce pressure on fragile wildlife habitats. While biotechnology has potentially great benefit, some risks have also been identified. The risk of gene transfer from GM crops to wild populations is a concern, with the fear of "superweeds" being created. The threat of disturbing ecological systems has been identified as a risk, as has the evolution of "superbugs" in adaptation to pest-resistant crops. For these reasons, GM crops are under strict regulation in South Africa and internationally.

Industrial (White) Biotechnology: is reducing chemical pollution and GHG emissions in industry, making manufacturing processes "greener". It is also producing new products that have less impact on the environment. Biological enzymes can make industrial processes more environmentally friendly. For example, enzymes in washing powders reduce the amount of detergent required, reduce washing temperature and save energy. Bioplastic made from biomass can substitute petroleum-based plastics. They are biodegradable and reduce landfill waste. Bio-refineries can transform bio-based waste into valuable feedstock or other useful products, making it not only environmentally friendly but also economically viable. Biogas, a renewable fuel, can be harvested from organic waste from industry.

Bioremediation: Bioremediation refers to the use of biological systems to reduce pollution of air, soil or water, generally using microorganisms or plants. Bioremediation can be used either to treat an already polluted environment or to treat waste before it leaves a production facility. Great care must be taken through careful monitoring when introducing microorganisms into an environment to clean up pollution so that the natural

ecological balance is not destroyed. Visit www.pub.ac.za to read the April 2010 newsletter and an example of bioremediation of acid mine drainage.

The effects of GM organisms and some other applications of biotechnology on the environment are still unpredictable, and regulations to ensure safe applications are essential. Nevertheless, biotechnology, in applying the immense diversity in species and biological pathways on earth, can in principle be a very powerful tool in creating environmentally friendlier alternatives to products and processes that presently pollute the environment or exhaust its non-renewable resources.