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UNIVERSITY OF JOHANNESBURG

Faculty of Science NEWSLETTER

Innovatively creating **new knowledge** and **leading scientists**

Microbiology Laboratory

Industrial Biotechnology has led to cleaner processes that produce less waste and use less energy and water in Industrial sectors such as chemicals, paper and pulp, textiles, food, energy, and metals and minerals. A good example here is the use of Biotechnology-based enzymes in laundry detergents.

DNA-fingerprinting has dramatically improved criminal investigations and forensic medicine. It is also responsible for hundreds of medical diagnostic test kits used to ensure that blood supply is kept safe from the AIDS virus and also used to detect other disease conditions early enough to be successfully treated.

It also includes the genetic modification of cells to improve products and processes for the production of specific pharmaceuticals such as insulin, disease and pest resistant agricultural products, bioremediation, transformation of steroid and many other applications.

Consumers already are enjoying biotechnology foods such as papaya, soybeans and maize and hundreds of bio-pesticides and related biotech agricultural products are used to

Erick van Zyl, HOD of the Department

THIS ISSUE **FOCUSES ON THE DEPARTMENT OF BIOTECHNOLOGY.**

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protect our food supply and to reduce the use of chemical pesticides, thus making foods safer and healthier and increasing crop-yields. Agricultural crops that have already reaped great benefit from the genetic improvement and protection against pests include maize, bananas, cotton, soybeans, tomatoes, potatoes, sweet-potatoes and various others.

Other positive impacts of biotechnology on agriculture include drought tolerance, frost resistance and soil improvement. It is clear that biotechnology holds the key to help eradicate malnutrition and to feed millions of starving people.

Environmental biotechnology products make it possible to clean up hazardous waste more efficiently by harnessing pollution-consuming microbes rather than dangerous chemicals. Biotechnology has the potential to bring unprecedented advances in human and animal health, agriculture and food production, manufacturing and sustainable environmental management.

Academic Staff

Kevin Maclean

Kulsum Kondiah

Lee Alagiozoglou

Student working with **the Bioreactor**

The Biotechnology is currently housed on the DFC campus but as part of the Faculty of Science. The Department is destined to relocate to the APK campus in the near future.

Biotechnology is considered a National Priority. It covers a very wide field and for that reason it is sometimes defined as: **The use of Biology for financial gain.**

As an art Biotechnology has been practice for many ages and includes traditional practices such as beer brewing, wine making, developing new animal breeds and plant varieties, production of yoghurt and cheese and various other fermentation products and processes. These practices have developed into exciting new sciences that are possibly best described as *the technology that uses biological systems, living organisms or their enzymes to make or modify products or processes for specific purposes.*

Biotechnology cuts across many biological boundaries including various industries such as pharmaceutical industries, cosmetics, dairy, health and environmental management, and agriculture to name but a few. It encompasses techniques originating from disciplines such as pure chemistry, biochemistry, microbiology, genetics, information technology and engineering and many others.

Research

It is currently one of the most research intensive industries and can be divided into four categories:

RED BIOTECHNOLOGY. This refers to medical biotechnology like genetic tests and therapy and includes scanning for genetically carried conditions, forensic tests, pre-natal diagnostic scanning, treatment of genetically derived conditions and many others.

GREEN BIOTECHNOLOGY encompasses plant and agricultural activities. It includes genetic improvement of crop plants to improve harvest yields, to develop plant resistance to drought and pests and to improve nutritional qualities, texture and taste.

BLUE BIOTECHNOLOGY refers to marine applications of biotechnology. This category of Biotechnology that has received least research attention thus far.

WHITE BIOTECHNOLOGY are those industrial industries that are based on biotechnological processes and includes brewing, production of pharmaceuticals such as penicillin and steroids, sewage purification, bio-fuel and yoghurt production to name a few.

UJ offers a Diploma in Biotechnology with the emphasis on **WHITE BIOTECHNOLOGY.** After obtaining the Diploma in Biotechnology the student can apply to enrol for advanced and postgraduate studies.

Research **in the Department of Biotechnology**

Dr Kondiah (Middle Back) and some members of her research group

The research group at the Department of Biotechnology was initiated in 2010 and focuses on addressing some of South Africa's prominent environmental issues using biotechnological approaches that are innovative yet inexpensive. One such problem is that of acid mine drainage (AMD), a threat that has continued to increase in Gauteng and has been a hot topic this year. AMD is the uncontrolled flow or seepage of polluted water from old mining areas into surface and groundwater. It is characterized by high acidity (pH <2) and salinity levels and elevated concentrations of toxic heavy metals such as cadmium, lead and even radionuclides. While such heavy metals are needed in low concentrations for metabolic reactions, at higher concentrations they lead to neurotoxicity, carcinogenesis and mutagenesis. Local communities in Gauteng currently use this polluted water for personal consumption and farming exposing them on a daily basis to the aforementioned threats. The costs involved with cleaning up acid mine decant are substantial and companies lack the capacity to handle the large volumes of decant generated every day from this mining hub. The Department of Biotechnology is involved in developing cheaper techniques to remove these toxic metals from acid mine decant using microorganisms, a process known as bioremediation, as well as developing a highly sensitive portable biosensor that will detect the presence of heavy metals in water.

Due to the composition of AMD, it is termed an *extreme environment* and is an ecological niche for a select microbiota. The microorganisms inhabiting this environment have adapted to survive the highly acidic pH and the high concentrations of toxic metals and are referred to as *acidophiles and metallophiles*, respectively. At the Department we are interested in using the metallophiles for bioremediation of AMD by exploiting their biosorption/bioaccumulation and detoxification strategies for coping with toxic metals. Microorganisms that are capable of biosorption bind the metal ions to their cell membranes effectively removing the toxic metal ions from solution while others are capable of reducing the toxic metal ion species to the nontoxic form. Such a step could easily and cheaply be incorporated at decant release sites and municipality water treatment sites. Additionally, the metalloregulatory proteins expressed by these microorganisms can be used as biomaterial to detect the presence of select heavy metal ions. The proteins can be immobilized in a nanomatrix to increase sensitivity and deposited on a disposable electrode making a cheap, portable electrochemical biosensor that can be used for in situ monitoring of acid mine decant during each stage of treatment and release. Currently, the project on developing the heavy metal biosensor has been funded by the International Foundation for Science and the NRF Thuthuka Programme.

Some Biotechnology postgraduate students are involved in BTech and MTech research in collaboration with industry covering a variety of Biotechnology topics.

The FACULTY OF SCIENCE is a vibrant, dynamic and diverse scientific community that is a premier centre for the generation, dissemination and application of knowledge in the natural sciences and technology.