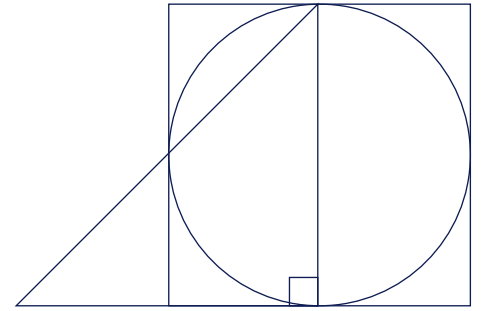


# Report

05/06



## Faculty of Natural and Agricultural Sciences



# Faculty of Natural and Agricultural Sciences

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# From the Dean's office



*Prof. Herman van Schalkwyk.*

The Faculty of Natural and Agricultural Sciences at the University of the Free State (UFS) leads the way in the practising of natural and agricultural sciences in South Africa and the highest levels of quality and credibility are reflected.

Our commitment, however, reaches far beyond just this. It reaches beyond the borders of the country and across continents; its multi-disciplinary and practical approach is vested in all the disciplines presented by the faculty.

In 2005/06 the Faculty experienced significant growth in measurable outputs. A contributing factor was the comprehensive apparatus strategy and plan which was implemented in 2005. With this strategy, university funds were used to leverage other funds in order to obtain huge discounts from suppliers of apparatus. In this way the faculty managed to obtain almost R50 million worth of apparatus in 2005.

The strategy was continued in 2006 when an agreement to the value of R7 542 531 was reached with Shimadzu, according to which apparatus was supplied to the faculty at discount prices. The agreement, which is valid for three years, entails the free replacement of apparatus which is purchased during this period with upgraded versions.

The new apparatus forms part of the UFS vision to compete internationally with quality research outputs in certain niche areas, to provide leadership in advanced training to students from the African continent and to establish the university as a leader among South African universities.

Two researchers with a B rating from the National Research Foundation (NRF) were also appointed. Both of these initiatives bore fruit and in 2006 the faculty increased its total research outputs by

about 13%. As an example, the Department of Chemistry's outputs increased by 100%.

The faculty has been bursting at the seams over the past couple of years. Student figures rose from 3 935 undergraduate, postgraduate and occasional students in 2005, to 4 224 in 2006. There is also strong representivity of students from other African countries and in 2005/06 almost 600 students studied at the faculty.

An extended B.Sc. programme has been presented to students since 2005. The programme aims at providing students who do not comply with all the requirements for the B.Sc. programme with the necessary sub-structure to complete the B.Sc. degree successfully. A preliminary evaluation of the results indicates that the programme is delivering the desired results.


The alignment of the Qwaqwa Campus, which was incorporated into the UFS in January 2003, remains a challenge. Regular discussions are held with staff on the campus in order to make the faculty's programmes more sustainable and to align it with the broader strategic plan of the UFS.

On a national level, the faculty is in the process of making its mark in terms of teaching and community service. In 2005 the faculty again actively began utilising its

experimental farms. A three-way agreement between the UFS, the National Farmers Union (NAFU) and the Mangaung Local Municipality led to the establishment of the Lengau Agricultural Development Centre on the Sydenham Experimental Farm. The centre provides training and mentorship to small-scale upcoming farmers.

To be dynamic and progressive requires innovative thinking. It requires commitment and a desire to deliver excellent teaching and learning opportunities to students. It requires a willingness to form partnerships, and a multi-disciplinary and practical approach to the tertiary education environment in South Africa.

This report covers the faculty's activities in 2005/06. It is a reflection of two years' commitment on the part of a team of skilled and motivated academics and support staff.



**Prof. Herman van Schalkwyk**

Dean: Faculty of Natural and Agricultural Sciences  
University of the Free State

# Microbial, Biochemical and Food Biotechnology



“Quality undergraduate training enhances quality postgraduate research.”

Prof. James du Preez.

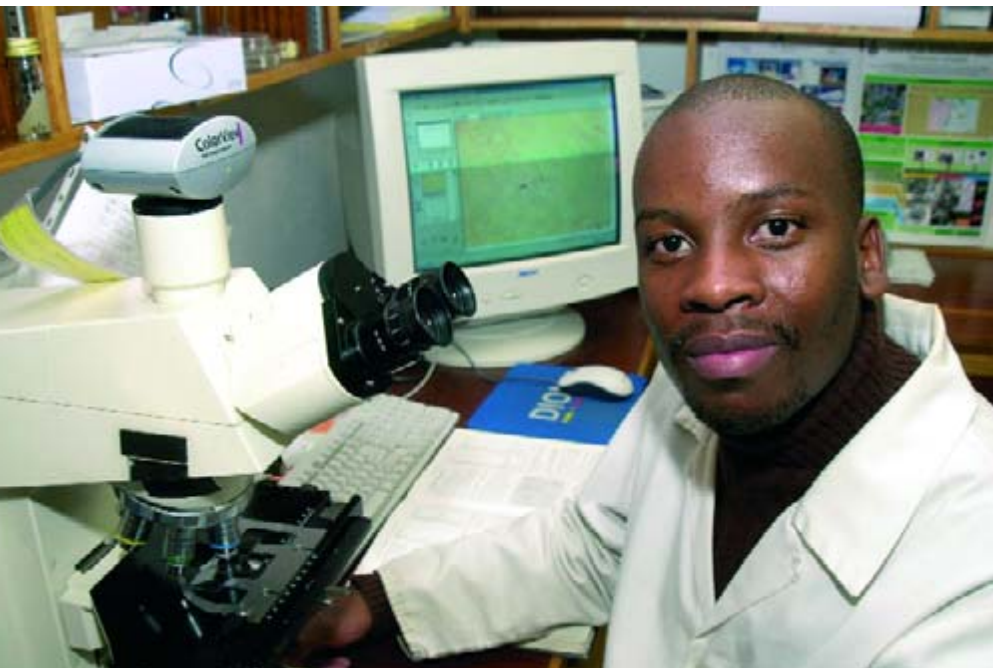
## Overview

The Department of Microbial, Biochemical and Food Biotechnology offers training in the broad disciplines of Biochemistry, Microbiology, Biotechnology, Food Science and Consumer Science at an undergraduate level as well as at B.Sc. Honours, M.Sc. and Ph.D. levels. A particular strength of the department is the close association between the disciplines of biochemistry and microbiology, resulting in a dynamic interchange of ideas and expertise.

Most of the academic staff in the disciplines of microbiology and biochemistry have ratings from the National Research Foundation (NRF) and research in the department is funded by a wide range of national and international agencies. This translates to the postgraduate students and postdoctoral fellows being trained in cutting-edge science by internationally recognised researchers.

The department was awarded the status of a Microbiological Resources Centre (MIRCEN) by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) in 1996, with the mission of serving as a resource of yeast cultures and training for Southern Africa. The MIRCEN yeast culture collection is the largest of its kind in the southern hemisphere, and is a valuable research resource in the department, as well as nationally and internationally.

One of the highlights of 2005 was the implementation of the strategic equipment plan of the Faculty of Natural and Agricultural Sciences. The department's first priority was to address the backlog in essential equipment required for undergraduate training, as the provision of good laboratory facilities for undergraduates is regarded as essential for quality training, which in the end enhances quality postgraduate research. To this end, 40 binocular oil-immersion microscopes and 20 spectrophotometers at a total value of R724 584 were purchased, exclusively for undergraduate training. Research requirements were not neglected, however, and during 2005 the department also received R471 425, which was used to purchase equipment for postgraduate training and research, including a diode array HPLC, an electrophoresis unit and a real time PCR machine. The latter was



Mr Olihile Sebolai in the laboratory.

mainly funded by external research funds with a R71 000 contribution from the UFS.

In 2006 several major opportunities to boost research and postgraduate training were realised. Prof. Hugh Patterton was successful in his application to obtain a bioinformatics node established at the UFS as a faculty facility, which will link with the national bioinformatics network. The aim of the UFS node is to perform internationally competitive research in bioinformatics, contribute to capacity building in bioinformatics by the training of students at under- and postgraduate levels, and to present training workshops to students and staff. The bioinformatics node will also be involved in providing computational support to projects that include bioinformatics components. The node will be housed in the Biotechnology Annex on the Main Campus in Bloemfontein, and apart from powerful, modern computing equipment for research purposes, the node will also include a 20-workstation lecturing facility for bioinformatics and related teaching.

Prof. Patterton also received a R1 million award from the NRF National Equipment Programme for the acquisition of a two-dimensional protein gel scanner as well as a microarray slide scanner. The placement of these instruments as well as the presence of the bioinformatics node is expected to significantly expand research activities in high throughput biology, particularly in genomics and in proteomics, at the UFS. Furthermore, an NRF Research Niche Area (RNA) in High

Throughput Biology was awarded to a consortium of UFS scientists led by Prof. Patterton. This opens up a new avenue of funding from the NRF. Numerous grant applications were subsequently successfully submitted in this new RNA.

Another major development towards the end of 2006 was the award of a huge BioPAD contract for research in biotechnology. This involves the establishment of a Platform for Metagenomics, with BioPAD and the UFS as partners, which forms part of a network of specialist platforms. This platform, which will be managed by Dr Esta van Heerden, aims at the further development of the infrastructure and expertise for accessing the microbial biodiversity in extreme environments by direct extraction of genetic material from the environment and isolation of specialist microbial consortia. This follows the successful completion of a similar BioPAD-funded project by the group under the leadership of Prof. Derek Litthauer, Drs Van Heerden and Lizelle Piater, and will kick off in 2007. A substantial investment in new equipment will also be made. Dr Piater was also awarded an NRF grant to purchase a Nanodrop spectrophotometer to the value of R86 000, the only one on campus.

The increased research and training activities arising from these awards will put a severe strain on the existing departmental infrastructure. This scenario was already foreseen in 2004, with the result that by the end of 2006 planning officially started for upgrading the biotechnology building on the Main Campus, which will also make provision for the increased demand for laboratory space. Some of the extremely urgent minor improvements to certain key laboratories would already be done early in 2007.

Changes and improvements to the undergraduate Biochemistry and Microbiology learning programmes and module content were implemented in 2005, including a switch from half semester to full semester modules, to better align them with modern requirements, and to improve student learning and success rates. In 2005 a total of 15 honours, eight M.Sc. and seven Ph.D. degrees were conferred on students of the department, and in 2006 17 honours, ten M.Sc. and five Ph.D. degrees.

With the appointment of Dr Betty Lodolo of South African Breweries Limited (SAB) as affiliate senior lecturer, the department had four affiliated academics plus two professors extraordinary who, through lectures and interaction with staff and students, provided invaluable enrichment in the training and research of undergraduate and postgraduate students as well as academic staff. This is exemplified by the recent success of Mr Olihile Sebolai, an





One of the largest groups of students from the department so far, presented their research on yeast nanorobotics (nanotechnology) at three international conferences in Europe in 2006.

M.Sc. student in Microbiology who, under the guidance of Prof. Lodewyk Kock, made an important discovery that could hold promise in the field of nanotechnology. His thesis was awarded six academic prizes by the faculty and UFS, including that of the best thesis overall and he was awarded honorary colours by the UFS Student Representative Council (SRC). Several papers arising from his dissertation were published in international journals and he was interviewed by the *Voice of America* as well as by International *Reuters* TV. He was also highlighted as SA Young Achiever in the *CEO Magazine* (Celebrating Excellence in Organisations, Vol. 4 (4) – 2005), received a commendation from Ms Naledi Pandor (national Minister of Education) as well as a Free State Province Premier's Excellence Award.

Other students who excelled in 2005 included Mr Dirk Opperman, Ph.D. student in Biochemistry, who was one of only five students world-wide and the only South African student, selected to participate in a congress of the National Aeronautics and Space Administration (NASA) in Colorado, United States of America (USA). Two students from the Veterinary Biotechnology Research group, Ms Kulsum Kondiah and Ms Charlotte Boucher, presented lectures at the Virology Africa 2005 conference, an international congress hosted in Cape Town. In addition, Ms Catrine Strauss, a final year Ph.D. student in Microbiology, was the only representative from Africa to present a talk

at the 24th International Specialised Symposium on Yeasts held in Oropesa, Spain.

Apart from the above, the department was well represented at other national and international congresses and symposia in 2005. Four academics and 11 postgraduate students attended the congress of the SA society for Biochemistry and Molecular Biology in Stellenbosch, where they presented three lectures and nine posters. Academic staff members also participated in the following events: Joint Meeting of the Divisions of the International Union of Microbiological Societies (IUMS) 2005, joint meeting of the divisions of the IUMS in San Francisco, USA, World Veterinary Poultry Association Congress in Istanbul, Turkey, Association of Avian Veterinarians Conference in Monterey, California, American Federation of Aviculture Congress in Miami, USA and the 51st International Congress of Meat Science and Technology in Baltimore, USA.

The department again maintained a high profile at various congresses in 2006. The 14th biennial congress of the South African Society for Microbiology in Pretoria was attended by nine academic staff members and 22 postgraduate students who presented lectures and posters. During this meeting Prof. Koos Albertyn stepped down as president of the society. Dairy Symposium 2006, a meeting of the South African

“Several workshops regarding edible oil misuse and accompanying adverse health effects were presented.”

Society for Dairy Technology held in Gordons Bay, was attended by two academic staff members, one post-doctoral student and four students. Four members of the department attended the South African Society for Biochemistry and Molecular Biology Conference in Pietermaritzburg. Prof. Martie Smit presented a lecture at the meeting of the Catalysis Society of South Africa in Mossel Bay. Further afield, six postgraduate students, one post-doctoral student and three staff members associated with the Lipid Biotechnology research group, presented eight posters and three lectures at three international conferences in Europe, namely the 2nd International Conference on Non-mammalian Eicosanoids, Bioactive Lipids and Plant Oxylipins in Berlin, Germany, the 3rd European Conference on Computational Mechanics in Lisbon, Portugal and the 25th International Specialised Symposium on Yeasts in Helsinki, Finland. This was probably the largest contingent of students from the department so far to present their research overseas. The Lipid Biotechnology Group also co-organised the conference in Berlin.

A student, Ms Jacqueline van Marwijk, presented a paper on the biological synthesis of gold nanoparticles at an international congress on gold in Limerick, Ireland. This congress was also attended by Dr Van Heerden. Some students travelled abroad for research purposes. Mr Opperman paid short visits to the Universidad Autónoma de Madrid, Spain to conduct research for his Ph.D. on gene expression in thermophilic microorganisms, and to the Centro de Astrobiología (CSIC-INTA), where he was joined by M.Sc. student Mr Armand Bester to investigate

transcription and translation levels of various proteins. These visits were funded by grants from the Oppenheimer Trust and industry. Dr Arno Hugo presented a poster at the 52nd International Congress of Meat Science and Technology in Dublin, Ireland. Prof. James du Preez, Departmental Chairperson, and Bennie Viljoen presented lectures at the 6th European Symposium on Biochemical Engineering Science (ESBES) in Salzburg, Austria and at the 8th International Mycological Congress in Cairns, Australia, respectively. Prof. Rob Bragg undertook an extensive trip to South America where he presented various seminars on biosecurity in the poultry industries in Argentina, Ecuador and Columbia.

International projects with Hungary and Norway on indigenous fermented foods and beverages led to research visits by Prof. Viljoen and three students to the Norwegian University of Life Sciences Oslo, Norway and one student visited the Corvinus University of Budapest, Hungary. Mr Olivier Jean-Luc Habimana from the Norwegian University of Life Sciences, Norway, in turn spent four months in the Food Biotechnology group, UFS, on the project. Prof. Viljoen presented his inaugural lecture on microbial interactions in foods, with emphasis on yeasts, in 2005.

A workshop to discuss external quality monitoring in the edible oil industry of South Africa was held at the UFS in 2006. This meeting resulted from the activities of the South African Fryer Oil Initiative (SAFOI) headed by Prof. Kock, which currently monitors edible oils in the food industry.



Guests attending Prof. Rob Bragg's inaugural lecture are, from the left: Prof. James du Preez, Departmental Chairperson, Bragg, Herman van Schalkwyk, Dean: Faculty of Natural and Agricultural Sciences and Frederick Fourie, Rector and Vice-Chancellor of the UFS.

The workshop was attended by major role players in the fast-food sector and various distributors of edible oils, a representative of Agri Inspec (a forensic investigation company collaborating with inter-state and government structures to combat fraud and international trade irregularities) and Mrs Ina Wilken, Chairperson of the South African National Consumer Union (SANCU) and keynote speaker at this workshop. These role players all pledged their support for the implementation of a quality-monitoring system for the whole food industry, as exemplified by the SAFOI seal of quality currently displayed on some brands of sunflower oil, cottonseed oil and palm oil that are destined for use by restaurants and fast food outlets. Mrs Wilken expressed the viewpoint that the SAFOI seal of quality should also be extended to include all the smaller oil containers used by households. Several workshops by Prof. Kock regarding edible oil misuse and accompanying adverse health effects were also presented to the national media in Pretoria, Johannesburg, Durban and Cape Town. This resulted in several articles in the major newspapers of South Africa such as the *Star*, *Business Report*, *Mercury*, etc.

Community service also enjoyed high priority. In 2005 Drs Van Heerden and Piater led several eager microbiology and biochemistry postgraduate students to the Koot Niemann School outside Bloemfontein to give pupils from Grades 8-10 a hands-on introduction to the world of microbiology. The following year they once again presented the annual winter school for biology teachers, with the focus on how to use normal household materials to do biology experiments. They also presented a lecture entitled: *Biotechnology: A career for women of today!* at a Women's Day Programme of the National Museum in Bloemfontein. Both Prof. Litthauer and Dr Van Heerden were invited to present lectures at the Boyden Observatory in 2005, Dr Piater was invited to give a public talk during the National Science Week 2005 at the UFS, under the auspices of the Department of Science and Technology, and Drs Piater and Van Heerden addressed the Bloemfontein Club 100 Ladies in a lecture entitled: *Is there life out there?*

During March 2005 some of the staff and students exchanged cerebral for physical activities. Ten members of the department braved the fierce Cape wind and completed the Cape Argus Pick 'n Pay Cycle Tour. Winds of change affected the staff situation in the department:

Dr Bethuel Nthangeni, Lecturer, resigned at the end of March to take up a research position at the Biosciences division of the Council for Scientific and Industrial Research (CSIR). In the interests of strategic planning, the department filled the vacancy at the level of associate professor by the appointment of Prof. Patterton, who as a researcher had an NRF B-rating. Another new appointment was Dr Maryna de Wit as Lecturer in Food Science. Ms Dorothy Riekert, Senior Lecturer in Consumer Science, retired at the end of 2005. Prof. Bragg was promoted to professor, Du Preez to senior professor and Dr Carlien Pohl to researcher. Dr Pohl subsequently had the opportunity to spend three months doing research in the Eicosanoid Research Group of Prof. Santosh Nigam in Berlin, Germany. Dr Pohl was also appointed as Lecturer to fill the vacancy arising from the resignation of Dr Evodia Setati in 2006, who accepted a position at the University of KwaZulu-Natal. Also in 2006, Dr Koos Albertyn was promoted to associate professor and Prof. Bragg's entertaining inaugural lecture was on the control of infectious avian diseases. The year 2006 started on a sombre note, however, when Ms Wilma Ras, who worked in the department's financial administration section, passed away.

During 2005 the following staff members were appointed to national and international boards/panels: Prof. Kock as member of the Assessment Panel for Microbiology and Plant Pathology of the NRF, Prof. Viljoen to the editorial board of the journal *Food Microbiology*, and Prof. Du Preez as an associate editor of the *World Journal of Microbiology and Biotechnology*. In 2006 two academics improved their NRF research rating, namely Dr Celia Hugo to a C2 and Prof. Du Preez to a B2 rating. The department has a total of 12 NRF-rated researchers, including four B-rated scientists.

### Research Groups

The department comprises three divisions, namely Microbiology and Biochemistry, Food Science and Consumer Science. Within these divisions there are various research groups. Although the overall research theme of the department is the broad field of microbial, biochemical and food biotechnology, the heterogeneous departmental composition causes some activities to fall outside this field.

In the **Food Science division**, Prof. Garry Osthoff and his team investigated the biochemical contribution of yeasts in cheese ripening



“Progress was made towards the development of a DNA vaccine for the control of the Beak and Feather Disease virus.”



in 2005. They found that accelerated cheese ripening by yeast inoculation was due to adapted proteolysis, which in turn pointed towards plasminogen activation and glutamate dehydrogenase activity. A couple of yeasts associated with dairy products have so far been identified to contain one or both of these enzyme activities. They also researched the milk of Africa's wild animals and found that higher levels of oligosaccharides are present in the milk of antelopes, with extremely high levels in elephant milk. The fatty acid profile of the milk of lion and elephant showed extreme levels of some types. The African buffalo, in turn, contains more casein relative to whey proteins. In 2006 they continued this line of investigation, describing the chemical composition of the milk of two more African wild cat species, namely the cheetah and the serval. Although similarities between lion and cat milk were observed, unique compositions were found regarding fatty acids and saccharides. Prof. Osthoff foresees that when these milks are better understood, they could serve as guidelines according to which the milk of the domesticated species could be improved by genetic means. Dr Arno Hugo and Mrs Carina Bothma collected data on the effect of dietary inclusion of conjugated linoleic acid on chemical and sensory quality of pork.

Prof. Osthoff and Dr De Wit embarked on research of the food qualities of the cactus pear. South Africa is the only country in the world that still possesses plants that originated from Burbank, USA. Although food and fodder qualities of a few of the 42 cultivars are known, detailed food quality data on most of the cultivars are lacking.

The sensory qualities of foodstuffs is an important aspect of the above research projects and, with a grant from the PA and Alice Malan trust fund, the sensory laboratory was upgraded to fulfil this function. Dr Koos Myburgh and Mr Piet Botes (head of the departmental analytical laboratory)

worked on the detection of milk adulteration in collaboration with the Dairy Standards Agency. The department's analytical techniques for this purpose have been accredited by the national Department of Agriculture.

Prof. Hester Steyn and her postgraduate students in the **Consumer Science division** initiated research in 2005 on the development of *Agave americana* fibres and the wild silk from *Gonometa postica*, both available in Southern Africa. The aim of these projects is to develop exotic natural fibre products and to create job opportunities for people in rural areas. This division has also become involved in the Lengau community development project of the faculty.

Under the leadership of Prof. Viljoen and aided by postdoctoral students Drs Analie Hattingh and Henry Gadaga, the **Food Biotechnology research group** continued to progress in the field of food microbiology with specialisation in dairy products and yeasts. One of the Ph.D. projects completed in 2006 by Mr Ameha Kebede from Ethiopia on indigenous fermented products paved the way for a totally new scientific focus area. Based on these results, the group has already successfully applied for a multilateral network project from the Norwegian Council of Universities Committee for Development, Research and Education (NUFU) including Norway and Zambia as co-workers and a grant totalling more than R6 million was awarded. The group was further successful in obtaining a grant from the PA and Alice Malan trust fund on the same topic.

Infectious coryza, a serious poultry disease in many countries around the world caused by *Avibacterium paragallinarum*, remains the major focus of the research activities of Prof. Rob Bragg and his **Veterinary Biotechnology research group**. The possibilities of developing a molecular serotyping scheme for the bacterium in the form of the ERIC PCR system, which has proven useful for other species of bacteria, were also investigated. Unfortunately, no correlation between the ERIC PCR method and the conventional serotyping system was found. Prof. Bragg was invited to Israel to assist the veterinary authorities of that country with the control of infectious coryza. This trip resulted in the interesting finding that the viral strain causing the problems in Israel was the same strain that has been causing substantial problems in South Africa. Prior to this it was thought that the strain was limited to Southern Africa. The UFS research group has also been involved in a large project with Onderstepoort Biological Products on the improvement of their infectious coryza vaccine. It is hoped that this vaccine will be launched in South Africa during 2007.

The research project on the oncolytic effects of Newcastle disease virus was completed in 2006, which revealed that there were substantially more receptors for the ND virus on cancer cells compared to normal cells, indicating that the ND virus had potential as a possible treatment of cancer. A novel technique for the rapid detection of virulent viruses, which would be particularly useful for laboratories in developing countries, was established. Prof. Bragg and his group also made progress towards the development of a DNA vaccine for the control of the Beak and Feather Disease virus. It is hoped that the first animal experiments will start in 2007. Some time was spent developing various serological techniques required to evaluate the vaccine. This involved the development and testing of ELISA systems using expressed coat protein and whole virus. The objective was to establish whether the expressed coat protein could be used in future serological techniques. Another project on parrot diseases is the isolation and characterisation of an Adenovirus from parrots. The virus has been successfully isolated and molecularly characterised. It is hoped that a vaccine will be established and tested during 2007. A new project on the investigation of the diversity of *Mycoplasma galliseptium* in poultry has already established that a substantial diversity exists in the South African strain.

In the **Fermentation Biotechnology research group** led by Prof. Du Preez, one of the Ph.D. projects completed in 2005 was on the production of leukotoxin (LKT) by the animal pathogen *Mannheimia haemolytica*, the principal causative agent of shipping fever pneumonia in cattle. A vaccine based on the toxoid of LKT provides protection against this disease, but the current procedures for the commercial production of LKT yields only very low levels of the LKT protein. This bacterium is difficult to cultivate due to its nutritionally fastidious nature. Through a systematic investigation of its growth characteristics and nutritional requirements by using mainly continuous cultures, a culture medium and cultivation protocol was developed that facilitated an LKT concentration 45 times greater than that obtained in the standard culture medium. A provisional patent has been registered. Another Ph.D. project, in collaboration with SAPP, was completed on xylanase production by fungal strains for potential application in the pulp and paper industry, using spent sulphite liquor (SSL) as carbon feedstock. Fungal strains were selected and cultivation conditions determined for xylanase production. It was demonstrated that the application of crude preparations of this enzyme obtained from the submerged cultivation of certain *Aspergillus* strains reduced the usage of chlorine dioxide in the bleaching stage of pulp manufacture up to 30% without compromising pulp brightness. Furthermore, the utilisation of industrial waste waters such as SSL to produce xylanases for on-site use at the paper mills would contribute to the development of effluent-free technology and would impact positively on the environment.

Research on the production of health-promoting oligosaccharides, known as prebiotics, also continued in the group under the leadership of Prof. Stephanus Kilian. It was shown that a number of yeasts produced oligosaccharides at high levels, warranting further investigation into the potential prebiotic effect of these compounds. Significant differences between the intestinal microbiota of layer hens and broilers regarding the composition of health-promoting bacteria were found. In addition, a number of yeasts that can use the prebiotic neokestose were identified as potential probiotics for use in synbiotic preparations.

In 2006 Prof. Du Preez together with Dr Pohl and Mr Botes initiated a research project on the fermentation of Agave juice extract in collaboration with Agave Distillers (Pty) Ltd., the only company in the world outside Mexico that produces Agave spirit (known in Mexico as tequila). This project is aimed at improving the efficiency of the process. In a collaborative effort between Prof. Albertyn



Ms Nandi Mfenyana, a post-graduate student at the department, investigating dead chickens embryos infected with a parrot adenovirus.

(**Molecular Biology research group**, see below) and Prof. Du Preez, the regulation and physiological role of the alcohol dehydrogenase (ADH) isozymes in *Saccharomyces cerevisiae* (baker's or wine yeast) were investigated, using aerobic glucose-limited continuous cultures and batch cultures of multiple *adh* deletion mutants of *S. cerevisiae*.

An Innovation Fund project in collaboration with CSIR Biosciences and members of the department, with most of the research conducted in the **Molecular Biology research group** under the leadership of Prof. Albertyn, resulted in the sale of the intellectual property rights generated by this project by the UFS in 2005 to a start-up biotechnology company for an amount of R14 million. This research, initiated in this department some years ago by Prof. Smit, entailed the development of a generic platform for the heterologous expression of specific hydrolase enzymes in a yeast host and was made possible due to a longstanding collaboration with Dr. J-M. Nicaud of INRA, France.

In 2006 one of the research projects completed in the **Molecular Biology research group** under the supervision of Prof. Albertyn, in collaboration with Prof. Smit of the **Biocatalysis research group**, resulted in the successful expression of epoxide hydrolases from different hosts, including yeasts, plants, humans and insects in the yeast *Yarrowia lipolytica*. A study on the development of a transformation system for the bacterium *Avibacterium paragallinarum*, undertaken in collaboration with Prof. Bragg of the **Veterinary Biotechnology research group**, was the first step in the development of a live vaccine against this important poultry pathogen. Under the supervision of Prof. Albertyn, Ph.D. student Ms Olga de Smidt succeeded in the difficult task of constructing multiple alcohol dehydrogenase (*adh*) deletion mutants of *Saccharomyces cerevisiae*. This paved the way for further physiological studies, in collaboration

“Equipment for monitoring evolved gasses, seismic activity and microbial biodiversity was installed in a laboratory almost 3.6 km below the surface.”

with Prof. Du Preez of the **Fermentation Biotechnology research group**, on the regulation and function of the ADH isozymes in *S. cerevisiae*.

Twelve years of research on the hydroxylation of hydrocarbon molecules by cytochrome P450 monooxygenases and over-expression of cytochrome P450 monooxygenase systems in the alkane degrading yeast *Yarrowia lipolytica* by Prof. Smit and Albertyn from the **Biocatalysis and Molecular Biology research groups**, respectively, led to an invitation to join c\*change, the Department of Science and Technology's - NRF Centre of Excellence in Catalysis based at the University of Cape Town. Being a collaborator in c\*change brings new opportunities for focused research in an interdisciplinary and multi-institutional environment. Funding from c\*change and the UFS made the acquisition of a multi-bioreactor system valued at R412 000 possible. Dr Syed Kajamohidden from India joined this group in 2006 in a post-doctoral position funded by c\*change to investigate monooxygenases for alkane activation.

In the **Lipid Biotechnology group**, two Ph.D. students and one M.Sc. student obtained their degrees in 2005 with Prof. Kock as the main supervisor. These projects concerned yeast taxonomy as well as investigations concerning nanotechnology and antifungal agents. These were highlighted by the NRF in the April 2005 issue of *News@nrf*. In addition, Ms Strauss completed her Ph.D., discovering that oxylipins played an important role in yeast flocculation – an important phe-

nomenon in the brewing industry. She also researched some of her findings at the headquarters of SAB under the supervision of Dr Lodolo. Thirteen articles were published or accepted for publication since the start of these studies. A photograph from this research was selected for the cover page of all issues in 2006 of one of the top international yeast journals, *FEMS Yeast Research* as well as the November issue of the *Canadian Journal of Microbiology*. Research highlights of this research group since 1982 in collaboration with the Centre for Confocal and Electron Microscopy were published in the November 2005 issue of *Bult*, a publication of the UFS targeted at alumni.

Prof. Litthauer and Drs Van Heerden and Piater lead the **Extreme Biochemistry research group** where the main research focus areas are extreme metagenomics and environmental sustainability. The South African deep mines are a fascinating source of genetic material and microbial isolates. Since 2001 the group has been the South African base from which the Life in Extreme Environments (LEEN) project, funded by NASA and the National Science Foundation, USA is being run. As a result, the first ever process of rigging an underground laboratory at a depth of almost 3,6 km below the surface (in one of the world's deepest mines!) was instigated during 2005 in an endeavour to do long-term monitoring of microbial diversity in holes drilled into active fault zones. This Natural Earthquake Laboratory in South African Mines (NELSAM) underground laboratory, which is a collaborative effort between scientists from the USA, Germany, Japan and South Africa, is nearing completion with the installation of equipment for monitoring evolved gasses, seismic activity and the microbial biodiversity in the ultra deep environment. Undoubtedly, this must certainly be the deepest biochemistry laboratory in the world! As important, though, will be the monitoring of functional gene expression by real-time PCR, for which purpose a real-time cyclor was purchased during 2005, and hopefully later also by DNA microarray.

Dr Van Heerden collaborates closely with the UFS Institute for Groundwater Studies and the first attempt at establishing a biological barrier using bacteria from the environment to redirect groundwater flow was successful. They were also instrumental in solving the Delmas contaminated water crisis with the Free State Department of Water Affairs and Forestry, by identifying the origin of the contamination using state-of-the-art molecular biology techniques.

The statistical methodology that was previously developed in the **Epigenomics re-**

**search group** of Prof. Patterson and incorporated into open source software, was used for the analysis of the expression of stress-related genes in *Saccharomyces cerevisiae*. An analysis of the genomic positions of these genes revealed that co-regulated and stress-related genes were often situated in close proximity on chromosomes. This physical clustering probably allowed for a degree of co-evolution, but, more importantly, was likely due to transcriptionally competent neighbourhoods in chromatin. These findings were published in *BMC Evolutionary Biology* (Impact Factor 4.5) in 2006.

#### Academic staff

**Professors:** Prof. James du Preez, Rob Bragg, Stephanus Kilian, Lodewyk Kock, Derek Litthauer, Martie Smit, Bennie Viljoen

**Professors Extraordinary:** Prof. Edgar DaSilva, Santosh Nigam

**Associate Professors:** Prof. Garry Osthoff, Hugh Patterson, Hester Steyn, Koos Albertyn

**Affiliate Associate Professor:** Prof. Mary DeFlaun

**Senior Lecturers:** Drs Arno Hugo, Celia Hugo, Koos Myburgh, Esta van Heerden, André van Tonder

**Affiliate Senior Lecturers:** Drs Chris du Plessis, Colin Kenyon, Bettie Lodolo

**Lecturers:** Drs Maryna de Wit, Bethuel Nthangeni, Lizelle Piater, Evodia Setati, Carlien Pohl, Ms Carina Bothma

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# Research outputs

## Publications

- Bareetseng, A.S., Kock, J.L.F., Pohl, C.H., Pretorius, E.E. & Van Wyk, P.W.J. 2005. Uncovering the first double brimmed hat-shaped ascospores in *Ambrosiozyma platypodis* Van der Walt. *Antonie van Leeuwenhoek International Journal of General and Molecular Microbiology* 87: 169-170.
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## Conference contributions

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**Bester, P.A., Piater, L.A., Van Heerden, E. & Onstott, T.C.** 2005. *The microbial diversity, chemical and physical properties in fissure water of the deep terrestrial subsurface of the Witwatersrand Basin*. Paper presented at the 19th South African Society for Biochemistry and Molecular Biology Conference, Stellenbosch, South Africa.

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**Bragg, R.R.** 2005. *Control of infectious diseases in cage birds*. Paper presented at the American Federation of Aviculture Congress, Miami, USA.

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# Statistical data of the faculty



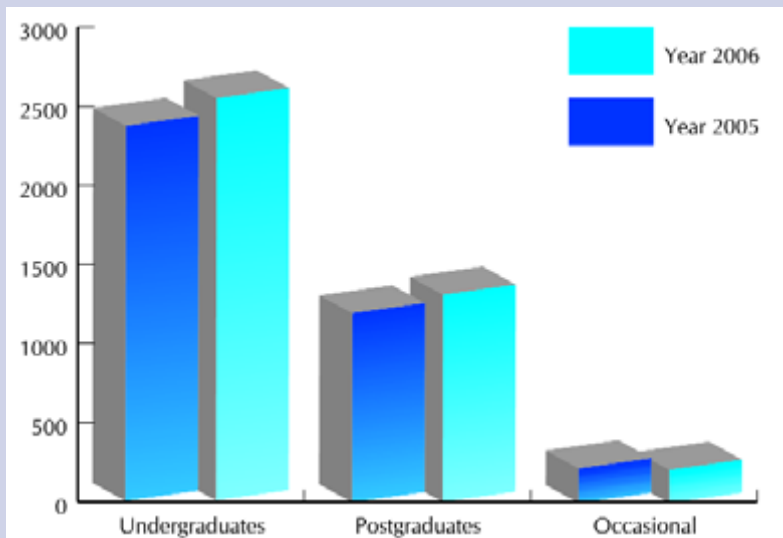
# Student figures

Faculty of Natural and Agricultural Sciences, 2005/06

Male					
2005					
Description	African	Coloured	Indian	White	Total
Undergraduate	676	31	26	724	1457
Postgraduate	351	22	15	400	788
Occasional	84	3	4	17	108
<b>Total 2005</b>	<b>1111</b>	<b>56</b>	<b>45</b>	<b>1141</b>	<b>2353</b>
2006					
Description	African	Coloured	Indian	White	Total
Undergraduate	729	28	21	768	1546
Postgraduate	385	21	16	431	853
Occasional	68	2	2	23	95
<b>Total 2006</b>	<b>1182</b>	<b>51</b>	<b>39</b>	<b>1222</b>	<b>2494</b>

Female					
2005					
Description	African	Coloured	Indian	White	Total
Undergraduate	563	41	11	394	1009
Postgraduate	206	16	11	221	454
Occasional	101	5	2	11	119
<b>Total 2005</b>	<b>870</b>	<b>62</b>	<b>24</b>	<b>626</b>	<b>1582</b>
2006					
Description	African	Coloured	Indian	White	Total
Undergraduate	641	39	17	401	1098
Postgraduate	243	15	17	234	509
Occasional	103	2	2	16	123
<b>Total 2006</b>	<b>987</b>	<b>56</b>	<b>36</b>	<b>651</b>	<b>1730</b>

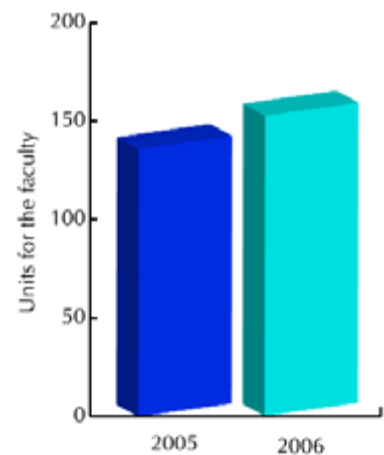
Total					
2005					
Description	African	Coloured	Indian	White	Total
Undergraduate	1239	72	37	1118	2466
Postgraduate	557	38	26	621	1242
Occasional	185	8	6	28	227
<b>Total 2005</b>	<b>1981</b>	<b>118</b>	<b>69</b>	<b>1767</b>	<b>3935</b>
2006					
Description	African	Coloured	Indian	White	Total
Undergraduate	1370	67	38	1169	2644
Postgraduate	628	36	33	665	1362
Occasional	171	4	4	39	218
<b>Total 2006</b>	<b>2169</b>	<b>107</b>	<b>75</b>	<b>1873</b>	<b>4224</b>



Student figures

Student nationality		
Nationality	2005	2006
Angola	1	
Asian countries	21	18
Botswana	20	20
European countries	6	6
Lesotho	142	142
Malawi	2	1
Mauritius		2
Mozambique	8	7
Namibia	40	42
No information	1	
North America	4	4
Other Africa	45	48
South Africa	3610	3893
South America		1
Swaziland	13	13
Zambia	4	6
Zimbabwe	18	21
<b>Total</b>	<b>3935</b>	<b>4224</b>

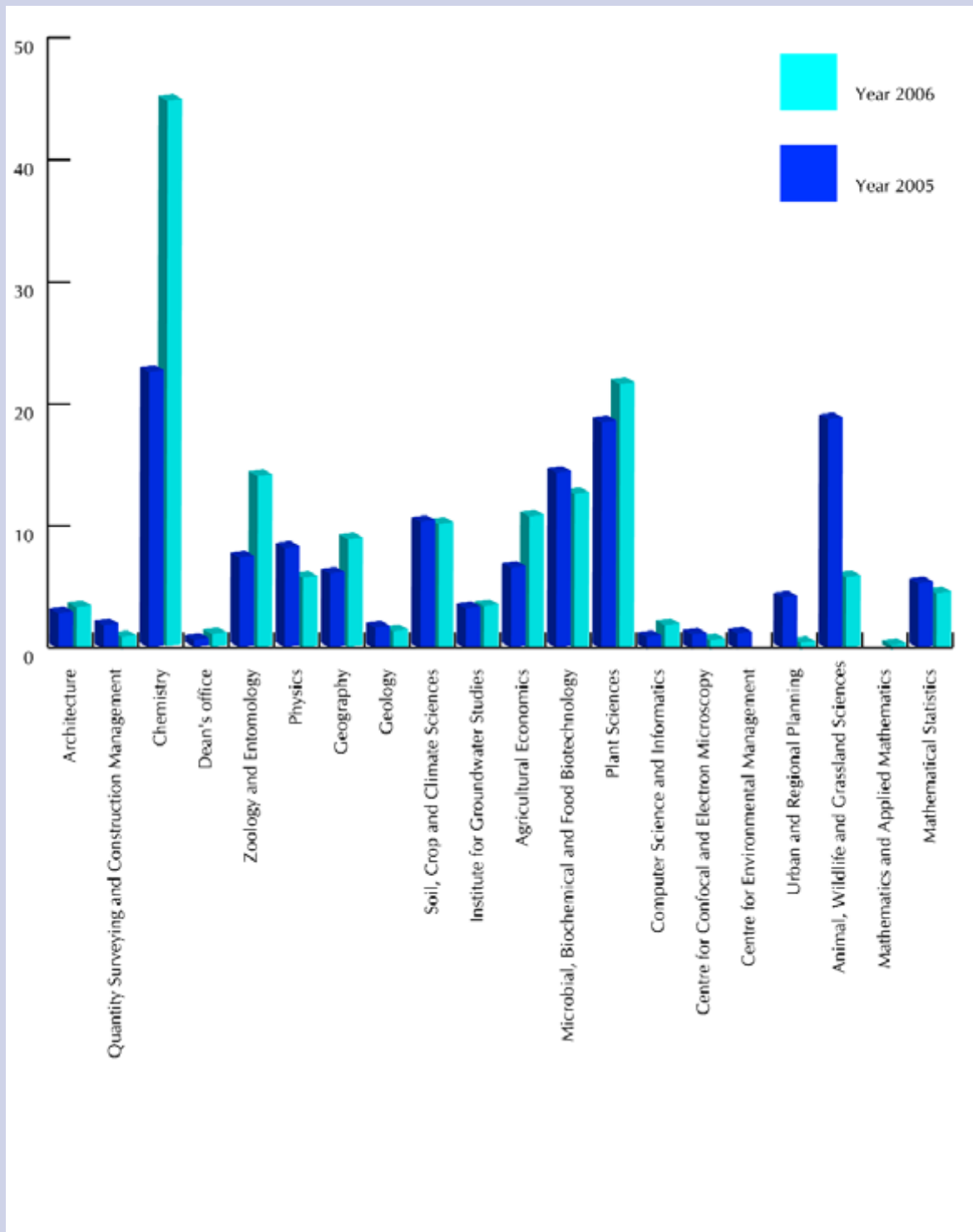
## Research outputs for the Faculty of Natural and Agricultural Sciences



Articles published in accredited approved research journals.

## Departmental research outputs

Articles published in accredited approved research journals, 2005/06



# Glossary



# Glossary

## A

ACIAR	Australian Centre for International Agricultural Research
AEASA	Agricultural Economics Association of South Africa
ALPRU	African Large Predator Research Unit
ARC	Agricultural Research Council
ARMSCOR	Armaments Corporation of South Africa
ARS	Agri Risk Specialists
ASAQS	Association of South African Quantity Surveyors
ASSA	Anatomical Society of South Africa
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVS	American Vacuum Society

## C

CANSA	Cancer Association of South Africa
CATSA	Catalysis Society of South Africa
CBD	Convention of Biological Diversity
CCEM	Centre for Confocal and Electron Microscopy
CePHMa	Centre for Plant Health Management
CfPB	Centre for People and Buildings
CIAT	International Centre for Tropical Agriculture
CIDB	Construction Industry Development Board
CIMMYT	International Maize and Wheat Improvement Centre
CIOB	Chartered Institute of Building
CIOB-SA	Chartered Institute of Building - South Africa
CSACEE	Central South African Council on Economic Education
CSIC-INTA	Centro de Astrobiología
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation

## D

DEAT	Department of Environmental Affairs and Tourism
DiMTEC	Disaster Management Training and Education Centre for Africa
DMISA	Disaster Management Institute of South Africa
DST	Department of Science and Technology

## E

EAAP	European Association for Animal Production
EASA	Education Association of South Africa
ECA	European Crystallographic Association
EIGG	Environmental Inorganic Geochemistry Group
EPWP	Expanded Public Works Programme
ESBES	European Symposium on Biochemical Engineering Science
ESREL	European Safety and Reliability
ESRP	Economic and Social Rehabilitation Programme

## F

FAO	Food and Agriculture Organisation
FEMS	Federation of European Microbiological Societies
FMP	Facilities Management Programme
FOTIM	Foundation of Tertiary Institutions of the Northern Metropolis

FSRPO	Free State Red Meat Producers Organisation
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## G

GIS	Geographical Information Systems
Glen ADI	Glen Agricultural Development Institute
GM	Genetically Modified
GMBA	Gauteng Master Builders' Association
GMO	Genetically Modified Organisms
GWK	Griekwaland-Wes Koöperasie

## H

HIV	Human Immunodeficiency Virus
HPCSA	Health Professions Council of South Africa
HPLC	High Performance Liquid Chromatography
HSPCM	Health and Safety Programme for Construction Managers

## I

IAGOD	International Association on the Genesis of Ore Deposits
IAH	International Association of Hydrogeologists
ICCC	International Conference on Coordination Chemistry
ICEC	International Cost Engineering Council
ICID	International Commission on Irrigation and Drainage
ICP	Inductively Coupled Plasma
ICRBM	International Conference on Rodent Biology and Management
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDC	Industrial Development Corporation
IGS	Institute for Groundwater Studies
IITA	International Institute of Tropical Agriculture
INCRoP	Insects on New Crops Programme
INTSORMIL	International Sorghum and Millet Research Support Programme

## IPMA

IPMA	International Project Management Association
IPMP	Intensive Project Management Programme
IRDP	Institutional Research and Development Programme
IRWH	In-field Rainwater Harvesting
IUCr	International Union of Crystallography
IUMS	International Union of Microbial Societies
IUPAP	International Union of Pure and Applied Physics

## J

JFM	Journal of Facilities Management
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## L

LExEn	Life in Extreme Environments
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## M

MIRCHEN	Microbiological Resources Centre
MIT	Massachusetts Institute of Technology
MRM	Mineral Resource Management
MSA	Master's Degree in Sustainable Agriculture
MSSA	Microscopy Society of Southern Africa
MUCPP	Mangaung University Community Partnership Programme
MURP	Master's Degree in Urban and Regional Planning

## N

NaCOF	National Climate Outlook Forum
NAFU	National African Farmers Union
NAMC	National Agricultural Marketing Council
NASA	National Aeronautics and Space Administration
NASSP	National Astrophysics and Space Science Programme
NCEE	National Council for Economic Education
NDA	National Department of Agriculture
NECSA	National Energy Commission of South Africa
NELSAM	Natural Earthquake Laboratory in South African Mines
NERPO	National Emergent Red Meat Producers' Organisation
NGO	Non-Governmental Organisation
NML	National Metrological Laboratory
NMMU	Nelson Mandela Metropolitan University
NMR	Nuclear Magnetic Resonance
NRF	National Research Foundation
NUFU	Norwegian Council of Universities Committee for Development, Research and Education
NWGA	National Wool Growers' Association

## O

OABS	Optimal Agricultural Business Solutions
OECD	Organisation for Economic Co-operation and Development

## P

PARSA	Parasitological Association of Southern Africa
PDMIW	Processing and Disposal of Mineral Industry Wastes
POT	Peaks over Threshold
PPP	Public Private Partnership
PRT	Protein Research Trust

## R

RICS	Royal Institute of Chartered Surveyors
RIEP	Research Institute of Education Planning
RNA	Research Niche Area
RPO	Red Meat Producers' Organisation

## S

SA	South Africa
SAACE	South African Association of Consulting Engineers
SAB	The South African Breweries Limited
SACI	South African Chemical Institute
SACPCMP	South African Council for the Project and Construction Management Profession
SACPVP	South African Council for the Property Valuation Profession
SACQSP	South African Council for the Quantity Surveying Profession
SADC	Southern African Development Community
SAFMA	South African Facilities Management Association
SAFOI	South African Fryer Oil Initiative
SAIP	South African Institute of Physics
SAISC	Southern African Institute of Steel Construction
SAMSI	Statistical and Applied Mathematical Sciences Institute

SANCIAHS	South African National Committee for the International Association of Hydrological Sciences	SEDA	Small Enterprise Development Agency	UNEP	United Nations Environment Programme
SANCU	South African National Consumer Union	SMME	Small, Medium and Micro Enterprises	UNESCO	United Nations Educational, Scientific and Cultural Organisation
SANPAD	South Africa-Netherlands Research Programme on Alternatives in Development	SRC	Student Representative Council	USA	United States of America
SAPOA	South African Property Owners' Association	SRL	Sustainable Rural Livelihood	USAID	United States Agency for International Development
SAPS	South African Police Services	SSAG	Society of South African Geographers	UTCHEM	University of Texas Chemical Compositional Simulator
SAQA	South African Qualifications Authority	<b>T</b>		UWC	University of the Western Cape
SASAS	South African Society for Animal Science	THRIP	South African National Research Foundation Thrust for Industry-Related Projects	<b>W</b>	
SASQUA	Southern African Society for Quaternary Research	TUE	Technical University Eindhoven	WARFSA	Water Research Fund of Southern Africa
SAVAH	South African Association of Visual Arts Historians	<b>U</b>		WATOC	World Association of Theoretically Orientated Chemists
SBE	Sustainable Built Environments	UCT	University of Cape Town	WFP	World Food Programme
		UFS	University of the Free State	WITS	University of the Witwatersrand
		UJ	University of Johannesburg	WRC	Water Research Commission
		UK	United Kingdom	WUA	Water Users' Association
		UN	United Nations		