2020/21

Undergraduate faculty brochure

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UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences

Fakulteit Natuur- en Landbouwetenskappe
Lefapha la Disaense tša Tlhago le Temo

Note: The National Benchmark Test (NBT) is no longer required for selection or admission purposes for the 2021 intake. Faculties are communicating with all applicants who have applied for programmes where the NBT was either compulsory, or recommended. (Updated 20 July 2020).

Message from the Dean

Are you ready for a challenge? Do you want to discover new things and change the world?

If the answer is yes and you choose to register for one of the programmes offered by the Faculty of Natural and Agricultural Sciences (NAS), the most diverse faculty at the University of Pretoria, you may indeed contribute to changing the world.

Prof Barend Erasmus
Dean: Faculty of Natural and Agricultural Sciences

In NAS you will learn to answer as-yet unanswered questions and be part of a scientific community dedicated to respond to the grand challenges facing humanity. Research is focused, among others, on achieving food and water security in Africa, making renewable energy affordable to African populations and eliminating poverty-related diseases.

Here you will be at the forefront of scientific research and will be inspired to think innovatively. You will be able to pursue careers ranging from the proverbial A to Z: from an actuary to a zoologist, from a forensic expert to a meteorologist. Moreover, you will not be limited to careers that already exist as the critical thinking skills that you learn at NAS will ensure that you will remain competitive in a rapidly changing job market.

The challenges facing humanity can only be solved by teams of scientists who work together across disciplinary boundaries. These teams consist of dedicated experts in the various disciplines who are already active in the Faculty, as well as scientists who move comfortably between disciplines in their search for new solutions to old problems. Together they can effect positive change in the world.

All the resources used by humans are extracted from the earth or grown in the soil. NAS has world-class capabilities to support both these activities in ways that will ensure a more sustainable future. I am excited about being part of the journey to realise this future, and I hope you are too!

As a student, you will be mentored by expert scientists while developing your knowledge and skills in state-of-the-art research facilities where you can access the support you need to excel in a challenging academic environment.

We are looking forward to being part of your journey towards becoming a scientist and making a difference that will benefit the world now and in the future.

Email nas@up.ac.za

Content

Produced by the Department of Enrolment and Student Administration in December 2019.
Comments and queries can be directed to ssc@up.ac.za or tel: +27 (0)12 420 3111.

Introduction

The Faculty of Natural and Agricultural Sciences is a diverse faculty with 13 departments, supported by more than 20 centres and institutes. More than 5 000 students, of which 70% are undergraduate and 30% postgraduate, register in this Faculty annually.

All degree programmes are designed to develop problem-solving individuals who can easily adapt to changing circumstances and take the lead in their chosen fields of specialisation. Our world-class qualifications provide access to numerous career opportunities for dynamic and creative people. Some of the Faculty's degree programmes are unique to the University of Pretoria, while others are also offered at other institutions.

The Faculty presents undergraduate and postgraduate degrees in the following fields:

Biological Sciences (BSc)	**Agricultural and Food Sciences (BSc and BScAgric)**
▪ Biochemistry ▪ Biotechnology ▪ Ecology ▪ Entomology ▪ Genetics ▪ Human genetics ▪ Human physiology ▪ Human physiology, genetics and psychology ▪ Medical sciences ▪ Microbiology ▪ Plant science ▪ Zoology	▪ Agricultural economics and agribusiness management ▪ Animal science ▪ Culinary science * ▪ Food science ▪ Nutrition ▪ Plant and soil sciences ▪ Plant pathology ▪ Wildlife management (Postgraduate)
Physical Sciences (BSc)	**Mathematical Sciences (BSc)**
▪ Chemistry ▪ Engineering and environmental geology ▪ Geography and environmental sciences ** ▪ Geoinformatics ▪ Geology ▪ Meteorology ▪ Physics	▪ Actuarial and financial mathematics ▪ Applied mathematics ▪ Mathematical statistics ▪ Mathematics
Consumer Science (BConSci)	**BSc – Extended programmes**
▪ Clothing retail management ▪ Food retail management ▪ Hospitality management	**Subject fields in the BSc – Extended programmes** ▪ Biological and agricultural sciences ▪ Physical sciences ▪ Mathematical sciences

* Replaced BSc (Food Management) in 2017
** Replace BSc (Geography) and BSc (Environmental Sciences) in 2021

Programmes unique to the Faculty

BSc (Nutrition)	**BSc (Meteorology)**	**MSc (Applied Mineralogy)**
BSc (Nutrition) is an interfaculty degree programme, jointly presented by Food Science (Faculty of Natural and Agricultural Sciences) and Human Nutrition (Faculty of Health Sciences).	This is the only degree of its kind offered in sub-Saharan Africa and it can be completed as a postgraduate qualification.	In South Africa, this postgraduate qualification is offered only at the University of Pretoria.

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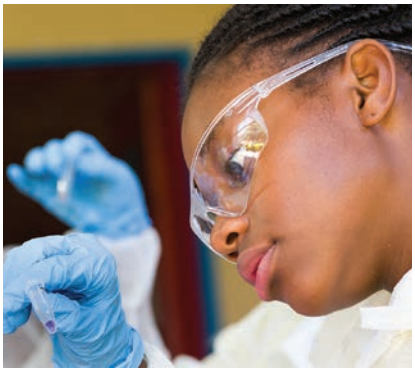

Undergraduate programmes

Important information on undergraduate programmes for 2021

- The closing date is an administrative admission guideline for non-selection programmes. Once a non-selection programme is full and has reached the institutional targets, then that programme will be closed for further admissions, irrespective of the closing date. However, if the institutional targets have not been met by the closing date, then that programme will remain open for admissions until the institutional targets are met.
- The following persons will be considered for admission: candidates who are in possession of a certificate that is deemed by the University to be equivalent to the required National Senior Certificate with university endorsement, candidates who are graduates from another tertiary institution or have been granted the status of a graduate of such an institution, and candidates who are graduates of another faculty at the University of Pretoria.
- Life Orientation is excluded from the calculation of the Admission Point Score (APS).
- Grade 11 results are used for the conditional admission of prospective students. Final admission is based on Grade 12 results.
- Please note that the Faculty does not accept GED and School of Tomorrow qualifications for entry into our programmes.

Note: The asterisks below refer to the minimum requirements for 2021 column in the tables below.

* Cambridge A Level candidates who obtained at least a D in the required subjects will be considered for admission. Students in the Cambridge system must offer both Physics AND Chemistry with performance at the level specified for NSC Physical Sciences in the tables below.

* International Baccalaureate (IB) HL candidates who achieved at least a 4 in the required subjects will be considered for admission. Students in the IB system must offer both Physics AND Chemistry with performance at the level specified for NSC Physical Sciences in the tables below.

University of Pretoria website www.up.ac.za/nas

Programmes	Minimum requirements for 2021*						
	Achievement level						APS
BIOLOGICAL SCIENCES	English Home Language or English First Additional Language		Mathematics		Physical Sciences		
	NSC/IEB	AS Level	NSC/IEB	AS Level	NSC/IEB	AS Level	
BSc (Biochemistry) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Biochemistry offers many opportunities for exciting and challenging careers in the food and pharmaceutical, fine chemicals and waste-processing industries. Careers at research councils, such as the Medical Research Council (MRC), the Agricultural Research Council (ARC), the Cancer Association of South Africa (CANSA) and the Water Research Commission (WRC) are possibilities, as are academic institutions, the Council for Scientific and Industrial Research (CSIR) and forensic and pathology laboratories. Possible careers include that of researcher, teacher, lecturer and medical representative. Graduates are comfortable in work environments such as universities, research institutes, pharmaceutical companies, biotechnology companies and related industries.							
BSc (Biological Sciences) Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
This is a generic first-year programme in Biological Sciences. Students who are uncertain about which specialisation degree programme to choose may apply for this programme. Those who intend to apply for admission to MBChB or BChD in the second semester, when places become available in those programmes, may register for BSc (Biological Sciences) modules in the first semester, replacing Mathematics (WTW 134) with Science and World Views (FIL 155), People and their Environment (MGW 112) and Medical Terminology (MTL 180), with the proviso that should they not be selected and should they wish to continue with one of the Biological Sciences programmes, they must complete Mathematics (WTW 165) in the second semester of their first year. **Note:** Mid-year consideration for Health Sciences: Students who wish to add these three modules (FIL 155, MGW 112 and MTL 180) are required to have an APS of at least 35 and a minimum of 70% for Mathematics in the final NSC or equivalent qualification.							
BSc (Biotechnology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Graduates mostly find work as laboratory-based researchers or bio-entrepreneurs using medical, animal, plant or microbe-based technologies to develop products and services. If students combine biotechnology with additional qualifications such as law, they will be equipped for success in careers such as patent law, pharmaceutical sales and marketing, project management, computer programming (natural computation) and science journalism. Please note that the level of training and qualification plays an important role in determining the type of work a qualified biotechnologist can pursue.							
BSc (Ecology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Graduates find work in environmentally-based statutory and private conservation organisations, organisations involved in the direct or indirect use of natural resources, environmental consultancies, environmental education initiatives and academic and training institutions.							

Undergraduate programmes

Programmes	Minimum requirements for 2021*						
	Achievement level						APS
BIOLOGICAL SCIENCES	English Home Language or English First Additional Language		Mathematics		Physical Sciences		
	NSC/IEB	AS Level	NSC/IEB	AS Level	NSC/IEB	AS Level	
BSc (Zoology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Graduates can look forward to a range of exciting career prospects. They could be employed at nature conservancies, environmental consultancies and conservation planning agencies, medical and veterinary research institutions, in biochemical and biotechnology industries, at educational institutions, in IT-related fields and in the corporate sector. Career opportunities include all the potential activities involved in modern research, development and training. These range from full-time involvement in the field or laboratory to full-time training activities, and usually include a stimulating combination of analytical work, fieldwork and human-resources-related work.							
BSc (Entomology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Graduates could be employed at nature reserves, environmental consultancies, conservation planning agencies, medical and veterinary research institutions, educational institutions and museums, pest management, quarantine and inspection services, in biochemical and biotechnology industries, in IT-related fields and in the corporate sector. Graduates with expertise in entomology are particularly highly sought after in the agricultural sector as insect management specialists or researchers.							
BSc (Genetics) **BSc (Human Genetics)** [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Graduates generally choose to work as molecular biologists, medical or clinical geneticists, cytogeneticists, biotechnologists, agricultural scientists, molecular ecologists, forensic scientists, genetic counsellors, bioinformaticists and computational analysts, veterinary scientists, teachers or lecturers at various institutions, and in bioscience-related industries. If students combine genetics with additional qualifications such as law, they will be equipped for successful careers in, for example, patent law, pharmaceutical sales and marketing, project management, computer programming (natural computation) and science journalism. Note that the level of training and qualification plays an important role in determining the type of work in which a qualified geneticist can become involved.							
BSc (Human Physiology) **BSc (Human Physiology, Genetics and Psychology)** [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Research is performed in cooperation with medical teams in private and government research laboratories (such as the CSIR and the MRC), the South African Bureau of Standards (SABS), pharmaceutical firms, universities, veterinary and industrial institutions and state departments (eg the Department of Health). Physiologists are also found in various other fields, including education (teachers, lecturers and instructors), sports physiology, biostatistics, bioengineering, industrial hygiene, journalism and medical technology, and in the industry as representatives of pharmaceutical firms. Graduates with Genetics and Psychology as subjects also have access to postgraduate programmes offered by the Department of Genetics and the Department of Psychology (in the Faculty of Humanities).							
BSc (Medical Sciences) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Postgraduate studies are highly recommended. Honours, master's and doctoral degrees can be obtained in any of the subdisciplines of anatomy: neuro-anatomy, clinical anatomy, cell biology, physical and forensic anthropology, histology and embryology. Students who obtain this degree can also continue with their studies to obtain postgraduate degrees in physiology, genetics and pharmacology. Career opportunities include research in any of the subdisciplines of anatomy, in academia, in forensic science and in the health science industry. Other careers that can be considered are in the sports sciences, virology, chemical pathology, immunology, health administration or ergonomics. Technical careers are also possible, for example in the Anatomy or Physiology departments at universities. Only 72 places are available in the first year of BSc (Medical Sciences). Students who apply for BSc (Medical Sciences) as their first choice before 30 September, and who meet the minimum admission requirements, will be admitted until the places have been filled.							
BSc (Microbiology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Microbiologists can pursue a variety of careers involving activities ranging from practical application to basic research. Career opportunities are available in the food, dairy, beer, wine, baker's yeast and fermentation industries, and at mines where they will be involved in corrosion control. Graduates can also follow careers as medical or veterinary microbiologists, researchers at organisations such as the CSIR, MRC or ARC, or lecturers and researchers at academic institutions.							

Undergraduate programmes

Programmes	Minimum requirements for 2021*						
	Achievement level						APS
BIOLOGICAL SCIENCES	English Home Language or English First Additional Language		Mathematics		Physical Sciences		
	NSC/IEB	AS Level	NSC/IEB	AS Level	NSC/IEB	AS Level	
BSc (Plant Science) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Careers range from working in a laboratory to studying plants in their natural environments. Graduates could be employed at biotechnology and pharmaceutical firms, South African National Parks, private ecological companies and research institutions such as the CSIR, ARC and the South African National Biodiversity Institute (SANBI).							
Candidates who do not comply with the minimum admission requirements for the abovementioned Biological Sciences programmes may be considered for admission to the BSc – Extended programme – Biological and Agricultural Sciences, which requires an additional year of study.							
BSc – Extended programme – Biological and Agricultural Sciences	4	D	4	D	4	D	**26**
This programme is not available for students who meet all the requirements for the corresponding mainstream programme. **Note:** Only students who apply in the final year of their NSC or equivalent qualification, will be considered for admission into any of the BSc – Extended programmes.							

Programmes	Minimum requirements for 2021*						
	Achievement level*						APS
AGRICULTURAL AND FOOD SCIENCES	English Home Language or English First Additional Language		Mathematics		Physical Sciences		
	NSC/IEB	AS Level	NSC/IEB	AS Level	NSC/IEB	AS Level	
BSc (Culinary Science)* [4 years] Closing dates: SA – 30 September Non-SA – 31 August *Replaced BSc (Food Management) in 2017	5	C	5	C	5	C	**32**
Careers: Graduates can be employed as culinary scientists, culinologists, sensory analysts, food researchers, food product developers, food safety and quality assurance managers, and food service managers.							
BSc (Food Science) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Food scientists with highly marketable training and professional skills work as food risk investigators, quality and safety assurance managers, food chemists, food microbiologists and biotechnologists, packaging and shelf-life specialists, safety auditors, product and process development managers, technical sales and marketing advisors, sensory scientists or food bio-scientists (for example brewers or flavourists) in the food, agro-processing and related industries. The work environments of food scientists include laboratories, food production sites, business premises (retail and wholesale), training areas, government institutions and research organisations. Food scientists also work in industries and companies that manufacture and supply materials (for example packaging and food additives, such as colourants and flavourants) to the food industry, or have secondary involvement in food production and sales.							
BSc (Nutrition) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
BSc (Nutrition) is an interfaculty degree programme, jointly presented by Food Science (Faculty of Natural and Agricultural Sciences) and Human Nutrition (Faculty of Health Sciences). **Careers:** The need for graduates with training in nutrition is driven by the worldwide recognition of the fact that food does not only meet basic nutritional needs, but also plays a key role in the promotion and maintenance of long-term good health. Career opportunities exist in food or related industries (such as pharmaceutical companies), government departments, international organisations (such as the United Nations Food and Agricultural Organisation (FAO) and the World Health Organisation (WHO)) and research organisations, and as account managers and advisors in the food, health and consumer sectors.							
BScAgric (Agricultural Economics and Agribusiness Management) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Agricultural economists are involved in many different areas of the economy. Their roles in the economy include: analysing and understanding consumer behaviour in terms of people's wants, needs and willingness to pay for food and clothing; conducting research in environmental economics to assist governments and businesses in ensuring the sustainable use of scarce resources such as water; training of smallholder farmers by providing extension services; trading of financial instruments and agricultural commodities on global and local stock markets; advising clients in the agricultural sector on how to manage their finances and risks; advising government on how to ensure that there will be enough food for all South Africans; and conducting research to ensure the sustainable and profitable supply of food and clothing across the various supply chains. Employment opportunities for agricultural economists include employment in the government, commercial banks, multinational agribusiness companies, former cooperatives, trading houses, food processors and manufacturers, and research councils. An agricultural economist is, therefore someone who is interested in the mathematics, business, science, and human side of agriculture.							

Undergraduate programmes

Programmes	Minimum requirements for 2021*						
	Achievement level*						APS
AGRICULTURAL AND FOOD SCIENCES	English Home Language or English First Additional Language		Mathematics		Physical Sciences		
	NSC/IEB	AS Level	NSC/IEB	AS Level	NSC/IEB	AS Level	
BScAgric (Animal Science) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Animal science is focused on the application of the scientific aspects of animal production and the quality control of products to ensure consumer satisfaction and careers in this field make an important contribution to agriculture in South Africa. Based on the most recent research and the needs of both animals and humans, animal science focuses on the entire livestock production value chain, from conception to consumption. There are numerous career opportunities for animal and wildlife scientists in research, commercial farming and the public sector, and for professionals in the animal science industry. Animal scientists can work on different levels in these sectors, eg as researchers or consultants on animal nutrition or breeding, technical representatives, managers of intensive and extensive animal production systems and policymakers. The BScAgric (Animal Science) degree is acknowledged as a professional qualification by SACNSP in terms of Act 106 of 1993, and is internationally recognised, which means that graduates can register as professional animal scientists.							
BScAgric (Plant Pathology) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Graduates could be employed as seed cultivators, farmers, researchers, lecturers or consultants.							
BScAgric (Applied Plant and Soil Sciences) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**32**
Careers: Graduates could be employed as teachers and lecturers at schools and academic institutions, as well as researchers and managers at various public and private institutions: ▪ **Public sector:** The ARC, Department of Water and Sanitation, Department of Environmental Affairs, Department of Tourism, Department of Agriculture, Forestry and Fisheries, Department of Mineral Resources, Department of Energy, the CSIR, provincial agriculture and nature conservation departments, SANBI, municipalities, South African National Parks, national farming and food production agencies ▪ **Private sector:** Companies involved in seed, fertiliser and plant protection research and development, environmental planning and management, nurseries, vegetable, fruit and ornamental cut-flower production and irrigation ▪ **Extension services involving knowledge transfer:** Nature conservation, national and provincial departments of agriculture and the environment, environmental management and rehabilitation, nurseries, crop, turf grass and weed management, private companies servicing field crops, vegetables, medicinal and aromatic plants, fruit, ornamental and cut-flower production ▪ **Entrepreneurial:** Consultants in crop, pasture, vegetable, medicinal and aromatic plants, ornamental and cut-flower production systems and landscaping enterprises, managing own farms and nurseries for extensive (field) or intensive (tunnel/greenhouse) production systems involving various crops, and managing companies specialising in irrigation, reclamation and soil conservation							
Candidates who do not comply with the minimum admission requirements for the abovementioned Agricultural and Food Sciences programmes may be considered for admission to the BSc – Extended programme – Biological and Agricultural Sciences, which requires an additional year of study.							
BSc – Extended programme – Biological and Agricultural Sciences	4	D	4	D	4	D	**26**
This programme is not available for students who meet all the requirements for the corresponding mainstream programme. **Note:** Only students who apply in the final year of their NSC or equivalent qualification will be considered for admission into any of the BSc – Extended programmes.							

Programmes	Minimum requirements for 2021*				
	Achievement level*				APS
CONSUMER SCIENCE	English Home Language or English First Additional Language		Mathematics		
	NSC/IEB	AS Level	NSC/IEB	AS Level	
BConSci (Clothing Retail Management) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	4	D	**28**
Careers: Graduates can be employed in retail management as brand managers, clothing buyers and planners, fashion designers, fashion marketers, fashion product developers, quality controllers and assurance managers, store managers, image consultants, textile technologists, visual merchandisers and pattern technologists, or can become entrepreneurs.					
BConSci (Food Retail Management) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	4	D	**28**
Careers: Graduates can be employed as brand managers, sales managers or store managers, food and beverage buyers and planners, food stylists, food journalists, food product marketers, visual merchandisers and consumer consultants, or can become entrepreneurs.					
BConSci (Hospitality Management) [4 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	4	D	**28**
Careers: Graduates can be employed as food and beverage managers, food service managers, culinary specialists, events coordinators, entrepreneurs, food product and menu developers, food journalists, food safety and quality assurance managers, and food stylists.					

Undergraduate programmes

Programmes	Minimum requirements for 2021*						
	Achievement level*						APS
PHYSICAL SCIENCES	English Home Language or English First Additional Language		Mathematics		Physical Sciences		
	NSC/IEB	AS Level	NSC/IEB	AS Level	NSC/IEB	AS Level	
BSc (Chemistry) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**34**
Careers: Graduates are employed in most technology-based institutions and work in laboratory environments that form part of industrial, research or academic institutions. A chemist must be able to participate in teamwork in a multidisciplinary environment and in a wide variety of enterprises in both the private and public sectors. It is important to note that the type of work available to a graduate in chemistry depends on the level of the qualification obtained. Advanced qualifications will eventually lead to positions in research and / or production management and require management and financial planning skills. Many career opportunities exist in the fields of education, research, journalism, environmental protection, food and beverages, energy, water, health, sports, pharmaceutics and cosmetics, geology, mining and law enforcement. These include the well-known professions of synthetic chemist, materials scientist, chemical pathologist, forensic chemist, analytical chemist, drug analyst, patent lawyer, environmental chemist, geochemist, food chemist, polymer chemist and soil chemist.							
BSc (Physics) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**34**
Careers: Graduates could be employed as university academics, whose duties include lecturing, research and the supervision of postgraduate students, researchers in national laboratories such as the Nuclear Energy Corporation of South Africa (NECSA), the South African Astronomical Observatory or iThemba LABS (Laboratory for Accelerator-based Sciences), researchers in industry, for example at the CSIR or Element Six, science advisors for non-governmental organisations, industry or government, radiation scientists, medical scientists and biophysicists, atmospheric scientists and climatologists, developers of renewable energy sources, geophysicists, innovators and entrepreneurs, and computational scientists. International collaboration also takes place with experts from abroad.							
BSc (Geography and Environmental Sciences) [3 years] Closing dates: SA – 30 September Non-SA – 31 August **Note:** This programme will replace the BSc (Geography) and the BSc (Environmental Sciences) programmes from 2021.	5	C	5	C	5	C	**34**
Careers: There are three main career fields in geography: teaching, research and the practical application of geographical knowledge and skills. Geographers can focus on environmental management, urban issues such as squatting, regional and rural development, or environmental issues, including pollution and the destruction of ecosystems through activities such as mining, agriculture and tourism. Geographers in the private sector are generally employed by real estate, planning, architecture and engineering firms, banks, tourism organisations, environmental conservation bodies and industry. Government departments involved in forestry, water and land affairs, the environment, tourism and education employ geography graduates. Parastatal organisations such as the SABS and the CSIR offer career opportunities in the various specialised fields related to the earth and environmental sciences. Many geographers are self-employed. They are mainly involved in areas such as marketing, planning, development, tourism, cartography, geographic information systems (GIS), remote sensing, environmental analysis and environmental auditing. Graduates can also pursue academic careers. Graduates could also be employed as environmental consultants, air quality managers, environmental impact analysts, environmental protection agents, hazardous materials specialists, public health educators, researchers, water quality specialists, natural resource managers, risk managers, environmental educators, wetlands scientists, wildlife conservationists, environmental planners and analysts, wastewater treatment experts, programme and project managers, natural resources experts and researchers.							
BSc (Geoinformatics) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**34**
Careers: Graduates are employed in areas such as agriculture, mineral exploration, engineering, forestry, water resource management, weather forecasting, environmental impact assessment (EIA), land-use planning, land development, rural community development, transport planning, tourism, market research, crime prevention, vehicle tracking, cartography, GIS technology, environmental planning and analysis, and disaster and environmental management. Graduates can apply for professional registration as GIS technologists with the South African Geomatics Council (SAGC).							
BSc (Geology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**34**
Careers: Large international mining companies are major employers of geologists and other geoscientists in research, exploration and mining projects. However, employment is increasingly to be found in smaller, entrepreneurial firms ('juniors'). Interesting careers are also offered by the Council for Geosciences, the CSIR, and the Council for Mineral Technology (MINTEK), the Department of Water and Sanitation, and at museums, engineering firms and consulting companies. Graduates may even operate as self-employed consultants in their own firms. Laboratory specialists, for example mineralogists, identify and examine minerals using sophisticated instruments and analytical equipment. Environmental and engineering geologists study the interaction between human activities and the geological environment, such as the pollution of soil and groundwater. They investigate geological structures and soil, and rock properties at construction sites, for example dams, tunnels and mines, in order to provide valuable information prior to construction. They also locate and evaluate suitable construction materials. The task of the hydrogeologist is to look for groundwater and monitor the responsible exploitation of that water.							

Undergraduate programmes

Programmes	Minimum requirements for 2021*						
	Achievement level*						APS
PHYSICAL SCIENCES	English Home Language or English First Additional Language		Mathematics		Physical Sciences		
	NSC/IEB	AS Level	NSC/IEB	AS Level	NSC/IEB	AS Level	
BSc (Meteorology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**34**
Careers: Meteorologists are employed by institutions involved in the study, interpretation and prediction of weather and climate-related phenomena. The South African Weather Service (SAWS), the CSIR, some universities, agricultural institutions and general industries employ meteorologists who practise mainly as specialists in the following areas: ▪ **Researchers:** They research all aspects of the weather and climate in order to improve man's understanding of atmospheric phenomena. Atmospheric modellers use supercomputers to solve complex flow dynamic equations of the atmosphere. The monitoring of air quality and the modelling of the impact of air pollution on society are two important aspects that need to be addressed. Research on climate change is receiving increasing attention. ▪ **Weather forecasters:** It is the duty of the weather forecaster to analyse data and predict the weather by using models that are run on supercomputers. Weather forecasts are issued on different time scales, from very short-range forecasting to forecasts that are valid for months ahead, as well as seasonal forecasts. Private positions for people with this qualification include presenting the weather forecast on television. ▪ **Climatologists:** They manage important data sets that contain large volumes of information gathered by the SAWS and other organisations. ▪ **Consultants:** Some meteorologists who work as consultants in the private sector and at universities provide specialised research services. ▪ **Lecturers:** A few academic positions for meteorologists and climatologists are available at South African universities. They ensure that the training of meteorologists meets international standards.							
BSc (Engineering and Environmental Geology) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	5	C	5	C	**34**
Careers: Graduates could be employed as geologists, mineralogists, extraction metallurgists, economic geologists, geochemists, environmental and engineering geologists, geohydrologists, laboratory specialists and consultants.							
Candidates, who do not comply with the minimum admission requirements for the abovementioned Physical Sciences programmes may be considered for admission to the BSc – Extended programme – Physical Sciences, which requires an additional year of study.							
BSc – Extended programme – Physical Sciences	4	D	4	D	4	D	**28**
This programme is not available for students who meet all the requirements for the corresponding mainstream programme. **Note:** Only students who apply in the final year of their NSC or equivalent qualification will be considered for admission into any of the BSc – Extended programmes.							

Undergraduate programmes

Programmes	Minimum requirements for 2021*				
	Achievement level*				APS
MATHEMATICAL SCIENCES	English Home Language or English First Additional Language		Mathematics		
	NSC/IEB	AS Level	NSC/IEB	AS Level	
BSc (Actuarial and Financial Mathematics) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	7	A	**36**
Careers: Actuarial and financial mathematics is a popular field, with career opportunities in the business market and at investment institutions such as banks and insurance companies. Mathematical skills are essential in portfolio management and the modelling of financial risk. This programme prepares students for professional careers as actuaries or financial engineers. The activities of actuaries or actuarial technicians include long-term capital projects, designing the benefits of medical schemes, pension fund management, the determination of contributions and financial management on a sound long-term basis, the evaluation of investments in shares, property and other transactions, and the determination of the premiums and reserves for insurers' outstanding claims. Financial engineers can be employed by banks and financial institutions, brokerage firms and investment institutions. The mathematical skills of financial engineers are essential in portfolio and risk management. Activities include asset management (trading in bonds, futures and derivative instruments such as options), designing new financial products and devising strategies to control credit risk.					
BSc (Mathematics) **BSc (Applied Mathematics)** [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	6	B	**34**
Careers: Graduates in mathematics and applied mathematics are employed by research institutions, educational bodies (universities and schools), the public sector (government and medical institutions) and the private sector (engineering companies, financial institutions and the computer industry). These graduates' training in abstract, analytical and computational thinking provides them with the background required to easily adjust to changing circumstances in the professional environment and to construct mathematical models of natural, technological and financial phenomena. Mathematicians and applied mathematicians apply, evaluate and adapt existing problem-solving techniques, or develop new techniques to solve problems.					
BSc (Mathematical Statistics) [3 years] Closing dates: SA – 30 September Non-SA – 31 August	5	C	6	B	**34**
Careers: The services of statisticians are needed by people in many professions, such as actuaries, economists, biologists, engineers and marketing executives. Some examples of career opportunities are: ▪ Google Analytics use statistics to track internet users to generate leads for their recommended engines. ▪ Movement information captured by cell phones is used by statistical predictive models to predict traffic congestion and suggest faster routes. ▪ Statisticians make use of statistical methodologies to detect fraud, assist with credit-related portfolios and forecast financial economic trends. ▪ Retail companies study customer satisfaction and customer experience by using statistical models. ▪ Spatial statistics can provide useful information about climate change, crime hotspots and rhino-poaching geographical maps. ▪ Statisticians advise animal scientists on factors affecting animal nutrition and genetic breeding plans. ▪ Government employs statisticians to understand how population demographics, health risks and other factors influence sustainable development programmes.					
Candidates, who do not comply with the minimum admission requirements for the abovementioned Mathematical Sciences programmes may be considered for admission to the BSc – Extended programme – Mathematical Sciences, which requires an additional year of study.					
BSc – Extended programme – Mathematical Sciences	4	D	5	C	**28**
BSc (Actuarial and Financial Mathematics) Admissions from the BSc – Extended programme to the BSc (Actuarial and Financial Mathematics) programme will be considered if students have passed all their first year modules with an average mark of at least 60%, passed IAS 111; and achieved a minimum mark of 60% in WTW 143 and WTW 153.					
This programme is not available for students who meet all the requirements for the corresponding mainstream programme. **Note:** Only students who apply in the final year of their NSC or equivalent qualification will be considered for admission into any of the BSc – Extended programmes.					

List of Acronyms

AECI	African Explosives and Chemical Industries	**NRF**	National Research Foundation
ARC	Agricultural Research Council	**SAGC**	South African Geomatics Council
CANSA	Cancer Association of South Africa	**SABS**	South African Bureau of Standards
CSIR	Council for Scientific and Industrial Research	**SACNASP**	South African Council for Natural Scientific Professions
GISc	Geographic Information Science	**SANBI**	South African National Biodiversity Institute
GIS	Geographic Information System	**SANSA**	South African National Space Agency
HSRC	Human Sciences Research Council	**SAWS**	South African Weather Service
MRC	Medical Research Council	**WRC**	Water Research Commission
NECSA	Nuclear Energy Corporation of South Africa		

BSc – Extended programmes

The BSc – Extended programmes are designed for students who show potential to succeed, but are not academically well prepared. The programmes have lower entrance requirements and include an additional year of study to enhance students' basic knowledge.

These programmes are gateways to science and science-based programmes. Students admitted to the BSc – Extended programmes will attend classes at the Mamelodi Campus during their first year. Students who successfully complete their first year will attend lectures on the Hatfield Campus from their second academic year onwards.

The programmes have two phases. The duration of the first phase is 18 months (three semesters). During this phase, students are academically and psychologically developed and trained for further studies. Those who successfully complete the first phase will obtain credits equivalent to the first semester of the first year of the BSc and BScAgric programmes and may register for the modules of the second semester of a preferred first year in BSc or BScAgric. Transfer to the second year of these specific BSc or BScAgric programmes takes place in the third year of registration.

Features of the BSc – Extended programmes

- In the first phase, the academic content is delivered at a slower pace than that of the regular degree programmes.
- Extra modules and support help students to cope with university life.
- Most of the teaching and learning take place in smaller groups.
- A variety of methods are used to deliver content to remedy possible gaps in foundational knowledge.

Subject fields in the BSc – Extended programmes

- Mathematical sciences
- Biological and agricultural sciences
- Physical sciences

Students who wish to follow careers in engineering should apply for the BSc – Extended programme – Physical Sciences, and those who wish to study health sciences or veterinary science should apply for the BSc – Extended programme – Biological and Agricultural Sciences.

'Although the physiology of micro-organisms is considered simple, they continuously cause havoc in the health sector and never fail to baffle even the smartest scientists. Over time, as technology improved, knowledge increased and antibiotics and other therapeutics were discovered, microorganisms managed to evolve and learnt how to adapt. Eager to fully understand how micro-organisms are capable of constantly evolving, I enrolled for a degree in Biochemistry and Microbiology at UP. However, it was only in my third year, during my time as a mentee at FABI, that I developed an interest in antimicrobial resistance and novel drug discovery.

I completed my microbiology mentorship programme and undergraduate BSc degree in 2017 and a BScHons (Biochemistry) degree in 2018. I am currently working towards an MSc in the field of antimicrobial drug discovery. My dream is to contribute to the discovery of novel drug treatments against resistant pathogens so as to prevent unnecessary human deaths due to the ineffectiveness of current drugs.

I am extremely grateful to the University of Pretoria and the Department of Biochemistry, Genetics and Microbiology for enabling me to accomplish my goals. Food Science chose me!'

Mandelie van der Walt – BSc Honours (Biochemistry)

Biological Sciences

Anatomy

BSc (Medical Sciences)

The Department of Anatomy forms part of the School of Medicine in the Faculty of Health Sciences and offers a BSc degree in Medical Sciences in the Faculty of Natural and Agricultural Sciences. The aim of this degree is to train students in the basic medical sciences, which include clinical anatomy, physical and forensic anthropology, histology, cell biology and embryology. These subjects can be combined with elective modules from physiology, pharmacology and genetics.

Career opportunities

Graduates are sought after by institutes in the academic, government and private sectors, where they are employed as lecturers, researchers, medical and forensic scientists, and sales representatives in the medical and pharmacological industries. Several of our postgraduates are currently studying at research facilities in North America and Europe.

Biochemistry, Genetics and Microbiology

BSc (Biochemistry)
BSc (Biotechnology)
BSc (Genetics)
BSc (Human Genetics)
BSc (Microbiology)

The Department of Biochemistry, Genetics and Microbiology strives to provide expert teaching, learning and research at both the undergraduate and postgraduate levels.

This includes continuous scientific research into basic life sciences in an effort to advance our understanding of all living organisms that are of critical importance to agricultural, environmental, animal and human health.

Biochemistry

Life at the cellular and molecular level depends on the specific interaction and cooperation of many individual biomolecules. To understand life at a fundamental level, biochemists study the role of individual biomolecules and relate this function to its unique structure. Challenges of global relevance, such as HIV/AIDS, malaria, tuberculosis, antimicrobial drug resistance and other human or animal diseases are addressed by using flow cytometry, cell sorting, biophysical analysis, protein crystallography, genome analysis, selective gene expression and metabolic profiles. Biochemists can work in medicine, veterinary science, the food and pharmaceutical industries and agriculture, and many other fields.

Description of the programme

First-year students are exposed to a range of biological and physical science subjects to ensure a firm scientific basis. In the second and third years, they delve deeper into biochemistry, combining theoretical lectures with appropriate practical studies to learn the principles and methodology of research. In the third year, the study of the genome, transcriptome, proteome and lipidome of a living cell is pursued. Proteome analysis, crystallography, cell structure and function, enzymology and immunology are applied to understand the molecular basis of disease.

Ideally, biochemistry is combined with chemistry, microbiology, genetics, human physiology, plant science, zoology and food science. All these subjects include both theoretical and practical aspects. Students may choose elective modules related to their studies.

Postgraduate studies in Biochemistry include honours, master's and doctoral degrees. The one-year honours degree is open to students from the biological or chemical sciences and includes exposure to a range of technologies, some self-study and a research project. At the master's and doctoral levels, students conduct research in fields such as HIV/AIDS, malaria, tuberculosis, anti-microbial drug resistance, diabetes, other human diseases and plant-derived medicines.

Career opportunities

Biochemistry and bioinformatics offer many opportunities for exciting and challenging careers in the food and pharmaceutical, fine chemicals and waste-processing industries. Careers at research councils, such as the MRC, ARC, CANSA and the WRC are possibilities, as are academic institutions, the CSIR and forensic and pathology laboratories. Graduates can also be researchers, teachers, lecturers and medical representatives. They are comfortable in work environments such as universities, research institutes, pharmaceutical companies, biotechnology companies and related industries.

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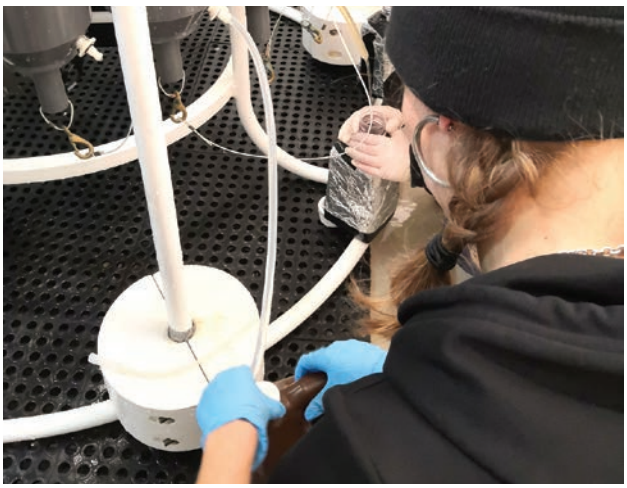

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Star students in the Faculty of Natural and Agricultural Sciences

Justin Harrison

Justin Harrison, an MSc graduate from the Department of Physics, was one of only 20 top young scientists from South Africa selected to attend the 69th Lindau Nobel Laureate Meeting dedicated to physics, which was held earlier this year in Lindau, Germany.

Martin Wierzbicki

Martin Wierzbicki, a recent MSc (cum laude) graduate in Genetics, was one of three global winners of a 2018-2019 Blue Sky Young Researchers and Innovation Award, bestowed on him by the International Council of Forest and Paper Associations (ICFPA) for his novel wood-based research project.

Pilirani Tendai Khoza

Pilirani Tendai Khoza, a master's student in Forestry and Environmental Sciences was selected for the 2019 Mandela Washington fellows, Leadership and Business Track. In 2018, through her involvement in the development of farming in Malawi, she also had the opportunity to meet the Queen of England at Buckingham Palace in London, where she received the Queen's Award.

Rahil Samlal

Rahil Samlal, a first-year BSc (Microbiology) student, was awarded the prestigious UP Derek Gray Award at the 2017 Eskom Expo for Young Scientists, which included a full bursary to study science at UP and a fully paid trip to Sweden to represent Africa at the Stockholm International Youth Science Seminar (SIYSS) at the end of 2018.

Biological Sciences

Genetics

Genetics and Human Genetics

Genetics is the study of how the genetic material in the cells of all living organisms is transmitted from parent to offspring across generations and how that genetic material is encoded and decoded to provide the blueprint of all life on earth. This pioneering discipline is at the core of the biological, agricultural, veterinary and medical sciences and has become essential in fields as diverse as virology and epidemiology, biodiversity conservation and sustainable agriculture.

The advent of advanced technologies continues to enhance existing research strategies. This allows for dynamic interdisciplinary collaboration, not only in the life sciences, but also in fields such as informatics and mathematics. The genomes of numerous animals, plants and pathogens, as well as those of humans, have been decoded. This has led to new informative methods for studying gene interactions at various cellular levels. Computational modelling has proven invaluable to novel gene discovery and understanding the origins and spread of emerging viruses, such as the H1N1-virus.

Description of the programme

The Division of Genetics is an active player on the international scientific stage and offers internationally recognised undergraduate and postgraduate degrees. These degrees are research oriented and place strong emphasis on developing analytical skills. The Division of Genetics offers both single- and dual-major options in its Genetics and Human Genetics programmes. Students can therefore choose to either specialise in genetics as a single major, or combine their genetics subjects with a second multidisciplinary major, such as biochemistry, microbiology, plant science, zoology or human physiology in the Human Genetics programme.

At the undergraduate level, students are provided with a thorough background in the principles of genetics, as well as the application of these principles in fields as diverse as genomics, plant and animal biotechnology, diagnostics and risk determination, bioethics, conservation ecology and population, behavioural and evolutionary studies.

Biotechnology

Molecular biotechnology involves the use of *in vitro* genetic manipulation and recombinant DNA methods to genetically alter plants, animals and microbes for commercial gain. Molecular biotechnologists aim to correct, modify, enhance or exploit specific genetic traits in their target organisms for a wide range of practical purposes. This includes improving food production, managing diseases, conservation and bioremediation. Biotechnology will play a pivotal role in the future of the medical, agricultural, veterinary and ecological sciences.

Description of the programme

The Biotechnology programme is an interdepartmental programme with a particular emphasis on molecular biology, which is aimed at empowering students to pursue their interest in biotechnology. Undergraduate training includes exposure to aspects of biochemistry, genetics and microbiology, in addition to the other subjects chosen by the student. Students are encouraged to decide on their postgraduate research direction during the course of their undergraduate studies and to choose their electives accordingly.

Career opportunities

Graduates acquire skills in numeracy, analytical and critical thinking, as well as creativity in problem-solving and data handling, all of which equip them for success in both scientific and non-scientific careers.

Biotechnologists function in both the science and business spheres, which gives graduates a competitive advantage in the biological industries. An increasing number of opportunities are available in privately owned biotechnology laboratories that specialise in contract work. However, graduates are encouraged to advance their studies by continuing with honours, master's and doctoral degrees in genetics or biotechnology, since such degrees are usually essential in scientific careers.

Microbiology

Microbiology provides many diverse and interesting study opportunities. Micro-organisms (viruses, bacteria and fungi) form an essential part of our planet and students are trained to study their functions and roles, as well as how microbes could be used or controlled in our everyday lives.

Micro-organisms are important to health and agriculture due to the diseases they cause. In this regard, microbiologists study the pathogens responsible for serious infectious diseases affecting humans, animals, wildlife and plants in order to treat and control them. Microbiology also focuses on the different applications that use beneficial micro-organisms in food production, water purification and other industrial applications.

Description of the programme

A microbiologist's basic training is a three-year BSc degree. Apart from exposure to a range of subjects in the biological sciences, there is also a focus on specialised microbiology topics, such as mycology, bacteriology, virology, microbial ecology, clinical microbiology, plant pathology, molecular microbiology, microbial interactions and food microbiology. Students can combine microbiology with genetics, biochemistry, zoology or plant sciences as part of a dual-major degree.

Postgraduate studies are essential for a career in research. The University of Pretoria has several internationally recognised research programmes of which postgraduate students form an integral part. At the molecular and cellular level, the focus is on issues such as the design of new vaccines, understanding pathogenicity, and the development of new and improved ways to detect and quickly identify microbes. There is also a focus on the discovery and description of new micro-organisms, and gaining a better understanding of their evolution and diversity.

Career opportunities

Microbiologists can pursue a variety of careers ranging from practical application to basic research. Career opportunities are available in the medical and veterinary sector, as well as in the food, fermentation, agricultural, environmental and water sectors. Research can be conducted at organisations such as the CSIR, MRC or ARC. Microbiologists are also employed as lecturers and researchers at academic institutions.

Biological Sciences

Human Physiology

BSc (Human Physiology)
BSc (Human Physiology, Genetics and Psychology)

Physiologists study the mechanisms by which the body functions, from the molecular and cellular levels through progressive differentiation to tissue, organs, systems and eventually the integrated interactions and control of body functions. Knowledge is applied during research investigations of normal and abnormal life processes. Basic and clinical research can be entered into at various levels, namely the molecular, cellular, structural and diagnostic levels. Human physiology is a major for two programmes in biological sciences: BSc (Human Physiology) and BSc (Human Physiology, Genetics and Psychology). Specialised physiology modules form part of student training in medicine, dentistry, nursing, dietetics, biokinetics, communication pathology, food science, occupational therapy, physiotherapy, radiography and some consumer science programmes.

Description of the programme

During the first year of study towards a BSc (Human Physiology) degree, students are exposed to a generic, basic range of subjects in biological and agricultural sciences. In the second year, physiological systems (neurophysiology, haematology, cardiovascular physiology, pulmonary physiology, renal physiology, nutrition and digestive physiology, endocrinology and reproductive physiology) are studied with biochemistry as a compulsory subject.

The programme is concluded in the third year with a selection of integrated physiology modules, namely sports physiology, nutrition and development, psycho-neuroimmunology and cell physiology, as well as industrial physiology. At the third-year level, students can select some elective modules. Psychology and genetics are compulsory subjects in all three years of study.

Career opportunities

Research is performed in cooperation with medical teams in private and government research laboratories such as the CSIR, MRC and SABS, pharmaceutical firms, universities, veterinary and industrial institutions, state departments (eg the Department of Health) and health farms.

Physiologists also work in other fields, such as education (teachers, lecturers and instructors), sports physiology, biostatistics, bioengineering, industrial hygiene, journalism and medical technology, and in the industry as representatives of pharmaceutical firms. Graduates who completed their degrees with Genetics and Psychology as majors also have access to postgraduate programmes offered by the Department of Genetics and the Department of Psychology (in the Faculty of Humanities).

Plant and Soil Sciences

BSc (Ecology)
BSc (Plant Science)

Plants are fascinating organisms and much is still unknown about their potential uses. It is, however, well known that plants are the best factories for synthesising valuable natural products. The Department of Plant and Soil Sciences is a large department that offers both BSc and BScAgric degrees. (Information about the BScAgric degree follows later in this document.)

The Department is dynamic, innovative, modern and relevant. Staff members undertake world-class research and 70% of them have received NRF ratings. Much of the research is of an applied nature, and contributes to the improvement of agricultural crops and methods, knowledge of plant diseases, the use of plant-derived compounds, biodiversity and plant biotechnology.

In medicinal plant science, students learn about the discovery and use of plant medicines and phytotherapeutically important molecules obtained from plants. In plant biotechnology, molecular tools and the use of model plants are discussed to study whole-plant physiology. Gene and promoter identification, transfer techniques for plant improvement and the analysis of plant transcriptomes for plant improvement using micro-arrays are investigated. In the study of plant diversity and ecology, students learn about South Africa's rich and diverse vegetation and how to facilitate conservation and management strategies for future generations.

Description of the programme

During the first two years of study, students are exposed to a range of subjects in the biological sciences. They can specialise during their third year. The Department specialises in plant diversity and ecology, plant biotechnology and medicinal plant science. In the third year, students do several practical sessions and experience plants in their natural habitat during a field excursion. Postgraduate degrees are also offered. The one-year full-time or two-year part-time honours degree includes a research project and some theoretical modules. At the master's and doctoral degree levels, students are required to complete research projects in one of the Department's research fields.

Career opportunities

Career opportunities range from working in a laboratory to studying plants in their natural environments. Opportunities for employment could be at biotechnology and pharmaceutical firms, South African National Parks, private ecological companies, research institutions such as the CSIR, ARC and SANBI, and universities.

Biological Sciences

Zoology and Entomology

BSc (Ecology)
BSc (Entomology)
BSc (Zoology)

Zoology is the scientific study of animals. Insects represent the majority of animals, in terms of individuals and species, and their study is termed entomology. Zoology and Entomology incorporate many more specialised disciplines, such as anatomy, behaviour, conservation biology, ecology, evolutionary biology, genetics, physiology, the epidemiology of wildlife diseases and plant-insect interactions. Zoologists and entomologists collaborate closely with agriculturalists, economists, engineers, mathematicians, physicists, plant scientists and veterinarians, among others, to document, understand, conserve and manage animal life.

Description of the programme

During the first two years of study, students in the BSc programmes are exposed to a range of subjects to provide a firm foundation for further study. In the third year, they take specified modules to qualify in zoology, entomology or ecology. Laboratory- and field-based practical experience in all the modules provide opportunities for students to engage with the methods used to gain new knowledge in the relevant fields. They learn the skills required in the workplace and for postgraduate study. Students can combine entomology or zoology with biochemistry, genetics or plant science as part of a dual-major degree.

Zoology is an ideal field of study for students with a keen interest in the biology, diversity and conservation of wild animals. Topics that are covered include physiology, behaviour, diversity and evolution, population and community ecology, and animal conservation in the face of human disturbance and exploitation.

Entomology is recommended for students with a fascination for insects. It entails controlling agricultural, forestry and household insect pests, conserving insects that provide valuable services to humans and ecosystems, and reducing the transmission of vector-borne diseases. Depending on their personal interests, graduates can become forensic entomologists, quarantine officials, insect pest management specialists, entomological collections curators, insect rearing and laboratory technicians, and environmental consultants and managers.

Ecology is recommended for students who want to understand how animals and plants interact with each other, and with the natural and human environment. In addition to modules dealing with animals, students take a number of modules on plant diversity and ecology in the third year.

Postgraduate study in zoology or entomology opens more doors for employment and makes it possible for students to pursue further studies in animal biology and management. An honours degree is the minimum requirement for accreditation as a practising natural scientist and for working as an environmental consultant in South Africa. The Department offers honours, master's and PhD degree programmes in Zoology and Entomology.

Career opportunities

Graduates can look forward to a range of exciting career prospects. They could be employed at nature conservancies, environmental consultancies and conservation planning agencies, medical and veterinary research institutions, in the biochemical and biotechnology industries, at educational institutions, in IT-related fields and in the corporate sector. Career opportunities include all the activities potentially involved in modern research, development and training, and natural resources policy formulation. These usually include a stimulating combination of analytical work, laboratory or fieldwork, and human resources management.

Student contribution

‘I chose to study in the Department of Animal and Wildlife Sciences because I have always enjoyed working with animals and knew how many different possibilities the field offered. While growing up I always imagined myself as a research scientist, and animal science allows me to do the two things that I enjoy most at the same time. Another dream I have is to be a part of a team that helps to alleviate hunger and poverty in Africa.

I grew up in a part of the country where rearing livestock and agricultural practices provided the main source of income and food for households, so I decided that a career in agriculture would be a convenient stepping stone to achieving my dreams. I soon realised that there was a big difference between the production returns in the communal and commercial farming sectors. The knowledge gained through my studies will enable me to teach the less advantaged how to apply science to diversify and optimise their production of milk, eggs, meat and wool. I would also like to raise awareness of breeding techniques, production systems, nutrition and management techniques about which I learnt during my undergraduate studies. I am currently pursuing postgraduate studies and I learn more every day.’

Shante Mhlaba
MScAgric
(Animal Sciences)

Agricultural and Food Sciences

Agricultural Economics, Extension and Rural Development

BScAgric (Agricultural Economics and Agribusiness Management)

Agricultural and food industries all over the world are facing the growing demands of an ever-increasing population. At the same time, natural resources, such as soil and water, and human resources are becoming scarcer and production costs are soaring. Agricultural economists need to find solutions that will enable farmers to farm more effectively and reduce costs to ensure the financial sustainability of farms and companies operating in agriculture.

Agricultural economics can be broadly defined as the study of how limited resources can be utilised to feed an ever-increasing world population. Agricultural economists are therefore concerned with the economic and financial issues related to farming, agricultural food chains and the prices of food on the shelf. The sub-disciplines of this field of study include marketing, financial management, economics, business management, policy formulation and accounting.

Description of the programme

The Department offers the following two undergraduate programmes:

- A four-year BScAgric (Agricultural Economics and Agribusiness Management) degree for students who are more interested in agriculture
- A BCom (Agribusiness Management) degree with the focus on agribusiness management and marketing (For more information on this programme, please refer to the Faculty brochure of Economic and Management Sciences.)

Career opportunities

The term 'farm to fork' refers to the process that takes food products from where they are produced to the consumer's plate. Agricultural economists play a role in every step of the process. Owing to the diverse nature of potential careers in this discipline, it would be difficult to compile a complete list of all the possible occupations. Depending on their areas of specialisation, agricultural economists are employed in the following fields:

- Input companies (as general managers, sales representatives, marketers or market analysts)
- Large farming enterprises (as general or financial managers)
- Agricultural enterprises (as market analysts, logistics managers or commodity traders)
- Commercial banks and insurance companies (as agri-specialists in insurance and financing)
- Public sector (several positions are available, usually with a strong focus on policy and market analysis)

Animal and Wildlife Sciences

BScAgric (Animal Science)

Animal Science is a scientific field that involves the study of three major areas, namely animal breeding and genetics, physiology and the nutrition of all farm, equine and companion animals. The Department of Animal and Wildlife Sciences offers a four-year BScAgric degree programme that will prepare you for a professional career in the livestock, poultry and pig industry. The Department of Animal Science at UP is more than 100 years old and has a rich history of producing animal scientists and performing relevant research that has contributed to the development of the South African livestock industry.

The way we practise livestock production has changed worldwide over the past century and new technological developments have created new opportunities for innovative research and application in all three disciplines of animal nutrition, animal breeding and genetics, and animal physiology. Animal scientists work in collaboration with veterinary scientists, crop scientists and agricultural economists to provide solutions to improve animal health and welfare, reduce CH4 emissions and increase the efficiency of production to meet the demands of the world's growing population.

Animal science is a profession in its own right, according to Act 27 of 2003, and this requires animal scientists to register with the SA Council for Natural Science Professions once they have completed their degrees and start working in the livestock industry.

Description of the programme

The Animal Science programme provides a sound basis of fundamental sciences during the first two years of study, which include the subjects Physics, Chemistry, Microbiology, Genetics, Mathematics and Biochemistry. These are essential for understanding and being able to integrate the advanced principles in animal genetics, animal physiology and nutrition that will be studied in the third and final year.

In the final year, the three major focus areas of genetics, physiology and nutrition are integrated to teach the management and application of large livestock, small stock, poultry, pigs and companion animals. The BScAgric (Animal Science) programme can lead to MScAgric programmes in animal nutrition, production physiology or animal breeding and genetics, or to an honours degree in Wildlife Management.

Career opportunities

Animal Science is an integral part of agricultural production and the work environment of an animal scientist encompasses the production chain from primary farming level, animal feed formulation, selection and breeding of farm animals and wildlife to the marketing and processing of the final products. In each link of this value chain career opportunities exist for animal scientists.

Animal scientists may find employment as:

- Technical advisors in the animal feeds and animal breeding industries (including poultry, pigs/ruminant livestock)
- Animal nutritionists performing feed formulations for different farm animal species/companion animals
- Animal nutritionists developing new animal feeds and feed additives
- Animal breeders and geneticists developing selection programmes and models
- Researchers in any of the three disciplines
- Animal scientists for livestock conservation and strategic planning in the Department of Agriculture
- Professional private animal science consultants
- Livestock extension and training specialists in the livestock and broader agricultural industry
- Meat scientists in retail or product development

Agricultural and Food Sciences

Consumer and Food Science

BConSci (Clothing Retail Management)
BConSci (Food Retail Management)
BConSci (Hospitality Management)
BSc (Food Science)
BSc (Culinary Science)
BSc (Nutrition)

The Department of Consumer and Food Sciences offers BConSci and BSc degree programmes. We provide relevant, world-class education and training for future leaders in consumer science, food science and nutrition and are very proud of our internationally recognised postgraduate research programme. Participation in national and international research projects attracts outstanding students from South Africa and elsewhere. We excel in many areas, eg the pioneering of cross-disciplinary research to help solve South Africa's critical food and nutrition challenges as part of the national Centre of Excellence in Food Security and the University's Institute for Food Nutrition and Well-being. Research focuses on food safety, nutritious and health-promoting African food and beverages, novel plant biopolymers, bioplastic microstructures and nanomaterials. Researchers also aim to understand consumers' use, consumption and decision-making, and their management of food, clothing and textile products. This leads to the development of value-added consumer products and sound business practices. Our graduates make a difference!

Consumer Science

These undergraduate programmes are structured for four years of full-time study. Since UP is currently the only South African university that offers consumer science degrees with a focus on the economic and management science aspects of the specific fields of specialisation, our graduates are sought after, especially in the retail sector.

The programmes deal with the properties of the product categories, consumers' purchasing and consumption behaviour, product management and the development of new products and services. Consumer science aims to encourage strategies to enhance informed, responsible buying and consumption behaviour, and consumer satisfaction, and to address the needs of people in small businesses and the retail sector.

Career opportunities

Career opportunities are diverse. A graduate's eventual career path is mostly determined by his or her personality and interests. Students are therefore provided with opportunities to investigate different possibilities through compulsory experiential training during their studies. In their fourth year of study, they complete a research paper that offers them an opportunity to participate in a formal research project and to consider the possibility of postgraduate studies.

Over the years, the Department has acquired valuable contacts, and students who perform well during their experiential training are often assured of appointments before the completion of their final examinations.

Graduates with a degree in clothing retail management are employed as brand managers, clothing buyers and planners, fashion designers, fashion marketers, fashion product developers, quality controllers and assurance managers, store managers, image consultants, textile technologists, visual merchandisers, pattern technologists and entrepreneurs.

Graduates with a degree in food retail management are employed as brand managers, sales managers or store managers, food and beverage buyers and planners, food stylists, food journalists, food product marketers, visual merchandisers, consumer consultants and entrepreneurs.

Graduates with a degree in hospitality management are employed as food and beverage managers, food service managers, culinary specialists, events coordinators, entrepreneurs, food product and menu developers, food journalists, and food safety and quality assurance managers. Graduates interested in teaching may consider teaching hospitality studies or training and consultation in the hospitality industry.

Sinqobile (Lolo) Sihlobo, did Science at school, but after finishing Grade 12 she decided that she wanted to go a different route and study something creative, innovative and more fulfilling. UP had always been her institution of choice and through research she found a programme that suited her perfectly, namely the BConSci (Clothing Retail Management) degree, which prepares students for various career opportunities in the clothing and fashion industries. She is currently working towards a master's degree.

Sinqobile Sihlobo
– BConSci (Clothing Retail Management)

Agricultural and Food Sciences

Food Science

The BSc (Food Science) undergraduate programme is a three-year full-time degree programme. Food scientists are concerned with the chemical composition, structure and nutritional value of foods. They monitor chemical, physical and biological changes that occur in foods during processing, preservation and storage. Nutrition scientists deal with the human requirements for food and the effects of food on health and well-being. Culinary scientists focus on the art and science of food and food preparation. Programmes are both academic and practical and prepare students for economically satisfying careers.

Students are provided with ample opportunities to gain career exposure during practical training sessions, visits to food companies, attendance at conferences and events, and participation in competitions and mentorship programmes. They are also actively involved in the South African Association for Food Science and Technology (SAAFoST), the Nutrition Society of South Africa and industry associations for meat, dairy products and cereals. Students organise activities through the student body TUKSFoST.

Career opportunities

The food industry is South Africa's largest manufacturing sector. Food scientists develop and supply foods that comply with the ever-changing demands of modern consumers. They lead the fight against hunger and malnutrition by developing safe, affordable, nutritious foods. Graduates are employed the world over as food scientists, food microbiologists or biotechnologists, food and nutrition analysts, food- manufacturing operation managers, food product or process developers, quality and safety assurance specialists, food packaging or shelf-life specialists, academics, sensory scientists and key food category managers.

All multinational and numerous smaller food companies employ nutrition graduates who quantify the nutrient composition of products, ensure that they conform to legislation and communicate the nutritional benefits of products to consumers. They develop food products and supplements to meet the specialised nutrition and health needs of specific consumer groups.

Culinary Science

The BSc (Culinary Science) undergraduate programme is a three-year full-time degree programme. Culinary scientists focus on the art and science of food and food preparation.

Career opportunities

BSc (Culinary Science) graduates are employed as culinary scientists, culinologists, sensory analysts, food researchers, food product developers, food service managers, and food safety and quality assurance managers.

Nutrition

The BSc (Nutrition) programme is a three-year full-time degree. Nutrition scientists deal with the human requirements for food and the effects of food on health and well-being.

BSc (Nutrition) is an interfaculty degree programme, jointly presented by Food Science (Faculty of Natural and Agricultural Sciences) and Human Nutrition (Faculty of Health Sciences).

Career opportunities

The need for graduates with training in nutrition is driven by the worldwide recognition of the fact that food does not only meet basic nutritional needs, but also plays a key role in the promotion and maintenance of long-term good health. Career opportunities exist in food or related industries (such as pharmaceutical companies), government departments, international organisations (such as the United Nations Food and Agricultural Organisation (FAO) and the World Health Organisation (WHO)) and research organisations, and as account managers and advisors in the food, health and consumer sectors.

All BSc graduates may register as candidate natural scientists with SACNASP.

'Anyone who knows me knows that I love food and what I like to call 'foodventures'. This, combined with a thirst for knowledge, an interest in chemistry and a curiosity about the science behind food opened the doors to food science. As I am now about to enter into the world of work, I hope to gain experience and become the best food scientist that I can be.

I hope to one day publish a research paper in the field of food chemistry and use my knowledge to make a difference in the daily lives of people. I am happy that I chose to study in a field about which I am passionate.'

Carina Mendes – BSc Hons (Food Science)
Winner of a SAAFoST-sponsored Aubrey Parsons Study Grant and the Pieter van Twisk Academic Achievement Award

Prof Jean Lubuma, Dean: Faculty of Natural and Agricultural Sciences, University of Pretoria and Mr Owen Frisby, SAAFoST Executive Director congratulated Carina Mendes at the Exceptional Achievers Function held at the University of Pretoria on 30 May 2019.

Agricultural and Food Sciences

Plant and Soil Sciences

BScAgric (Applied Plant and Soil Sciences)
BScAgric (Plant Pathology)

Ever-increasing human populations and increased industrialisation exerts pressure on our natural resources. Some of the greatest challenges in developed and developing countries around the world are sustainable food production and soil utilisation, as well as the protection and reclamation of soil and groundwater resources. These challenges can be met through a broad understanding of plant and environmental interactions and insight into chemical, physical and biological processes.

The agricultural component of the Department of Plant and Soil Sciences consists of five broad disciplines: agronomy, horticultural science, soil science, pasture science and forestry science.

The Department of Plant and Soil Sciences is a large department that offers both BSc and BScAgric degrees. (Information about the BSc degree can be found on page 13 of this brochure.)

The Department is dynamic, innovative, modern and relevant. Staff members undertake world-class research and 70% of them have received NRF ratings. Much of the research is of an applied nature and contributes to the improvement of agricultural crops and methods, knowledge of plant diseases, use of plant-derived compounds, biodiversity and plant biotechnology.

Applied Plant and Soil Sciences

The BScAgric (Applied Plant and Soil Sciences) degree is a four-year, full-time programme. Each discipline has specific focus areas, which in many instances involve cross-cutting research projects. Multidisciplinary training, as well as specialisation in agronomy, horticultural science, pasture science and soil science, enables both graduate and postgraduate students to embark on a diverse range of careers in the agricultural and environmental fields.

Students who have successfully completed their undergraduate programmes have the option to register for a one-year honours degree on a full-time basis.

Plant Pathology

Plant pathology is the study of plant diseases. Whereas the medical and veterinary careers focus on human and animal health, the plant pathologist focuses on plant health, which ensures healthy plants and enough food for the increasing global population. The effects of climate change, chemical residues and other toxic substances on plant health are important aspects in plant pathology. Food security and food safety are also important focus areas in modern plant pathology studies.

Cutting-edge technologies, such as molecular biology, are applied in plant pathological research, for example to study phytobiomes and the interactions between micro-organisms and plants. Plant pathology is indeed the field of study of the future and integrates various subject disciplines, such as biotechnology, microbiology, molecular biology, genetics, plant science and food science.

The undergraduate and postgraduate programmes focus on the study of organisms that cause diseases, how plants are affected by diseases and how plant diseases can be controlled.

Postgraduate students can specialise in areas such as postharvest pathology, food safety and plant protection.

During the first two years of the BScAgric (Plant Pathology) degree, students are exposed to a range of subjects in agricultural and biological sciences that include the more fundamental subjects such as biochemistry, genetics and biotechnology, as well as the more applied subjects in agriculture.

Specialisation occurs in the second year. Students take subjects in plant biotechnology, microbiology, genetics, plant production, entomology and plant pathology. During the third year, they study plant diseases directly and visit various production systems, businesses and farms where they observe plant protection in action. This takes place during field excursions and holiday work. In the final year of study, students complete a research project and a number of theory modules.

Postgraduate studies in this programme include honours, master's and doctoral degrees. At the master's and doctoral levels, students are expected to complete a research project in one of the research areas in the Department.

The Department offers the following postgraduate programmes:
- BScAgricHons (Crop Science)
- BScHons (Environmental Soil Science)
- MScAgric (Agronomy), MScAgric (Horticulture),
- MScAgric (Pasture Science), MScAgric (Soil Science)
- MSc (Soil Science), MSc (Biotechnology), MSc (Forest Science), MSc (Forest Management and the Environment)
- PhD (Agronomy), PhD (Horticulture), PhD (Pasture Science),
- PhD (Soil Science), PhD (Forest Science), PhD (Biotechnology)

Career opportunities

Graduates from the various disciplines of the Department of Plant and Soil Sciences have the following career opportunities:
- **Education and training:** Graduates can work at universities, colleges and schools.
- **Plant pathologists:** Graduates are in demand in various industries. Careers range from researchers to practitioners who work in laboratories, on commercial farms (which includes fieldwork) or in the food trade industry.
- **Research and management:** Graduates are also hired at research institutes, government departments, seed, fertiliser and agro-chemical companies, municipalities and in the mining industry.
- **Extension services for technology transfer:** Grower associations, national and provincial Departments of Agriculture, Forestry and Fisheries, Environmental Affairs, Tourism, Mineral Resources, Energy, and Water Affairs and Sanitation also hire graduates.
- **Entrepreneurial:** Graduates can work as consultants or in production.

Physical Sciences

Chemistry

BSc (Chemistry)

Everything around us involves chemistry. Chemists recognise the major role science plays in supporting modern lifestyles. Chemistry is responsible for many aspects of our lives: the clothes we wear are made from synthetic fabrics produced by chemical processes; the drugs used for curing many illnesses are the result of intensive chemical research; a chemical process produces the paper we write on, and the ink we write with is a mixture of many chemicals. Chemistry assures the quality of the food we eat, the air we breathe and the water we drink. Our bodies are a complex mixture of chemicals, and the principles of chemistry are fundamental to understanding the processes involved in the functioning of all living organisms and the development of new medications and materials. It is the interaction and collaboration of chemistry with the other sciences and engineering that meet the ever-increasing demands of a modern society.

Chemistry has been described as the central science as its impact on our lives and society is all-pervasive. Since 1901, the Nobel Prize for Chemistry has been awarded to 153 individuals for work covering all aspects of the chemical sciences. The concepts of sustainable growth, including the reduction of carbon emissions, renewable fuels, secure food and fresh water supplies, recycled materials, environmentally responsible manufacture and waste disposal are all firmly embedded in chemical expertise. Chemistry is also at the heart of cutting-edge research in the fields of biotechnology, nanotechnology and new materials required for faster computers and improved solar voltaic cells.

Description of the programme

This programme focuses on the fundamental aspects of the discipline and aims to provide students with a thorough background in the chemical sciences. Undergraduate training in this programme provides an opportunity to combine chemistry with other fields of interest, such as physics, geology, mathematics and computer science, or subjects from the biological sciences, such as biochemistry, microbiology and botany. In the first year of study, students are introduced to chemistry. This is followed by a more in-depth study of analytical, inorganic, organic and physical chemistry in the second and third years. All the subjects taught in this programme have theoretical and practical components.

First-year modules in mathematics and physics are compulsory for the BSc (Chemistry) degree. More advanced modules in mathematics and programming are recommended for students who want to pursue postgraduate studies in the computer modelling of molecules, materials or processes.

Postgraduate degrees in chemistry-based programmes are research oriented. The one-year honours degree consists of advanced modules in analytical, organic, inorganic and physical chemistry and includes two practical projects undertaken with departmental research teams of the student's choice. MSc and PhD studies involve research projects in the specialised fields of organic and organometallic synthesis, electrochemistry, nanotechnology, computer modelling of compounds and materials, chemical education and separation science, with the emphasis on industrial, environmental, food, forensic and clinical applications. Experienced research leaders and excellent research facilities are available to expand the international research profile of the Department and expose students to the frontiers of research in their field of choice.

Career opportunities

Graduates are employed in most technology-based institutions and work in the laboratories of industrial, research or academic institutions. A chemist must be able to participate in teamwork in a multidisciplinary environment in a wide variety of enterprises in both the private and public sectors. It is important to note that the type of work available in chemistry depends on the level of the qualification obtained.

Advanced qualifications will eventually lead to positions in research and/or production management and require management and financial planning skills. Many career opportunities are found in the fields of education, research, journalism, environmental protection, food and beverages, energy, water, health, sport, pharmaceutics and cosmetics, geology, mining and law enforcement. These include the well-known professions of synthetic chemist, materials scientist, chemical pathologist, forensic chemist, analytical chemist, drug analyst, patent lawyer, environmental chemist, geochemist, food chemist, polymer chemist and soil chemist.

Geology

BSc (Geology)

Geology is the scientific study of the dynamic system of the earth and includes the atmosphere, hydrosphere, lithosphere and biosphere. The study of geology integrates the principles of physics and chemistry, as well as mathematics and biology, in studying the history and processes of the earth. The ever-growing human population continuously exerts pressure on natural resources, such as water, energy, mineral deposits and building materials that are required to meet the basic needs of humankind.

Description of the programme

This is a full-time, three-year programme that consists of both practical and theoretical components and leads to different fields of specialisation, such as mineralogy, igneous petrology, metamorphic petrology, sedimentology, engineering geology, geochemistry, hydrogeology, economic geology, structural geology, as well as geophysics and geostatistics. Studies are practical and require extensive work in field camps, in areas that are often difficult to access, and in both underground and surface mining operations. Students who have successfully completed their undergraduate programmes have the option to register for an honours degree in geology, engineering geology or hydrogeology. The honours degree is a one-year, full-time programme and serves as the minimum requirement for employment and for practising as a professional geologist.

The Department offers two major undergraduate programmes: BSc (Geology) and BSc (Engineering Geology and Hydrogeology).

Geology

Undergraduate studies cover diverse topics that are of importance to our daily life and promote the general well-being of our society. This includes the study of minerals and rocks, mineral and energy resources (eg iron, gold, coal, oil and gas), surface water reservoirs (eg rivers, beaches, lakes and glaciers), groundwater, volcanoes, earthquakes, plate tectonics, global climate change and the evolution of life. Geologists investigate the earth's history of 4.5 billion years to find new resources and to better understand the past, present and future development of the planet.

Physical Sciences

Engineering Geology and Hydrogeology

Engineering geology is the study of geological structures, as well as soil and rock properties at construction sites (such as dams, tunnels, mines, roads, buildings and stadiums) in order to provide accurate information prior to the erection of such structures.

Hydrogeology is the study of water in the subsurface and focuses on groundwater and soil moisture, for example water quality (pollution, mine water), quantity for abstraction and the influence of water on engineering projects.

Career opportunities

The honours degree is generally a minimum requirement for permanent and successful employment in industry and government. Independent consultation mostly requires a master's or doctoral degree and professional recognition.

Geologists are involved in fieldwork, laboratory work, office work, and computer modelling based on GIS, and require written and/or oral reports on the completed task. Employment is often offered by small exploration and larger mining companies, as well as government, independent research laboratories, universities and other tertiary educational institutions. In general, geologists can work as environmentalists, mineralogists, geochemists, and exploration geologists. They can also work in the mines (as production geologists), in the ocean (as marine geologists), in computer laboratories (working with databases, GIS and three-dimensional modelling) and as independent consultants.

Engineering geologists are employed by organisations such as the Council for Geosciences, the CSIR and mining companies, usually in the rock mechanics departments of these organisations. Consulting civil engineering firms design dams, tunnels, roads, bridges, railway lines and industry- or infrastructure-related slopes. Graduates may operate their own consulting practices where general site investigations for urban development and infrastructure construction will comprise a large part of their work.

Hydrogeologists are employed by the government (Department of Water Affairs and Sanitation), the Council for Geosciences, the CSIR, mining companies and consulting practices. The four major focus areas are water resource evaluation, groundwater resource development, modelling mine water and contaminant transport problems. Consulting hydrogeologists are typically involved in water supply, groundwater quality, monitoring and remediation, and water licence applications.

Geography, Geoinformatics and Meteorology

BSc (Geography and Environmental Sciences)
BSc (Geoinformatics)
BSc (Meteorology)

Geography and Environmental Sciences

Geography, as a bridging science, is the link between the natural and human components of our environment. Location and spatial distribution of settlements and other human activities, such as agriculture and tourism, as well as the processes, patterns, problems and potential answers associated with these activities, are also studied. Geography is a planning and management science aimed at improving the quality of life of all communities.

Description of the programme

Both the BSc (Geography) and BSc (Environmental Sciences) programmes comprise fundamental modules that develop general skills. Training in spatial analytical techniques includes GIS and remote sensing, and enables graduates to analyse complex environmental issues. Students can also select modules from other disciplines.

The BSc (Environmental Sciences) programme studies the multitude of interactions between the living (including humans) and non-living components of the earth. As a result of an increase in the human population and technological advances, our impressions of the environment have become more widespread and create complex, multidisciplinary challenges, for example the impact on ecosystems, natural resources, human health and well-being.

Career opportunities

Geographers and environmental scientists' main career fields are in education, research and the practical application of geographical knowledge and skills.

Graduates are employed by private companies, such as TomTom South Africa, the Environmental Systems Research Institute (ESRI) South Africa, the CSIR, banks, tourism industries and other environmental conservation bodies. Geographers' holistic training makes them highly sought after for policymaking and developing strategies on many managerial levels by government departments such as Agriculture, Forestry and Fisheries, Water Affairs and Sanitation, Environmental Affairs, Statistics South Africa (StatsSA) and the South African National Space Agency (SANSA), as well as by municipalities. Many geographers and environmental scientists are self-employed in areas such as environmental planning, analysis, risk and impact assessment, environmental auditing, marketing, development, tourism, cartography and GIS, and remote sensing. A master's or doctoral degree is essential to pursue an academic career in this field.

Geoinformatics

Geoinformatics or Geoinformation Science integrates elements of various disciplines dealing with geographical data, such as geography, cartography, computer science, geodesy, mathematics, remote sensing and statistics. Geoinformatics can measure and supply information on how one's behaviour impacts on one's immediate environment, as well as how the environment influences one's well-being.

Description of the programme

Two study options are available at the undergraduate level. The BSc (Geoinformatics) degree focuses on general geographic information science with geographical thinking and spatial analysis at the core, while the BSc (Information and Knowledge Systems) degree focuses on computer science in GIS applications. More information can be obtained at www.up.ac.za/ebit. Students obtain theoretical knowledge and practical skills in the collection, storage, processing, analysis and visualisation of geographic information, as well as in the applications that use geographic information to solve social and environmental problems. Graduates are trained to identify needs and apply problem-solving processes.

Career opportunities

After the successful completion of the BSc (Geoinformatics) degree, graduates can apply for professional registration as GISc technologists with the South African Geomatics Council (SAGC).

Physical Sciences

With appropriate work experience (work-integrated learning) and law examinations, graduates can apply for registration as candidate GISc practitioners with a view to becoming registered professional GISc practitioners.

Graduates with a BSc (Geoinformatics) degree readily find work with GIS vendors (ESRI or Intergraph) or organisations such as the CSIR, GIS consultants (AfriGIS, GeoTerra Image, GISCOE), civil engineering consultants (Aurecon, SSI), SANSA, South Africa's National Mapping and National Geospatial Information (NGI) or any municipality in the country. Many government departments, such as Environmental Affairs, Science and Technology, Rural Development and Land Reform, Water Affairs and Sanitation, and Statistics South Africa, also employ GISc professionals.

Meteorology

Weather and climate are extremely important in people's lives as they can affect many of our daily activities, such as agriculture, sports, travel and tourism. In the long term, they may even determine whether humankind survives or not. There is increasing concern that human activities may irreversibly change the earth's weather and climate. Serious concerns are also expressed regarding the effects of air pollution. Meteorologists and atmospheric scientists are interested in understanding how the physics and dynamics of the atmosphere work.

Description of the programme

Undergraduate modules include physics and calculus, atmospheric structures and processes, the South African climate and weather patterns, physical meteorology, remote sensing, geographic data analysis, dynamic meteorology, vector analysis and a weather forecasting module. The practical component is presented by a professional meteorologist using specialised software. Additional electives can be chosen from mathematics and applied mathematics, physics, statistics, chemistry, computer science, geography and geology.

Career opportunities

Meteorologists are employed by institutions involved in the study, interpretation and prediction of weather and phenomena relating to the climate. SAWS, the CSIR, some universities, agricultural institutions, municipalities and industries employ meteorologists who practise as specialists in mainly the following areas:

- **Researchers:** All aspects of weather and climate are researched to improve our understanding of atmospheric phenomena. Atmospheric modellers use supercomputers to simplify and solve complex flow dynamic equations of the atmosphere. Air quality and the effect of air pollution on society is constantly monitored, and the impact of climate change receives increasing attention.
- **Weather forecasters:** They analyse data and predict the weather by using models run on supercomputers. Weather forecasts are issued on different time scales, from very short-range forecasting to forecasts that are valid for months ahead, as well as seasonal forecasts. Some private positions, such as presenting the weather forecast on television, are available.
- **Climatologists:** They manage important data sets that contain large volumes of information gathered by SAWS and other organisations.
- **Meteorologists:** They work as consultants in the private sector and at universities to provide specialised research services.
- **Academic positions:** These are available at some South African universities for candidates who have completed a master's or doctoral degree in Meteorology. Academics ensure that the training of meteorologists meets international standards.

Physics

BSc (Physics)

Physics is the study of the laws of nature. Its principles form the foundation of all the basic sciences, such as astronomy, biology, chemistry and geology. Physics also forms the foundation of applied science and engineering, which led to major technological developments from the horse-drawn cart to the supersonic jet, from the candle to the laser, from smoke signals to satellite transmission.

Description of the programme

Physics students will develop their creativity, inventiveness and problem-solving abilities, which will enable them to advance to management positions at all levels of industry.

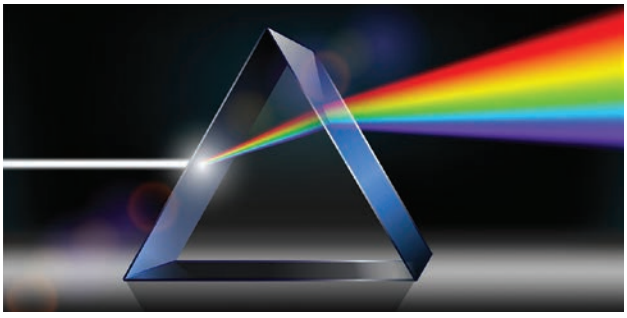
Physicists is the Department of Physics are trained in a wide range of sub-disciplines, such as astronomy, biophysics, theoretical physics, materials science and physics education. Materials are studied for nuclear applications and their properties are investigated during irradiation. Materials for solar cells and opto-electronic equipment, as well as carbon-based magnetic systems, are also investigated. Furthermore, active studies are undertaken in biophysics, astronomy, mathematical physics, high-energy theory, quantum theory (resonances and information theory), solid-state physics, incorporating computational physics and the effect of symmetries. The Department has a high international standing and many international collaborators.

The useful and transferable skills that students learn in experimental, theoretical and computational physics enable them to become competent physicists. They can also use their skills in a variety of career options outside of academia, for example in commerce and industry.

Career opportunities

Graduates can work as academics at universities, where their duties include lecturing, research and the supervision of postgraduate students. They can also work as researchers in national laboratories, such as the Nuclear Energy Corporation of South-Africa (NECSA), the South African Astronomical Observatory and iThemba LABS (Laboratory for Accelerator-based Sciences).

Graduates can become researchers in industry, for instance at the CSIR or Element Six, or science advisors for non-governmental organisations, industry or government. They can also work as radiation scientists, medical researchers and biophysicists, atmospheric scientists and climatologists, developers of renewable energy sources, geophysicists, innovators and entrepreneurs, and computational scientists. For more information, please visit the Department of Physics website at www.up.ac.za/physics.



Mathematical Sciences

Actuarial Science

BSc (Actuarial Science)

The Department of Actuarial Science is extremely proud of its alumni. Former students occupy the highest positions in the insurance and investment world, not only in South Africa, but also abroad. We strive to keep our programme competitive and to make it possible for our students to leave the University with a number of exemptions from the examinations of the Actuarial Society of South Africa (ASSA). Our lecturers include highly skilled academics who serve on various ASSA committees.

Description of the programme

Developments in the modern financial industry have led to a rapidly changing financial world. These changes create a growing need for graduates who are thoroughly skilled in the financial models and quantitative techniques that are used in modern actuarial and financial mathematical applications. Throughout their three years of study, students who are enrolled for a BSc (Actuarial and Financial Mathematics) degree can choose between an actuarial or a financial mathematics option for their coursework. The programme provides students with a broad education that will serve them beyond what is usually expected of a graduate in these fields.

The actuarial programme is structured to provide the aspiring actuary with the opportunity to comply with the requirements for exemption from the ASSA examinations in the shortest possible time. In order to achieve the maximum exemptions, a follow-up honours degree is recommended. Students who elect not to complete the follow-up course will be well equipped to enter the financial services industry or apply for a host of other postgraduate degree options.

For aspiring financial analysts or engineers, the programme provides depth and develops the student's ability to design and analyse financial products. The analytical techniques that are essential for modelling the stochastic behaviour of financial processes and analysing the resulting effects on investment portfolios are studied.

Career opportunities

Many actuaries follow careers in the more traditional fields of insurance and retirement funds. However, actuaries are also making headway in other fields due to the recognition they are earning for their unique analytical skills. This includes health care, financial consulting, risk management and banking. Because of their unique skills, many actuaries are appointed to senior management positions after their initial role in solving problems by using mathematical and statistical calculations and models.

Financial engineers can be employed by banks and financial institutions, brokerage firms and investment institutions. They are essential in portfolio and risk management. Activities include asset management (trading in bonds, futures and derivative instruments such as options), designing new financial products and devising strategies to control credit risk.

Mathematics and Applied Mathematics

BSc (Mathematics)
BSc (Applied Mathematics)

Mathematics, which originated from arithmetic and geometry, is about pattern and structure and is the language of science and technology. Applied mathematics is concerned with the modelling and treatment of real-life problems in a variety of fields, such as engineering, finance, statistics, physics and biology. The power of mathematics and applied mathematics lies in their abstract, analytical and computational nature. Nowadays, mathematics is essential for all technological, financial and managerial industries that form the backbone of the South African economy.

The Department of Mathematics and Applied Mathematics is not only one of the largest departments on the Hatfield Campus, but also one of the largest mathematics departments in the country, with approximately 19 500 student enrolments for mathematics modules. The Department prides itself on excelling in both teaching and research, as well as in community-based activities.

The diverse and competent staff complement has expertise in various fields. Researchers regularly travel abroad to attend

'Why I am studying Mathematics? One of my main reasons for studying Mathematics is probably the South African Mathematics Olympiad. In high school, when I participated in the Olympiad for the first time, I felt quite challenged. Fortunately I had the opportunity to attend a mathematics camp at the end of Grade 9, and it was there that I discovered the beauty of mathematics in its purest form: wild and free, waiting to be explored and tamed. The result was that I continued to spend a lot of time doing maths and now find myself studying mathematics at UP. Mathematics is something I thoroughly enjoy as it affords me the freedom to reason independently, the excitement of solving seemingly impossible problems and the satisfaction of deriving an elegant relation! This is the reward for long hours spent puzzling over proofs, trying all possible routes that might yield at least a useful lemma. It is because I believe that God created mathematics to reflect the beauty of nature that I am passionate about this subject and determined to explore it to the fullest extent'

James Louw – BSc (Mathematical Sciences)
Best first-year student in the Faculty, 2018

Mathematical Sciences

conferences and to pay research visits. The Department has 29 researchers who have received NRF ratings in fields ranging from the more traditional abstract analysis to contemporary epidemiology, where the modelling of biological phenomena leads to exciting options. The Department regularly hosts international visitors.

A degree in mathematics trains students to apply, evaluate and adapt existing problem-solving techniques, or to develop new mathematical models and techniques to solve problems stemming from natural, technological and financial phenomena.

The Department offers two undergraduate programmes: BSc (Mathematics) and BSc (Applied Mathematics).

Description of the programmes

- **BSc (Mathematics):** Compulsory subjects are analysis, abstract algebra, geometry (third-year level), calculus, linear algebra, differential equations, discrete structures (second-year level), mathematical modelling, mathematical statistics, numerical analysis and dynamical processes (first-year level).
- **BSc (Applied Mathematics):** Compulsory subjects are analysis, continuum mechanics, numerical analysis, partial differential equations, dynamical systems (third-year level), calculus, linear algebra, discrete structures, differential equations (second-year level), mathematical modelling, mathematical statistics and dynamical processes (first-year level).

Career opportunities

Graduates in Mathematics and Applied Mathematics are employed by research institutions, educational bodies (universities and schools), the public sector (government and medical institutions) and the private sector (engineering companies, financial institutions and the computer industry). The training of these graduates in abstract, analytical and computational thinking provides them with the background required to easily adjust to changing circumstances in the professional environment and to construct mathematical models of natural, technological and financial phenomena. Mathematicians and applied mathematicians apply, evaluate and adapt existing problem-solving techniques or develop new techniques to solve those problems.

Statistics

BSc (Mathematical Statistics)

Statistics is the science of collecting, analysing and summarising data. It involves computer programming skills, mathematical thinking and the ability to make sense of information. Statisticians are needed by people in many professions, such as actuaries, economists, biologists, engineers and marketing executives.

It has been said that statistics makes information matter. We say: 'Statistics is the app for everything!'

Students are expected to have a knack for problem-solving, with special emphasis on numerical interests and software programming abilities. Verbal and written communication skills are of the utmost importance in this field. Since statistics is a scarce-skill profession, it offers endless job opportunities and true career satisfaction achieved by solving real-life problems.

Description of the programme

The BSc (Mathematical Statistics) programme is offered to full-time students over a period of three years. Students who have successfully completed the undergraduate programme have the option to register for an honours degree in Mathematical Statistics. Master's and doctoral degrees can be subsequently obtained.

Career opportunities

- Large companies require statisticians and data scientists to make sense of large sets of consumer information, to increase their annual revenue and to make informed decisions about their consumers.
- Google Analytics use statistics to track internet users to generate leads for their recommended engines.
- Movement information captured by cell phones is used by statistical predictive models to predict traffic congestion and suggest less congested routes.
- Statisticians make use of statistical methodologies to detect fraud, assist with credit-related portfolios and forecast financial economic trends.
- Health insurance companies employ statisticians to study lifestyle behaviour to improve health care plans in South Africa.
- Retail companies study customer satisfaction and customer experience using statistical models.
- Spatial statistics can provide useful information about climate changes, crime hotspots and rhino-poaching geographical maps.
- Statisticians advise animal scientists on factors affecting animal nutrition and genetic breeding models.
- Government employs statisticians to understand how population demographics, health risks and other factors influence sustainable development programmes.

Community engagement initiatives

Sci-Enza

Sci-Enza (previously known as the Exploratorium) is a science centre where the general public, mostly groups of learners, can discover aspects of science and technology. A variety of interactive exhibits in physics, plant science, zoology, mathematics and engineering are available. Organised groups visiting the centre are given a science show, as well as a guided tour of the botanical garden and a visit to the Camera Obscura on the Hatfield Campus. A reading corner containing popular scientific books, magazines and video facilities can be used by visitors. Sci-Enza is open during office hours on weekdays.

Please contact +27 (0)12 420 2865/3767 for more information; or to make an appointment.

Article

Master's student in Horticulture off to Australia

Prof Elsa du Toit (left) and Ms Elmien Coetser (right)

Ms Elmien Coetser, an MSc Agric (Horticulture) candidate at the University of Pretoria (UP) has been chosen by the delegates at the recent International Plant Propagator's Society (IPPS) Southern Africa Region's Annual Conference to go to Australia on the Australia/Southern Africa student exchange programme in May 2019.

'I am extremely grateful to my supervisor, Prof Elsa du Toit, who nominated me, and to the IPPS members who chose me for this exchange programme. This will mean a lot to me in terms of career development as well as being an amazing travelling opportunity. I will be visiting many nurseries and botanical institutions in Australia, as well as attending the combined Australia and New Zealand International IPPS Conference. From this tour I will be able to learn new techniques of plant propagation, as well as managing a business in plant propagation,' Ms Coetser said.

She added that she is excited about the opportunity to meet delegates from across the globe, including the USA, New Zeeland, India, Belgium, the UK, Australia and China, who are professionals of all kinds in the plant propagation industry. 'This is a valuable networking opportunity where I can make new connections and even improve on my people skills. I am truly honoured to be chosen and I hope that I can bring back valuable skills and information to use here in South Africa.'

Ms Coetser's research project for her master's degree is on tissue culture of Moringa oleifera and she is supervised by Prof Elsa du Toit from the Department of Plant and Soil Sciences. She assists as a demonstrator and help for certain Horticultural Sciences subjects and works as a part-time technical assistant at Du Prins Wholesale Nursery, where she is showing potential in her work on plant propagation. Ms Coetser is also a member of the Golden Key International Honour Society since 2015 and was on the Faculty of Natural and Agricultural Sciences' Dean's Merit List of Exceptional Academic Achievers for 2014.

She also had great praise for the UP with Science Programme*. 'It was a wonderful programme that played a large role in inspiring me to go into natural sciences after school. This programme showed us that science is very broad and very exciting and that you don't need to be a 'Sheldon' to become a scientist. They made science so much fun and got me excited to study.'

In school she never fully realised what options there were in natural sciences, especially in botany, which was her major interest, because it seemed that most people were interested in becoming a doctor, an engineer, a teacher or a lawyer.

'UP with Science inspired me to do well in my subjects at school and made me think about science in real life differently. The programme provided me with a bursary to do a BSc degree at UP. At university, this background allowed me to see that all aspects of nature are a part of science. I am now very proud to have my degree in plant and soil sciences.'

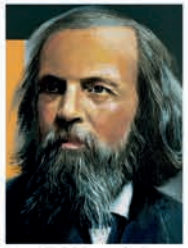
The IPPS is a global network of plant production professionals, including those involved in horticultural research and education. IPPS aims to improve the knowledge, skills and professionalism of its members.

* The UP with Science Programme was a science enrichment programme for high school learners presented by UP from 1998 to 2016.

Faculty of Natural and Agricultural Sciences
Fakulteit Natuur- en Landbouwetenskappe
Lefapha la Disaense tša Tlhago le Temo

Periodic Table of the Elements

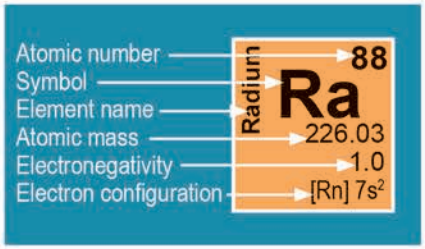
- **Pink** *(left)*: the **s** block elements (consisting: hydrogen, alkali metals, alkaline earth metals).
- **Blue** *(middle)*: the **d** block elements (they are the transition metals).
- **Yellow** *(right)*: the **p** block elements (consisting:some metals, metalloids, non-metals, noble gases, and halogens).
- **Peach** *(two rows at the bottom)*: the **f** block elements (they are the inner transition elements, consisting of actinides and lanthanides).
- **Symbols** printed in **solid black:** solids at 25˚C.
- **Symbols** printed in **white with outline:** gases at 25˚C.
- **Symbols** printed in **grey with outline:** liquids at 25˚C.



Dmitri Mendeleev

1 Ia	2 IIa	3 IIIb	4 IVb	5 Vb	6 VIb	7 VIIb	8 VIIIb	9 VIIIb	10 VIIIb	11 Ib	12 IIb	13 IIIa	14 IVa	15 Va	16 VIa	17 VIIa	18 VIIIa
Hydrogen **H** 1 1.0079 2.2 $1s^1$																	Helium **He** 2 4.0026 $1s^2$
Lithium **Li** 3 6.941 1.0 $[He]\ 2s^1$	Beryllium **Be** 4 9.0122 1.5 $[He]\ 2s^2$											Boron **B** 5 10.811 2.0 $[He]\ 2s^2\ 2p^1$	Carbon **C** 6 12.011 2.5 $[He]\ 2s^2\ 2p^2$	Nitrogen **N** 7 14.007 3.1 $[He]\ 2s^2\ 2p^3$	Oxygen **O** 8 15.999 3.5 $[He]\ 2s^2\ 2p^4$	Fluorine **F** 18.998 4.1 $[He]\ 2s^2\ 2p^5$	Neon **Ne** 10 20.18 $[He]\ 2s^2\ 2p^6$
Sodium **Na** 11 22.990 1.0 $[Ne]\ 3s^1$	Magnesium **Mg** 12 24.305 1.2 $[Ne]\ 3s^2$											Aluminium **Al** 13 26.982 1.5 $[Ne]\ 3s^2\ 3p^1$	Silicon **Si** 14 28.086 1.7 $[Ne]\ 3s^2\ 3p^2$	Phosphorus **P** 15 30.974 2.1 $[Ne]\ 3s^2\ 3p^3$	Sulphur **S** 16 32.066 2.4 $[Ne]\ 3s^2\ 3p^4$	Chlorine **Cl** 17 35.453 2.8 $[Ne]\ 3s^2\ 3p^5$	Argon **Ar** 18 39.948 $[Ne]\ 3s^2\ 3p^6$
Potassium **K** 19 39.098 0.9 $[Ar]\ 4s^1$	Calcium **Ca** 20 40.078 1.0 $[Ar]\ 4s^2$	Scandium **Sc** 21 44.956 1.2 $[Ar]\ 3d^1\ 4s^2$	Titanium **Ti** 22 47.88 1.3 $[Ar]\ 3d^2\ 4s^2$	Vanadium **V** 23 50.942 1.5 $[Ar]\ 3d^3\ 4s^2$	Chromium **Cr** 24 51.996 1.6 $[Ar]\ 3d^5\ 4s^1$	Manganese **Mn** 25 54.938 1.6 $[Ar]\ 3d^5\ 4s^2$	Iron **Fe** 26 55.845 1.6 $[Ar]\ 3d^6\ 4s^2$	Cobalt **Co** 27 58.933 1.7 $[Ar]\ 3d^7\ 4s^2$	Nickel **Ni** 28 58.693 1.8 $[Ar]\ 3d^8\ 4s^2$	Copper **Cu** 29 63.546 1.8 $[Ar]\ 3d^{10}\ 4s^1$	Zinc **Zn** 30 65.41 1.7 $[Ar]\ 3d^{10}\ 4s^2$	Gallium **Ga** 31 69.723 1.8 $[Ar]\ 3d^{10}4s^2\ 4p^1$	Germanium **Ge** 32 72.64 2.0 $[Ar]\ 3d^{10}4s^2\ 4p^2$	Arsenic **As** 33 74.922 2.2 $[Ar]\ 3d^{10}4s^2\ 4p^3$	Selenium **Se** 34 78.96 2.5 $[Ar]\ 4d^{10}4s^2\ 4p^4$	Bromine **Br** 35 79.904 2.7 $[Ar]\ 3d^{10}\ 4s^2\ 4p^5$	Krypton **Kr** 36 83.8 $[Ar]\ 3d^{10}\ 4s^2\ 4p^6$
Rubidium **Rb** 37 85.468 0.9 $[Kr]\ 5s^1$	Strontium **Sr** 38 87.62 1.0 $[Kr]\ 5s^2$	Yttrium **Y** 39 88.906 1.1 $[Kr]\ 4d^1\ 5s^2$	Zirconium **Zr** 40 91.2245 1.2 $[Kr]\ 4d^2\ 5s^2$	Niobium **Nb** 41 92.906 1.2 $[Kr]\ 4d^4\ 5s^1$	Molybdenum **Mo** 42 95.94 1.3 $[Kr]\ 4d^5\ 5s^1$	Technetium **Tc** 43 98.906 1.4 $[Kr]\ 4d^6\ 5s^1$	Ruthenium **Ru** 44 101.07 1.4 $[Kr]\ 4d^7\ 5s^1$	Rhodium **Rh** 45 102.91 1.5 $[Kr]\ 4d^8\ 5s^1$	Palladium **Pd** 46 106.42 1.4 $[Kr]\ 4d^{10}$	Silver **Ag** 47 107.87 1.4 $[Kr]\ 4d^{10}\ 5s^1$	Cadmium **Cd** 48 112.41 1.5 $[Kr]\ 4d^{10}\ 5s^2$	Indium **In** 49 114.82 1.5 $[Kr]\ 4d^{10}5s^2\ 5p^1$	Tin **Sn** 50 118.71 1.7 $[Kr]\ 4d^{10}5s^2\ 5p^2$	Antimony **Sb** 51 121.76 1.8 $[Kr]\ 4d^{10}\ 5s^2\ 5p^3$	Tellurium **Te** 52 127.6 2.0 $[Kr]\ 4d^{10}\ 5s^2\ 5p^4$	Iodine **I** 53 126.904 2.2 $[Kr]\ 4d^{10}\ 5s^2\ 5p^5$	Xenon **Xe** 54 131.29 $[Kr]\ 4d^{10}\ 5s^2\ 5p^6$
Caesium **Cs** 55 132.91 0.9 $[Xe]\ 6s^1$	Barium **Ba** 56 137.33 1.0 $[Xe]\ 6s^2$	Lanthanum **La** 57 138.91 1.1 $[Xe]\ 5d^1\ 6s^1$	Hafnium **Hf** 72 178.49 1.2 $[Xe]\ 4f^{14}\ 5d^2\ 6s^2$	Tantalum **Ta** 73 180.95 1.3 $[Xe]\ 4f^{14}\ 5d^3\ 6s^2$	Tungsten **W** 74 183.84 1.4 $[Xe]\ 4f^{14}\ 5d^4\ 6s^2$	Rhenium **Re** 75 186.21 1.5 $[Xe]\ 4f^{14}\ 5d^5\ 6s^2$	Osmium **Os** 76 190.23 1.5 $[Xe]\ 4f^{14}\ 5d^6\ 6s^2$	Iridium **Ir** 77 192.22 1.6 $[Xe]\ 4f^{14}\ 5d^7\ 6s^2$	Platinum **Pt** 78 195.08 1.4 $[Xe]\ 4f^{14}\ 5d^9\ 6s^1$	Gold **Au** 79 196.97 1.4 $[Xe]\ 4f^{14}\ 5d^{10}\ 6s^1$	Mercury **Hg** 80 200.59 1.5 $[Xe]\ 4f^{14}\ 5d^{10}\ 6s^2$	Thallium **Tl** 81 204.38 1.4 $[Xe]\ 4f^{14}5d^{10}6s^2 6p^1$	Lead **Pb** 82 207.20 1.6 $[Xe]\ 4f^{14}5d^{10}6s^2 6p^2$	Bismuth **Bi** 83 208.98 1.7 $[Xe]4f^{14}5d^{10}6s^2 6p^3$	Polonium **Po** 84 208.98 1.8 $[Xe]\ 4f^{14}5d^{10}6s^2 6p^4$	Astatine **At** 85 210 2.0 $[Xe]\ 4f^{14}5d^{10}6s^2 6p^5$	Radon **Rn** 86 222.02 $[Xe]\ 4f^{14}5d^{10}6s^2 6p^6$
Francium **Fr** 87 223.02 0.9 $[Rn]\ 7s^1$	Radium **Ra** 88 226.03 1.0 $[Rn]\ 7s^2$	Actinium **Ac** 89 227.03 1.0 $[Rn]6d^1 7s^2$	Rutherfordium **Rf** 104 261.11	Dubnium **Db** 105 262.11	Seaborgium **Sg** 106 266	Bohrium **Bh** 107 264	Hassium **Hs** 108 277	Meitnerium **Mt** 109 268	Darmstadtium **Ds** 110 271	Roentgenium **Rg** 111 272	Copernicium **Cn** 112 285	Nihonium **Nh** 113 286	Flerovium **Fl** 114 289	Moscovium **Mc** 115 289	Livermorium **Lv** 116 293	Tennesine **Ts** 117 294	Organesson **Og** 118 294

Cerium **Ce** 58 140.12 1.1 $[Xe]\ 4f^2\ 6s^2$	Praseodymium **Pr** 59 140.91 1.1 $[Xe]\ 4f^3\ 6s^2$	Neodymium **Nd** 60 144.24 1.1 $[Xe]\ 4f^4 6s^2$	Promethium **Pm** 61 146.92 1.1 $[Xe]\ 4f^5 6s^2$	Samarium **Sm** 62 150.36 1.1 $[Xe]\ 4f^6 6s^2$	Europium **Eu** 63 151.96 1.0 $[Xe]\ 4f^7 6s^2$	Gadolinium **Gd** 64 157.25 1.1 $[Xe]\ 4f^7\ 5d^1 6s^2$	Terbium **Tb** 65 158.93 1.1 $[Xe]\ 4f^9 6s^2$	Dysprosium **Dy** 66 162.50 1.1 $[Xe]\ 4f^{10}\ 6s^2$	Holmium **Ho** 67 164.93 1.1 $[Xe]\ 4f^{11} 6s^2$	Erbium **Er** 68 167.26 1.1 $[Xe]\ 4f^{12} 6s^2$	Thulium **Tm** 69 168.93 1.1 $[Xe]\ 4f^{13} 6s^2$	Ytterbium **Yb** 70 173.04 1.1 $[Xe]\ 4f^{14} 6s^2$	Lutetium **Lu** 71 174.97 1.1 $[Xe]\ 4f^{14} 5d^1 6s^2$
Thorium **Th** 90 232.04 1.1 $[Rn]\ 6d^2\ 7s^2$	Protactinium **Pa** 91 231.04 1.1 $[Rn]\ 5f^2 6d^1 7s^2$	Uranium **U** 92 238.03 1.2 $[Rn]\ 5f^3 6d^1 7s^2$	Neptunium **Np** 93 237.05 1.2 $[Rn]\ 5f^4\ 6d^1\ 7s^2$	Plutonium **Pu** 94 244.08 1.2 $[Rn]\ 5f^6\ 7s^2$	Americium **Am** 95 244.06 1.2 $[Rn]\ 5f^7\ 7s^2$	Curium **Cm** 96 247.07 1.2 $[Rn]\ 5f^7\ 6d^1\ 7s^2$	Berkelium **Bk** 97 247.07 1.2 $[Rn]\ 5f^9\ 7s^2$	Californium **Cf** 98 251.08 1.2 $[Rn]\ 5f^{10}\ 7s^2$	Einsteinium **Es** 99 252.08 1.2 $[Rn]\ 5f^{11}\ 7s^2$	Fermium **Fm** 100 257.10 1.2 $[Rn]\ 5f^{12}\ 7s^2$	Mendelevium **Md** 101 258.10 1.2 $[Rn]\ 5f^{13}\ 7s^2$	Nobelium **No** 102 259 $[Rn]\ 5f^{14}\ 7s^2$	Lawrencium **Lr** 103 262.11 $[Rn]\ 5f^{14}\ 6d^1\ 7s^2$



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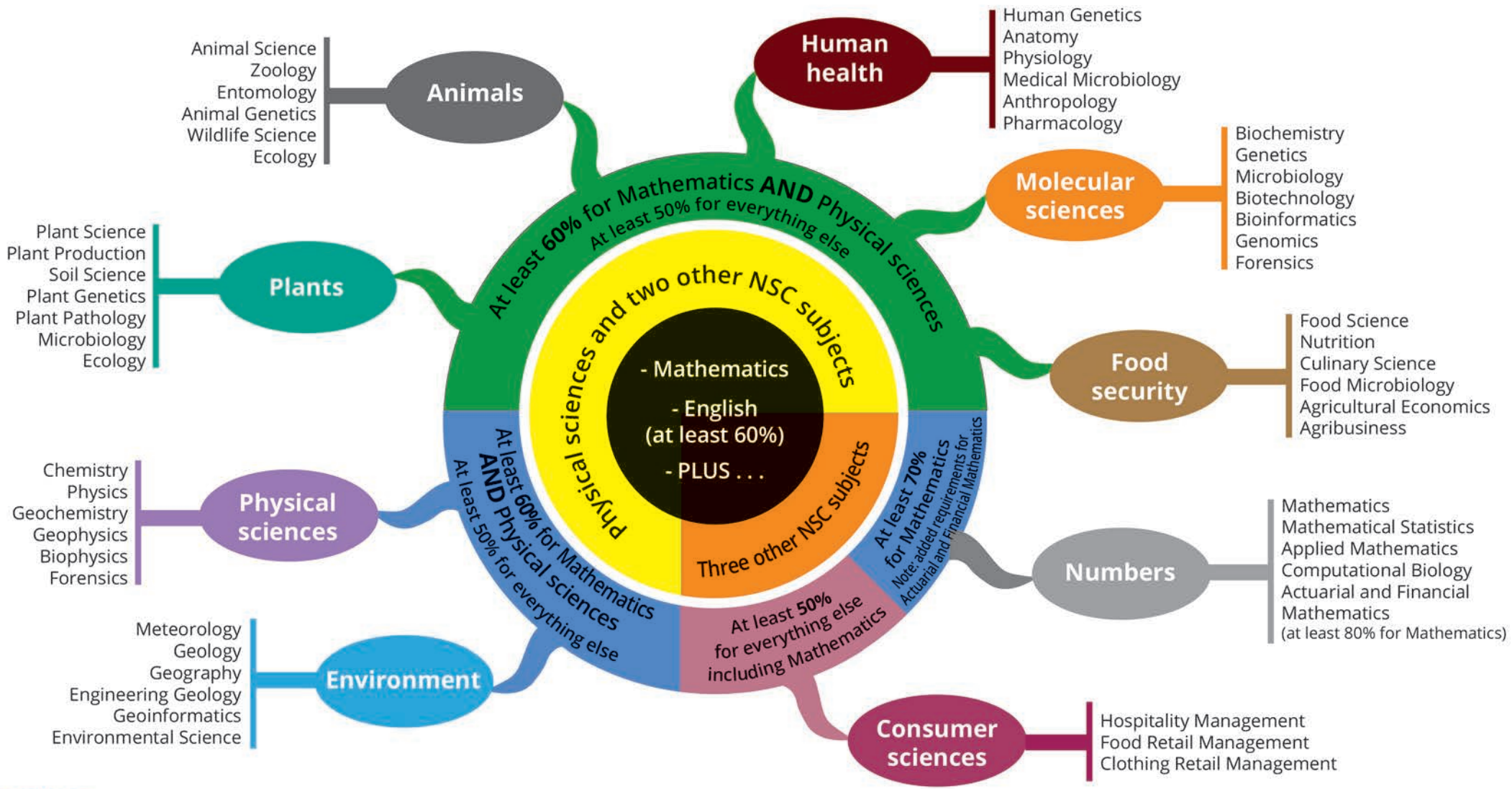
Faculty of Natural and Agricultural Sciences

In which field do you dream of working?



PLEASE NOTE: Mathematical Literacy is **not accepted** in this Faculty

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Article

UP and International Veterinary Vaccinology Network teach learners about vaccination

'Who knew that science can be cool?'

This was one of the many positive comments from Prestige College learners during a University of Pretoria (UP) and International Veterinary Vaccinology Network (IVVN) outreach programme that took place recently in Hammanskraal, north of Pretoria.

A group of female scientists from the University of Pretoria, Ethiopia's Addis Ababa University and Uganda's Makerere University visited the school to deliver the second phase of the IVVN African Schools Outreach Programme. The aim of this programme is to provide women scientists working in veterinary vaccinology across Africa with the training and resources (in the form of a mobile laboratory in a suitcase) to host schools outreach workshops in their local communities, with the overall goal of inspiring the next generation of scientists.

The workshop, designed by the Easter Bush Science Outreach Centre from Scotland's University of Edinburgh, was really hands-on, and the Grade 10 learners had the opportunity to micropipette and perform their own experiment similar to scientists working in laboratories across Africa. Students then had the opportunity to interact with the scientists.

One of the excited learners, Lesedi Hale, said, 'My experience today was one I will never forget. I learned many things about science—a subject I thought was uninteresting. Now I am starting to question my career choices based on today's demonstration. Who knew that science can be cool?'

Another Grade 10 learner, Buhle Mazibuko, echoed Hale's sentiments. 'Today was very informative. As a learner who is approaching university, such occasions help me to decide on what I want to be when I grow up and what I find interesting. I am very grateful for this scientific experience. I learnt a lot and I got many of my questions answered, and I think I might have even found my career.'

Professor Christine Maritz-Olivier from UP's Department of Biochemistry, Genetics and Microbiology is a leading researcher in the field of ticks and tick-borne diseases, and led the UP delegation. 'Our scientists working on finding solutions for animal diseases are passionate about communicating our activities to our local communities,' she said. 'This allows our school pupils and families to meet and greet the researchers from the University, get real practical exposure to what it means to be a scientist, and become excited about how science is striving to make our communities healthier. We are privileged to work with the IVVN from the Roslin Institute and the University of Edinburgh (UK) to initiate the first roll-out of an exciting programme on communicating the science behind animal vaccination.'

Dr Carly Hamilton, IVVN Network Manager, emphasised the importance of this outreach. 'The IVVN is committed to increasing the number of women working in the field of veterinary vaccinology across Africa. As part of our activities, the IVVN African Schools Outreach Programme provides training and resources for inspirational African scientists to host outreach workshops in schools within their local communities. We were delighted to host a training session at UP and hope the scientists' new skills and resources will enable staff and students at UP to inspire the next generation of scientists across South Africa.'

After implementing the programme across schools in Kenya, Nigeria and Zambia, the IVVN are expanding the programme to schools in South Africa, Uganda and Ethiopia.

Follow the progress of the programme at @IntVetVaccNet #InspiringFutureScientists and www.up.ac.za

For enquiries regarding the IVVN African Schools Outreach Programme, please contact:

Dr Carly Hamilton (IVVN Network Manager)
Email IVVN@roslin.ed.ac.uk

Prof Christine Maritz-Olivier (University of Pretoria)
Email christine.maritz@up.ac.za

University of Pretoria
Private Bag X20, Hatfield, 0028, South Africa
Tel +27 (0)12 420 4111, **Fax** +27 (0)12 420 4555
www.up.ac.za

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