biotechnology

# Careers in **Biotechnology**

Tiny, microscopic, living things are around us all the time. Most of these microbes are harmless and can be used to make products that benefit us. For example, wine-making uses a single-cell microbe, called yeast, to convert sugar to alcohol and carbon dioxide.

## Who knows enough about micro-organisms to make us competitive at wine making internationally?

# The Microbiologist!

***... the biggest challenge of the job:***
*"Working with something that you can't see and to draw your conclusions from that!"*

***... career satisfaction:***
*"Research always involves striving towards something new and better for the company."*

**Meet Jeremy Eksteen,** Microbiologist at Distell in Stellenbosch
**BSc (Microbiology), BSc Hons (Wine Biotechnology), MSc (Wine Biotechnology)**

## What does Jeremy do?

Jeremy works for Distell, which makes and sells wines and spirits. Ingredients including grapes, marulas, apples and cereals go through complex processes such as fermentation, which is changing the chemical makeup of something, and distillation, which is when a substance is purified or separated.

Jeremy is an expert on the microbes used in wine and spirit making. His job is to find the best (fastest and cheapest) ways to make the Distell products, using microbes. He also helps his colleagues – who check the wines and spirits to make sure they are safe to drink according to the rules and regulations – to find solutions for problems.

## What do I need to be a microbiologist?

**Characteristics:** A love and aptitude for science, enquiring mind and enthusiasm for solving problems
**Important school subjects:**
Biology, Mathematics, Physical Science
**Qualifications:**
NDip or BTech in Biotechnology or Food Technology (with Microbiology); BSc – Natural Sciences/ Biological and Life Sciences/Biotechnology/Microbiology/Molecular and Cell Biology or similar
**Note:** You need an MSc or PhD for higher positions in lecturing and research

## Where can I get a job as a microbiologist?

Agricultural and industrial research organisations, food and pharmaceutical industries, beverage and fermentation companies, environmental and pollution control companies, some health care facilities, pathology practices

**Related careers:**
Biotechnologist, Food technologist. Specialised fields include Bacteriologist (specialising in bacteria), Virologist (specialises in viruses), or Mycologist (specialises in fungi)

# Biotechnology is changing the way we ...

...treat our sick
...run our factories
...make our products
...track down criminals
...protect our livestock
...conserve our wildlife
...keep our environment clean
...grow our plants and feed our people

Man has been studying living organisms for many, many years. Today, scientists are continuing to make new discoveries and now understand better than ever before how living things work. Which is why the use of living organisms to benefit humans has reached new heights - and, this is why South Africa needs more and more individuals trained in biotechnology!

**Choose a Career in Biotechnology!**

## Introducing:

South Africans already making a difference through biotechnology!

PUBLIC UNDERSTANDING OF
BIOTECHNOLOGY

Agriculture (growing crops and keeping animals for food) is an important part of the South African economy. However, the herds of cattle, sheep, goats and horses are constantly under attack from diseases. These are caused by pathogens (disease causing micro-organisms) such as viruses, which infect animals, causing them to die or to spread the disease, which loses a lot of money.

## Who can help us in the battle against micro-organisms that harm our livestock?

# The Veterinary Virologist!

**Meet Theresa Smit,**
Virology Research and Development Manager
at Onderstepoort Biological Products in Pretoria
**BSc (Laboratory Medicine),**
**BSc Hons (Influenza),**
**MSc (Simian Immunodeficiency Virus (SIV),**
**PhD (HIV/Aids)**

***... the challenge of the job:***
*"Working against the clock. Research is time-consuming, and the pressure is always on to get vaccines out there quickly."*

***...a common misconception about the job:***
*"Many people overestimate the amount of time I spend with animals. Most of my job is spent in a laboratory and I don't spend as much time with animals as a Vet."*

## What does Theresa do?

Theresa researches and develops new or improved vaccines against diseases of livestock animals. A vaccine helps to stimulate the defence response of the body. It is usually a dead or weakened version of a micro-organism given to an animal to stimulate their bodies to make specific antibodies - but without causing disease. This means that if the animal is infected with the disease, it is able to resist and survive.

Onderstepoort Biological Products (OBP) makes millions of doses of vaccines per year that can be used to keep horses, cattle and sheep, healthy. Theresa ensures that the vaccines made are of the highest quality.

## What do I need to be a veterinary virologist?

**Characteristics:** Versatility, analytical mind, good at problem solving
**Important school subjects:**
Biology, Mathematics, Physical Science
**Qualifications:**
B Tech – Veterinary Technology; BVSc; BSc - Veterinary Biology/Virology/ Microbiology/Molecular Biology or similar, BSc (Hons)

**Note:** You need an MSc or PhD (Research) or MMedVet or DVSc for higher positions in lecturing, research and management of laboratories or departments

## Where can I get a job as a veterinary virologist?

Animal disease diagnostic laboratories, pathology laboratories, universities, agricultural research organisations, private animal vaccine producers such as Onderstepoort Biological Products

**Related careers:**
Laboratory Veterinarian, Veterinary Bacteriologist, Veterinary Pathologist, Veterinary Laboratory Technician, Vaccine Production Technologist, Immunologist

Micro-organisms are tiny living things that cannot be seen by the naked eye. Despite their size, they can be used to make many valuable products such as antibiotics and alcohol. They can also be used to speed up chemical reactions (catalysts). Since large amounts of these products are needed they must be made in the most economical way, meaning that the micro-organisms need to work as hard as they possibly can.

## Who understands micro-organisms and can get them to work optimally to make many products?

# The Fermentation Scientist!

**Meet Sani Gumede,**
Fermentation Scientist
at the CSIR in Johannesburg
**B Tech (Biotechnology)**

***...the biggest challenge of the job:***
*"The work is experimental. This means that things don't always work out how you had hoped!"*

***...career satisfaction:***
*"Seeing the economic and social impact that comes from finding a suitable micro-organism which eventually results in commercially successful products."*

## What does Sani do?

Once Sani's colleagues have found a specific micro-organism to make a specific product, Sani has to get the micro-organism to do the best possible job of making it.
To do this, he starts by growing the micro-organisms in glass flasks in the laboratory. Different organisms like different temperatures, different "food", and different pH-levels and Sani has to get this recipe right. He then scales up the process to large fermenters and later to the huge scale that the factories will use.

## What do I need to be a fermentation scientist?

**Characteristics:**
Creative, detail-driven, team player and patient
**Important school subjects:** Biology, Mathematics, Physical Science
**Qualifications:** B Tech (Biotechnology); BSc – Natural Sciences/Biological and Life Sciences/Biotechnology/Microbiology/Molecular and Cell Biology

## Where can I get a job as a fermentation scientist?

Universities, distilleries, research organisations, some private companies

**Related careers:**
Microbiologist, Biotechnologist, Biochemist, Bioprocess Engineer


science and technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

***… a common misconception:***
*"People think fermentation is just beer-making and do not know or understand the powerful industrial uses."*

biotechnology

# Careers in **Biotechnology**

More and more people are demanding that less chemicals are used to make products they use, while the manufacturers of these products are continually trying to improve and increase their output without harming the environment. The key to meeting both these needs has been found in enzymes – natural substances which are used to speed up chemical reactions (catalysts).

## Who can help industry find the right enzyme-based product, or introduce a newly-discovered enzyme to solve a specific problem?

# The Technical Sales Representative!

**Meet Thando Mbandlwa,**
a Technical Sales Representative
at Novozymes SA in Johannesburg
**BSc (Biochemistry and Chemistry)**

***… the challenge of the job:***
*"In sales, the reality is that you will be turned down at some stage, regardless of how good your product is!"*
***… career satisfaction:***
*"Grasping the problem and selling the solution!"*
***… a common misconception encountered:***
*"People who say that they don't eat bread with enzymes in it!"*

## What does Thando do?

Thando helps producers in the sugar, baking, brewing and detergent industries to select enzyme-based products to improve their performance.

Different enzymes are used for different tasks, depending on what chemical reaction they help. For example, enzymes are used in bread baking to ensure longer shelf-life, improve crumb structure, and to add volume. The detergent industry uses enzymes to ensure cleanliness without using too many chemicals. The enzyme protease speeds up the breakdown of proteins to remove a gravy spill or a dirty collar whereas lipase speeds up the breakdown of fat, making it water soluble.

## What do I need to be a technical salesman?

**Characteristics:**
Good communication and problem-solving skills, ability to move between a scientific, manufacturing and margin-driven sales domain
**Important school subjects:**
Biology, Mathematics, Physical Science
**Qualifications:**
NDip or BTech in Biotechnology or Food Technology; BSc – Natural Sciences/ Biotechnology/Microbiology/Chemical, Molecular & Cellular Sciences/ Biochemistry/Biological Sciences/Molecular and Cellular Biotechnology

## Where can I get a job as a technical salesman in the biotechnology domain?

Multinational, commercial companies producing biological products with distributing offices in South Africa

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

The variety of genes present in different populations (groups of people) throughout the world has changed over hundreds of years. These changes have been caused by natural and man-made disasters, changes in lifestyle and by historical events. Can this history of populations help us to understand the links between certain genetic variations and disease - or health?

**Who can explain why one group of people is more likely to get a certain disease and help us use this knowledge to fight sickness and improve health?**

# The Human Geneticist!

**Meet Himla Soodyall,**
a Human Geneticist at the National Health Laboratory Service (NHLS) affiliated with the University of the Witwatersrand
**BSc (Microbiology and Biochemistry),**
**BSc Hons (Microbiology),**
**MSc (Biotechnology),**
**PhD (Human Genetics),**
**Post Doc in Anthropology**

***... the challenge of the job:***
*"It is challenging to work in a field fraught with public fears and misconceptions."*
***... career satisfaction:***
*"It is extremely rewarding to contribute to capacity development in the country in which I was given chances during the apartheid era."*
***... a common misconception about the job:***
*"Everyone thinks I do everything related to genes!"*

## What does Himla do?

Himla studies how DNA, the inherited material that makes us who we are, is passed from parents to children. This helps us understand why certain people are at risk for certain diseases and how this risk developed throughout history. DNA often changes for no reason (mutations). Some mutations can cause disease, while others do not, and geneticists are able to identify those that are and those that aren't linked to disease.

Recently, Himla has been studying the differences in people from all over Africa and how this compares with people from around the world. This can explain why people in certain countries are prone to certain diseases, such as diabetes and types of cancer.

## What do I need to be a human geneticist?

**Characteristics:**
Natural inquisitiveness, endurance
**Important school subjects:**
Biology, Mathematics, Physical Science
**Qualifications:**
BSc – Biochemistry/Natural Sciences/Biological and Life Sciences/Biotechnology; Microbiology/ Molecular and Cell Biology/Environmental and Biological Sciences/Chemical and Biological Sciences
**Note:** You need an MSc or PhD for higher positions in lecturing and research.

## Where can I get a job as a human geneticist?

Laboratories conducting medical diagnostic services, universities, medical research laboratories

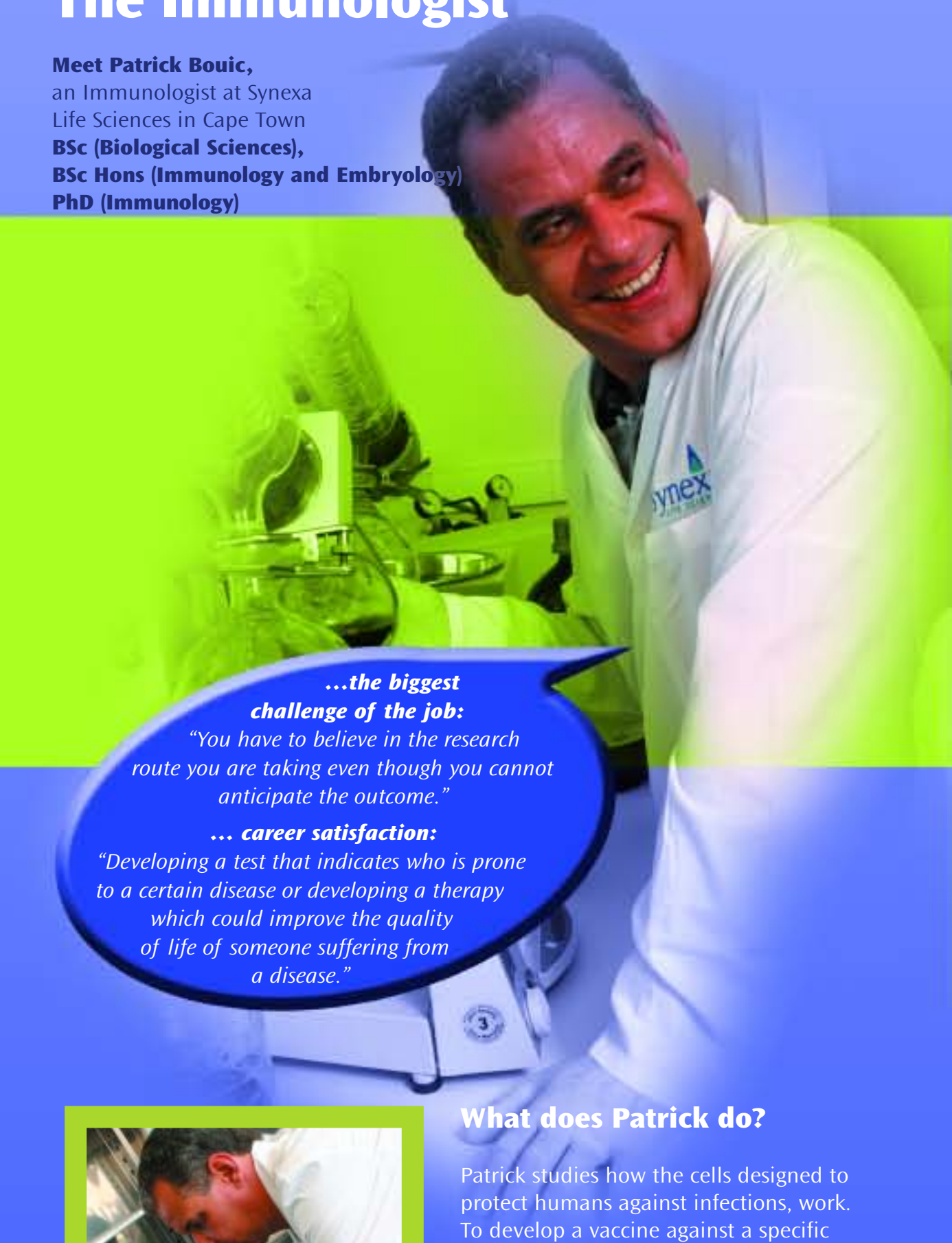
**Related careers:**
Pathologist, Geneticist, Clinical Geneticist, Genetic Counsellor

To stay healthy, people everywhere need to keep their immune systems, which recognize and fight microbes that attack their bodies, working well. This is difficult for people that do not eat properly because of lack of food, those with stressful lives and those affected by environmental pollutants. Without an optimal immune system that can fight infections, diseases such as tuberculosis (TB), hepatitis and HIV/AIDS cause millions of deaths every year.

## Who knows enough about how cells work to develop new vaccines and treatments to fight these diseases?

# The Immunologist

**Meet Patrick Bouic,**
an Immunologist at Synexa Life Sciences in Cape Town
**BSc (Biological Sciences),**
**BSc Hons (Immunology and Embryology)**
**PhD (Immunology)**



***…the biggest challenge of the job:***
*"You have to believe in the research route you are taking even though you cannot anticipate the outcome."*

***… career satisfaction:***
*"Developing a test that indicates who is prone to a certain disease or developing a therapy which could improve the quality of life of someone suffering from a disease."*

## What does Patrick do?

Patrick studies how the cells designed to protect humans against infections, work. To develop a vaccine against a specific disease, he has to find out how to trigger these protective cells to work before we get infected. A vaccine teaches our bodies to recognise disease-producing microbes. Patrick is also researching the immune activities of natural products, such as Buchu, a small indigenous shrub only found in the Western Cape, and how it can be used with man-made medicines to treat chronic diseases such as arthritis.

His job at Synexa focuses on ensuring that the biological products they make, are of a high quality and as safe as possible.

## What do I need to be an immunologist?

**Characteristics:** Curious nature, critical mind, enjoy interacting with people
**Important school subjects:** Biology, Mathematics, Physical Science
**Qualifications:** BSc – Biotechnology/Microbiology/Molecular and Cell Biology/ Biological and Life Sciences and BSc Hons – Medical Cell Biology/Immunology
**Note:** You need an MSc (Immunology/Medical Cell Biology) and/or PhD for higher positions in lecturing and research
**Pre-requisite:** Registration with Health Professional Council of SA (HPCSA) to work with human blood and tissues

## Where can I get a job as an immunologist?

Research organisation (e.g. Medical Research Council), universities, biotechnology start-up companies, large pharmaceutical companies

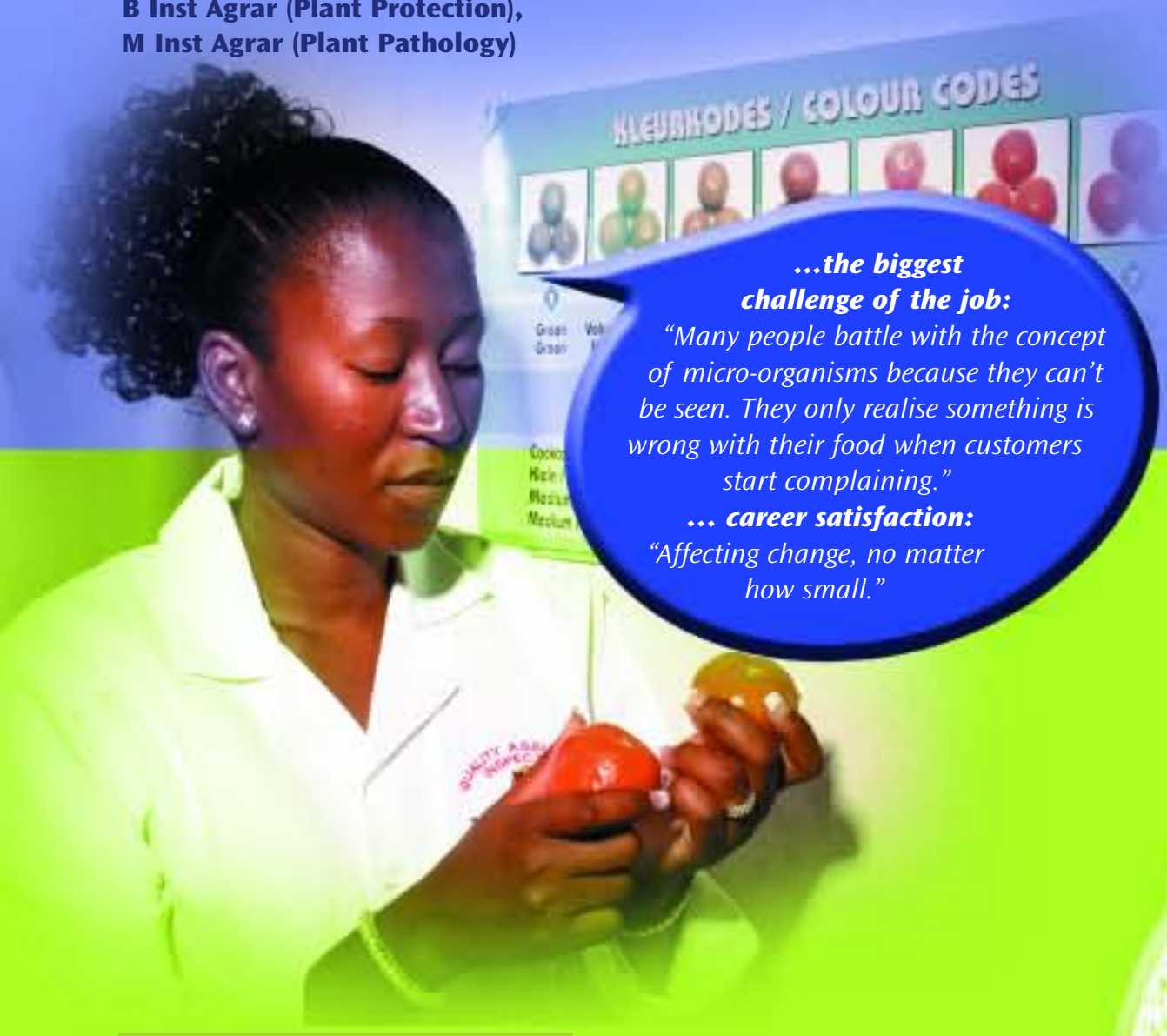
**Related careers:**
Cell Biologist, Vaccine Development, Microbiologist, Medical Technologist

Worldwide, people are becoming more concerned about the safety of food. Can we combine our knowledge of micro-organisms (tiny living things) and how plants work to ensure a safer global food supply?

## Who can help us ensure that our food is of the highest quality?

# The Plant Pathologist!

**Meet Margareth Mahlangu,**
Quality Assurance and Food Safety Manager at the Johannesburg Fresh Produce Market
**B Inst Agrar (Plant Protection),**
**M Inst Agrar (Plant Pathology)**




***...the biggest challenge of the job:***
*"Many people battle with the concept of micro-organisms because they can't be seen. They only realise something is wrong with their food when customers start complaining."*

***... career satisfaction:***
*"Affecting change, no matter how small."*

## What does Margareth do?

A plant pathologist studies micro-organisms and environmental conditions that cause plant diseases and recommends how these diseases can be managed or controlled.

Margareth is an expert in plant diseases, and has a back-ground in microbiology (study of microscopic living things). Some micro-organisms cause food to spoil and others cause diseases. Contamination with chemicals or pesticides can also make food unsafe. Her job at the Johannesburg Fresh Produce Market (JFPM) is to make sure that the fresh fruit and vegetables traded every day (average of 2700 tons) are safe to eat and of the highest quality.

## What do I need to be a plant pathologist?

**Characteristics:**
Attention to detail, patient, dynamic, persistent
**Important school subjects:**
Biology, Mathematics, Physical Science
**Qualifications:**
BAgric/BScAgric/B Inst Agrar

## Where can I get a job as a plant pathologist?

Agricultural research organisations, universities, Department of Agriculture, retailers, agricultural consulting companies, diagnostic laboratories, biological control companies, seed and plant production companies

**Related careers:**
Microbiologist, Crop Scientist, Molecular Biologist, Plant Physiologist

science and technology

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***...the working environment:***
*At a junior level, it can involve a lot of lab work, and the 'yuck' factor can be quite high, as you will work with contaminated plants or be doing quality checks. At a more senior level there is more office work."*

biotechnology

# Careers in **Biotechnology**

Cancer of the oesophagus – the tube that links the mouth to the stomach - is the most common cancer in South African black males. Research looks at what causes this disease, how it can be treated, and why some people are more likely to develop it than others.

## Who can help us understand why a normal cell turns into an abnormal cell and causes cancer?

# The Medical Biochemist!

**Meet Iqbal Parker,**
Head of Medical Biochemistry and Director of Research at the Faculty of Health Sciences, University of Cape Town and Head of the MRC/UCT Oesophageal Cancer Research Group
**BSc Natural Sciences,**
**BSc Hons (Biochemistry),**
**PhD (Biochemistry)**


***…a common misconception about the job:***
*"That you can design an experiment to finish on a Friday afternoon or prior to a public holiday!"*

***…the ultimate career satisfaction:***
*"Being at a dead-end and then suddenly realising that there is another option. What looks like a disappointing result can lead to something truly exciting! "*

***… worst nightmare:***
*"Coming up with something that contradicts the findings of one of the major players and engaging in a battle to get it published."*

## What does Iqbal do?

Biochemistry is about trying to understand the chemical processes that happen in living cells that are needed for the cell to survive, reproduce, and do its "job". For example, the job of red blood cells is to make haemoglobin which carries oxygen around the body. To do all this, a cell needs DNA.

Iqbal's job is to find new ways to treat and cure medical conditions and diseases by using his knowledge about what happens within the building blocks of cells. Iqbal and his team are finding, for example, that some people are less likely to get cancer because their "detox" genes code for the "best" enzymes to remove toxins caused by smoking and drinking.

## What do I need to be a medical biochemist?

**Characteristics:**
Perseverance, commitment, analytical mind, meticulous nature
**Important school subjects:** Mathematics, Biology, Physical Science
**Qualifications:**
BSc – Biochemistry/Natural Sciences/ Biological and Life Sciences/ Biotechnology/ Microbiology/Molecular and Cell Biology/Human Life Sciences/ Bio-organic Chemistry/Chemical, Molecular & Cellular Sciences, or similar

## Where can I get a job as a medical biochemist?

Mostly research institutions, including universities and medical research groups such as the Medical Research Council (MRC), biotechnology companies, some multinational pharmaceutical companies

**Related careers:**
Clinical Biochemist, Chemical Pathologist, Medical Scientist

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

Can we use living things to clean up waste and pollution caused by industry, without stopping industrial development?

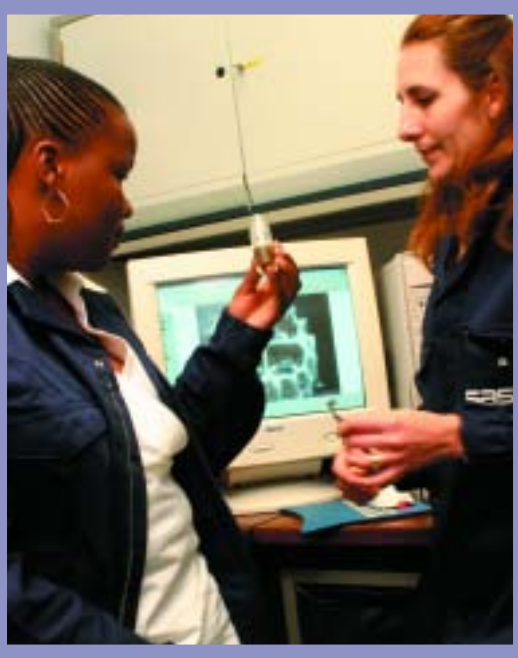
## Who can help us find micro-organisms (tiny living things) that can be used in recycling or used to break down and remove toxins from waste?

# The Environmental Biotechnologist!

**Meet Patricia Molipane,**
a Biotechnologist specialising in waste water treatment at Sasol's Research and Development Department in Secunda
**BSc (Microbiology and Biochemistry),**
**BSc Hons (Biotechnology),**
**MSc (Biotechnology)**

***... the challenge of the job:***
*"The industrial research programme is shorter than in many other research environments and focuses on practical aspects and not fundamental research."*

***... a common misconception:***
*"The responsibility of the job is sometimes underestimated. Important decisions are taken based on your recommendations!"*



## What does Patricia do?

Sasol is an international chemical and fuel company that uses a lot of water for cooling. This results in a lot of different types of waste water (sewage). Patricia's job is to evaluate new technologies and to find the best and cheapest ways of cleaning this waste water. Some of the water is cleaned using "biological treatments" – meaning that micro-organisms are used. These 'bugs' use the carbon in the wastewater as an energy source.

## What do I need to be an environmental biotechnologist?

**Characteristics:** Team player, good interpersonal skills, independent problem-solving abilities, assertive and self-motivated

**Important school subjects:** Mathematics, Biology, Physical Science
**Qualifications:**
BTech – Biotechnology; BSc – Biochemistry/Biotechnology/Microbiology/Chemical and Biological Sciences or similar
**Note:** Some employers require a minimum of a BSc Honours degree.
You need a Masters or PhD for higher positions in lecturing and research.

## Where can I get a job as an environmental biotechnologist?

Companies in the chemical, paper, sugar and electricity domains as well as some universities

**Related careers:**
Industrial Microbiologist, Biochemist, Biotechnologist, Bioprocess Engineer

Around the world, making sugar is a very competitive industry. In South Africa, half of the sugar produced is exported, but it is difficult to make a profit due to the low sugar prices worldwide. New ways have to be found to keep our sugar production competitive. One way is to grow types of sugarcane that are best suited to the South African growing conditions.

## Who can help our sugarcane growers by making their plants resistant to pests and diseases?

# The Agricultural Biotechnologist!

**Meet Sandy Snyman,**
a Senior Research Officer in the Biotechnology Department of the South African Sugarcane Research Institute (SASRI) near Durban
**BSc (Botany and Microbiology),**
**BSc Hons (Plant Pathology),**
**MSc (Biology),**
**PhD (Plant Biotechnology)**

***…the biggest challenge of the job:***
*"The personal frustration that comes from knowing that although we have succeeded in creating an improved plant through genetic engineering, it might never be sold commercially because of consumer resistance to GMOs!"*

***… a common misconception:***
*"That we are lab rats! The job is both in the lab and field and we interact with many different researchers."*

## What does Sandy do?

Sandy's job is to improve sugarcane in South Africa. She uses different methods, including Genetic Modification (GM), which changes the genetic "recipe" of the sugarcane. This is when a new gene that codes for a particular characteristic (e.g. insect resistance) is put into the sugarcane plant.

Sandy and her team also use tissue culture techniques in the laboratory. This is when different plant cells are multiplied or grown in a specially prepared hormone medium which provides them with everything they need to grow. These clusters of cells can develop into whole plants. They are also investigating how the amount of sugar in sugarcane can be increased.

## What do I need to be an agricultural biotechnologist?

**Characteristics:** Natural curiosity, methodical and precise by nature

**Important school subjects:** Biology, Mathematics, Physical Science
**Qualifications:**
MSc – Natural Sciences/Biological and Life Sciences/Biotechnology/ Microbiology/Molecular and Cell Biology or similar
M Tech (Biotechnology)

## Where can I get a job as an agricultural biotechnologist?

Agricultural research institutes, many of which are linked to the Agricultural Research Council (ARC), universities and commercial companies such as Mondi and Sappi

**Related careers:**
Plant Pathologist, Molecular Biotechnologist, Plant Molecular Biologist, Plant Breeder, Agricultural Scientist

Breakthroughs in mapping the genetic material of living things – finding out where genes "live" in the DNA and what they do – plus new laboratory techniques, are generating huge amounts of data.

## Who can help us find out what all this data tell us about a living organism?

# The Bioinformaticist!

**Meet Nothemba Kula,**
a Bioinformaticist at the South African National Bioinformatics Institute (SANBI) in Cape Town
**BSc (Microbiology),**
**BSc Hons (Microbiology),**
**MSc (Microbiology),**
**MSc (Bioinformatics)**

***… the biggest challenge of the job:***
*"Making sure what you're doing hasn't already been done - keeping up with the developments in this domain!"*

***… career satisfaction:***
*"Researching issues that will benefit people."*

## What does Nothemba do?

Bioinformaticists are usually experts in both biology and computer science. With this combined knowledge they develop new software to make sense of all the biological data that has become available.
They can, for instance, find specific genes in bacteria and plants or other living things. Nothemba is working with other bioinformaticists from around the world to find a way to cut out the specific stretch of DNA of the malaria parasite which causes the disease. If this was removed, it could reduce the number of people infected and dying from malaria.

## What do I need to be a bioinformaticist?

**Characteristics:** Attention to detail, ability to work independently, and to integrate and acquire new skills fast
**Important school subjects:** Biology, Mathematics, Physical Science
**Qualifications:**
BSc - Applied Biotechnology/Biotechnology/Biochemistry/Microbiology/ Molecular and Cellular Biology or similar combined with a post-graduate university qualification in Bioinformatics or one of the national courses presented at a node of the National Bioinformatics Network.

## Where can I get a job as a bioinformaticist?

Medical Research Council, South African National Bioinformatics Institute (SANBI), various universities, some pharmaceutical multinationals

**Related careers:**
Genomics, genome technology, software developing, pathogen genomics, bioinformatics analyst.

science and technology

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Science and Technology
**REPUBLIC OF SOUTH AFRICA**

***… the most common misconception:***
*"That you need to be a hard core computer programmer and that it is impossible to learn these skills if you come from a biological background."*

# CAREERS IN **BIOTECHNOLOGY**

Although the world's population continues to grow, the amount of land available to grow crops for food remains the same.

# Who can help us grow more and "better" crops to keep feeding the world?

# The Plant Breeder!

**Meet J.D. Rossouw,**
a Plant Breeder at Monsanto in Gauteng **BSc (Agric), MSc (Plant Breeding/Genetics), currently enrolled for PhD (Plant Breeding/Plant Pathology)**

***…the biggest challenge of the job:***
*"Commercially-speaking, to stay ahead of the competition!"*

***…career satisfaction:***
*"To stand alongside a farmer who has experienced the benefits of one of our products."*

***… a common misconception:***
*"That I'm a farmer!"*

## What does J.D. do?

J.D.'s job is to develop new, improved types of maize that produce more and better cobs, cope better with stress and can resist diseases that infect the maize. He does this by selecting maize plants with these characteristics and breeds them. This results in the genetic "recipe" of the plants being changed and improved. Once these "hybrids" have been fully tested, which can take many years, they are sold to farmers.

Most plant breeders specialise in one crop only, and in J.D.'s case, this is maize. To do his job he has to understand the science behind plant breeding, the growing conditions of maize in South Africa, the agricultural market and the needs of those who use or eat the maize. He also has to predict how these factors will change in the next ten years.

## What do I need to be a plant breeder?

**Characteristics:** Passion for working outdoors; patience, as it can take five to seven years before a hybrid is ready to be sold; an ability to work systematically, independently and in teams
**Important school subjects:** Biology, Mathematics, Physical Science
**Qualifications:**
BSc – Natural Sciences/Biological and Life Sciences/Microbiology/Molecular and Cell Biology/Agriculture or similar

## Where can I get a job as a plant breeder?

Private, commercial seed companies (international and local) such as Monsanto, Pannar, Pioneer, Syngenta and various smaller companies, public research institutes and universities

**Related careers:**
Plant Pathologist, Plant Geneticist, Plant Biotechnologist, Genomics

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

Drought and plant diseases are two of the biggest problems we face in feeding the continent, as they can drastically limit the amount of food produced.

**Who can help us change and improve living things, such as plants, so they can survive better in droughts and fight diseases?**

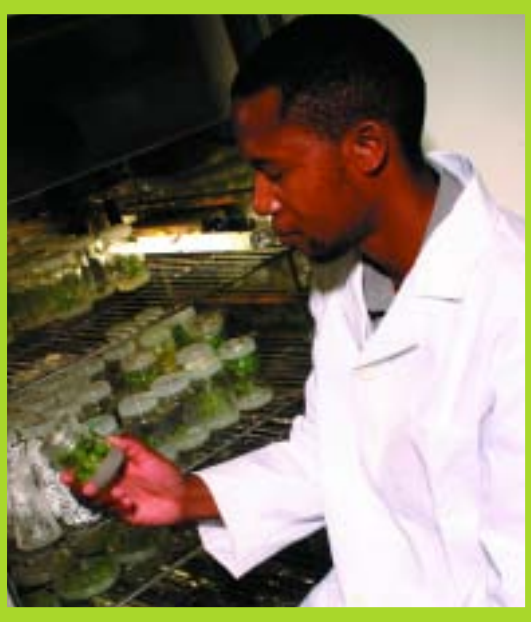
# The Plant Molecular Biologist!

**Meet Ndiko Ludidi,**
a Plant Molecular Biologist
at the University of Stellenbosch
**BSc (Biochemistry and Microbiology),**
**BSc Hons (Biochemistry),**
**MSc (Biochemistry), PhD (Biochemistry)**

***… the biggest challenge of the job:***
*"Not being able to track progress visually. You are working with DNA, RNA and proteins – you do not know whether you have successfully isolated DNA until you get to the results – months later."*

***… career satisfaction:***
*"My work could ultimately benefit a whole lot of people."*

***..a common misconception:***
*"That I am into manipulating all living things!"*



## What does Ndiko do?

Ndiko studies the DNA of plants, which is the inherited material that is passed on from generation to generation and is found in almost all living things. His specific job is to identify and describe genes (a stretch of DNA) in a plant that carry the code for specific characteristics. He especially looks for genes that can be used to improve crop plants by making them better at coping with drought and making them resistant to fungal/bacterial infections. Changing the genetic recipe of a plant in this way is called genetic engineering. This can often be quite complex because more than one gene is involved in controlling a characteristic.

## What do I need to be a plant molecular biologist?

**Characteristics:**
Patience, accuracy, curiosity
**Important school subjects:** Biology, Mathematics, Physical Science

**Qualifications:** N Dip – Biotechnology; BTech – Biotechnology; BSc – Biochemistry/Natural Sciences/Biological and Life Sciences/Biotechnology/Microbiology/Molecular and Cell Biology/Environmental and Biological Sciences/Chemical and Biological Sciences.

## Where can I get a job as a plant molecular biologist?

Agricultural research organisations, universities, commercial seed companies, research institutes funded by a specific agricultural industry

**Related careers:**
Plant Biotechnologist, Plant Geneticist, Biologist, Agronomist, Molecular Geneticist, Plant Pathologist, Agricultural Biotechnologist

South Africa has a rich and diverse wildlife. Although wildlife can be used to make money, it also needs to be protected so that future generations can benefit from it. If we don't look after it, some plants and animals could become extinct and be lost forever. Who can help us understand how different plants and animals live together and survive?

## Who can help us manage and protect our diverse wildlife?

# The Conservation Geneticist!

**Meet Paulette Bloomer,**
an Associate Professor in the Department of Genetics of the University of Pretoria
**BSc (Zoology and Microbiology),**
**BSc Hons (Zoology),**
**PhD (Zoology)**


***… the biggest challenge of the job:***
*"I am not only a conservationist, I also support sustainable development. Balancing all the issues is not simple."*
***… career satisfaction:***
*"Contributing in a small way to the understanding and protection of South Africa's rich biodiversity for future generations."*
***..a common misconception:***
*"That using biotechnology in conservation is about 'bringing back' species."*

## What does Paulette do?

Paulette studies species of animals which are in danger of becoming extinct and finds out why they only live in certain areas and how they are genetically related to one another. For example, a type of mole called "Juliana's Golden Mole" is almost extinct and is only found in small numbers at three different places in South Africa. Paulette and her collegues in the Zoology department are finding out why only a few moles are left and what has caused this (nature or man). She will also see if the three populations (groups) of moles at the three different locations are related. One of the populations may be completely lost because of urban development – and Paulette will investigate to see what could happen if this group of moles is lost.

## What do I need to be a conservation geneticist?

**Characteristics:** Passion for the environment, good communication skills and ability to work in multi-disciplinary teams
**Important school subjects:**
Biology, Mathematics, Physical Science
**Qualifications:**
BSc degree with Zoology, Botany, Genetics or Microbiology
BSc – Molecular and Cellular Biology/Conservation Ecology/Natural and Environmental Science/Biotechnology

## Where can I find a job as a conservation geneticist?

Research institutions, universities, National Zoological Gardens, diagnostic laboratories

**Related careers:**
Careers in biology eg Zoologist, Botanist, Microbiologist, Ecologist, Phylogeneticist, Botanist, Conservation Biologist; Molecular Geneticist, Molecular Taxonomist, Museum Scientist

Amino acids are the building blocks of protein that are needed for growth, health and reproduction. Plants and many tiny organisms can make these amino acids, but animals have to get amino acids from their food. Scientists found a very tiny organism with a built-in ability to over-produce certain amino acids. This lead to a new way of making amino acids for animal feed companies.

## But who knows enough about these tiny organisms and how to grow them in enormous quantities?

# The Bioprocess Engineer

**Meet Thomas Potgieter,**
Technology Manager at
Bioproducts SA in Durban
**BSc Chemical Engineering,**
**PhD (Bioprocess Engineering)**

***… the biggest challenge of the job:***
*"Living in an undefined world. Research is about not knowing."*
***… career satisfaction:*** *"The Eureka feeling. The privilege of finding a solution."*
***…work environment:***
*"This is not a desk job. Junior bioprocess engineers could spend a lot of time in a plant and in the lab."*

## What does Thomas do?

Thomas works at Bioproducts SA, which owns the only lysine plant in South Africa. Lysine is an essential amino acid needed by pigs and poultry. It is made through a fermentation process that converts sugar into cells, carbon dioxide, water and lysine, using a specific type of bacteria. Amino acids like lysine are important because they balance the protein in animal feed and thereby increase the nutritional value. Thomas' job is to ensure that the fermentation process using the bacteria to make lysine, is as effective and efficient as possible. He also researches new ways to produce amino acid products for which different types of bacteria are used.

## What do I need to be a bioprocess engineer?

**Characteristics:** Aptitude for maths and science, problem-oriented, perseverance
**Important school subjects:** Biology, Mathematics, Physical Science
**Qualifications:** BSc Chemical Engineering combined with a Biotechnology qualification

## Where can I get a job as a bioprocess engineer?

Universities, research organisations, private companies such as SA Bioproducts as well as smaller, entrepreneurial companies

**Related careers:**
Biotechnologist, Biochemist, Process Engineer, Analyst, Biological Systems Engineer, Bioengineer, Industrial Microbiologist, Plant Production Manager

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***..a common misconception:***
*"That you have to be exceptionally clever to be a chemical engineer. You do have to be exceptionally committed, but you don't have to be a rocket scientist!"*

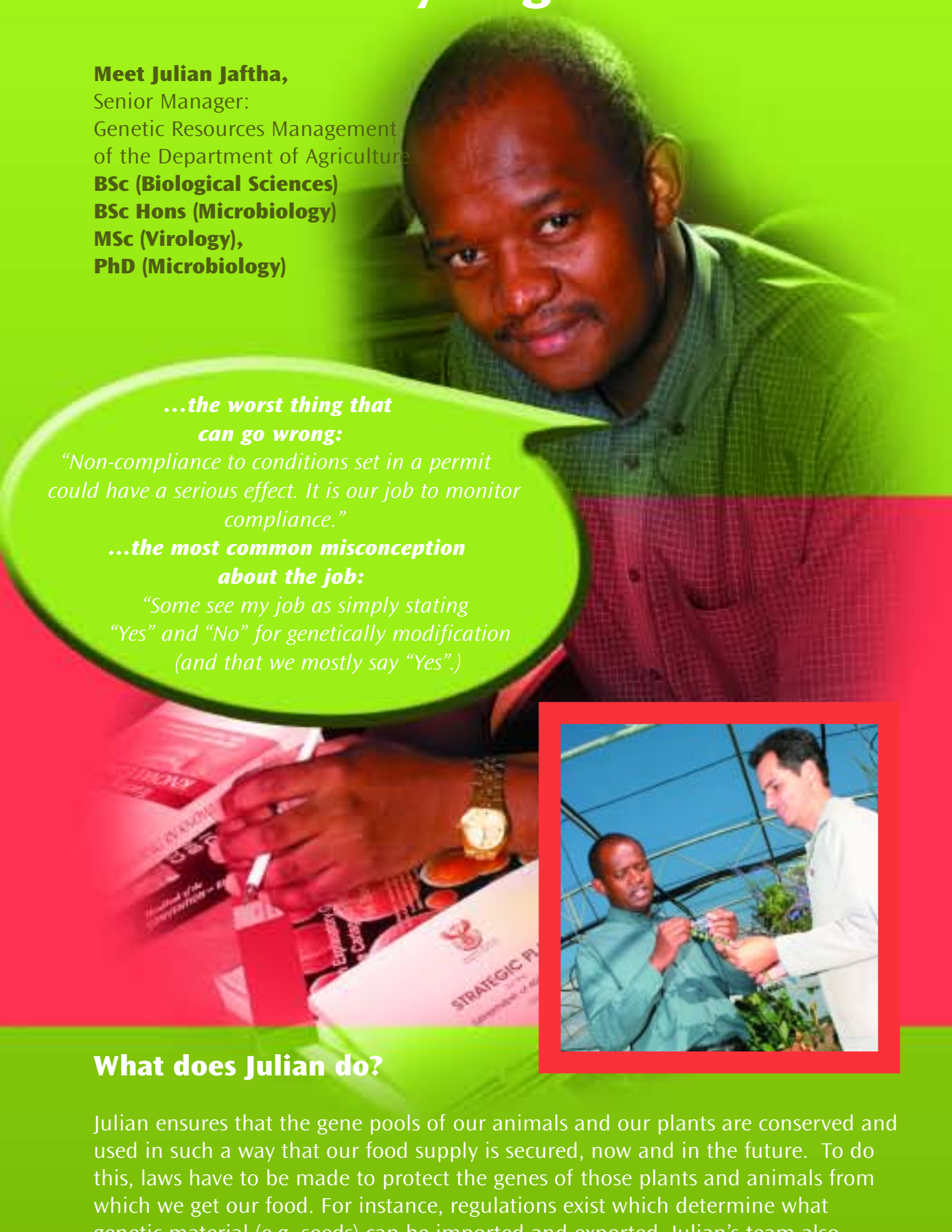
# CAREERS IN **BIOTECHNOLOGY**

The South African Constitution states that every South African has the right to sufficient safe and nutritious food. To provide enough food for our people, we have to use our natural resources responsibly. If we don't, we could lose many of our plants and animals species.

## Who can help us secure our food through responsible use of our animal and plant heritage?

# The Biosafety Regulator!

**Meet Julian Jaftha,**
Senior Manager:
Genetic Resources Management
of the Department of Agriculture
**BSc (Biological Sciences)**
**BSc Hons (Microbiology)**
**MSc (Virology),**
**PhD (Microbiology)**



***…the worst thing that can go wrong:***
*"Non-compliance to conditions set in a permit could have a serious effect. It is our job to monitor compliance."*

***…the most common misconception about the job:***
*"Some see my job as simply stating "Yes" and "No" for genetically modification (and that we mostly say "Yes".)*

## What does Julian do?

Julian ensures that the gene pools of our animals and our plants are conserved and used in such a way that our food supply is secured, now and in the future. To do this, laws have to be made to protect the genes of those plants and animals from which we get our food. For instance, regulations exist which determine what genetic material (e.g. seeds) can be imported and exported. Julian's team also studies the indigenous seeds farmers are using in rural areas and the characteristics these seeds have, for example a hybrid of a plant species that has adapted over many years to grow in very dry conditions. They store some of these seeds in the national genebank to make sure that the useful characteristics that these seeds "carry", are not lost.

Julian and his team also make sure that modern scientific advancements, such as scientists' ability to change the genetic make-up of a plant, do not influence the safety of our food for animals and humans and are not harmful to the environment. As part of this regulation process, Julian works with independent experts and other government departments to decide whether they will issue a permit for field trials or to import a GMO crop. Scientists do not need permits for research in laboratories.

## What do you need to be a biosafety regulator?

**Characteristics:** Sound linguistic capabilities have to back up your aptitude for science as you will draft laws and formulate conditions of permits; sound communications skills and assertive qualities
**Important school subjects:** Biology, Mathematics, Physical Science
**Qualifications:** BTech – Biotechnology; BSc – Natural Sciences/Biological and Life Sciences/Biotechnology/Microbiology/Molecular and Cell Biology or similar Post-graduate degree and research experience in the relevant scientific fields would be advantageous

## Where can I get a job as a biosafety regulator?

Government, consultants

**Related careers:**
It is crucial to have a scientific background and therefore a microbiologist or biotechnologist could progress to a career as regulator, which is not a career entry point.

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

Worldwide, violent criminals continue to leave a trail of victims behind them. But they also leave a trail of biological evidence behind in the form of blood, saliva, hair, skin... Today we know that an individual's unique DNA is found in all human tissue. How can we put this knowledge to work in solving crimes?

## Who can help us put the criminals behind bars and set the innocent free?

# The Biological Forensic Analyst!

**Meet Arnold Greyling,** a Control Forensic Analyst at the South African Forensic Science Laboratories of the South African Police Services (SAPS) in Pretoria **BSc (Human Physiology and Biochemistry), BSc Hons (Biochemistry)** and numerous applied training courses from international forensics bodies

***... a misconception:***
*"That, because we work for the SAPS, we work for the prosecution. We are objective scientists. Sometimes our evidence helps to find people guilty and sometimes it helps to prove their innocence!"*

***... the challenge of the job:***
*"You need to be able to rise above the routine and realise that every case has impacted on someone's life."*

## What does Arnold do?

Just like fingerprints, DNA can link a person to a crime scene, because every human has unique DNA. Detectives take samples from the scene and supply it to the forensic analyst at the laboratory to identify the type of material, for instance the type of body fluid that was found. The analyst determines whether the DNA profile of the crime scene sample can be matched to the DNA profile of a reference sample. The analyst gives his results in terms of statistical probability, for example, there is a 90% chance that the DNA profile found at the crime scene is the same DNA as the profile in the sample provided.

Forensic analysts are routinely called to court to interpret the scientific findings as objectively (neutrally) as possible. It is also Arnold's job to decide which new, state-of-the-art technology and equipment could be used to improve the laboratory's ability to produce reliable results.

## What do I need to become a biological forensic analyst?

**Characteristics:** High moral values and work ethics – you will testify in court and write affidavits; confidence; sound time-management skills
**Important school subjects:** Mathematics, Biology, Physical Science, English
**Qualifications:** B Tech (Biotechnology); BSc with subjects such as Biochemistry, Human Genetics, Human Physiology, Microbiology. Intakes preferred without Masters degree or PhD. In-house training is compulsory and individuals will work under mentorship before forensic case work is taken on independently.

## Who employs biological forensic analysts?

South African Police Services, some small, independent contractors

**Related careers and fields:**
Biochemist, Molecular Biologist, Human Geneticist

Smoking chimneys and chemical waste streams are side effects of modern living standards. Can we find more environmentally friendly alternatives from Mother Nature in the form of enzymes?

## Who can help us unlock the potential of enzymes in our factories, for nutrition and for medicines?

# The Enzymologist!

**Meet Bethuel Nthangeni,**
Research Scientist at
the CSIR in Johannesburg
**BSc (Biochemistry, Microbiology and Physiology), BSc Hons (Biochemistry), MSc (Biochemistry), PhD (Biochemistry)**

***… the future:***
*"Most people do not understand the potential of enzymes! I believe we will get to a future where enzymes will have replaced chemical synthesis of products! No more chimneys with dark smoke!"*

***… career satisfaction:***
*"Sometimes you have to dig really hard into your intellectual resources to get an enzyme to perform a certain job. Once you do – especially if it has commercial value – it feels great!*

## What does Bethuel do?

Enzymes, which are a type of protein that speed up biological reactions (catalysts), are found in every living thing (plants, animals, humans, insects and microbes). Enzymes are made in the cells, according to their specific genetic recipe. To work, an enzyme needs a very specific target called a "substrate" with which it matches like a key fitting into a lock. Like other catalysts, an enzyme does its job without being used up or destroyed, but being a protein, it is completely biodegradable. Some enzymes found in nature work at very high or low temperatures. All of these factors make enzymes good environmental-friendly alternatives to chemical methods used for making products.

Bethuel's research aims at finding and making enzymes of the highest quality for use in the pharmaceutical industry. He is also interested in enzymes from extreme environments (extremophiles) that occur, for example, very deep under the ground in the South African goldmines, for use in chemical and food industries.

## What do I need to become an enzymologist?

**Characteristics:** Natural curiosity about all living things, good observation and analytical skills, patience
**Important school subjects:** Mathematics, Biology, Physical Science
**Relevant training and qualification:**
B Tech - Biotechnology, M Tech – Biotechnology; BSc – Biochemistry/Natural Sciences/Biological and Life Sciences/Biotechnology/Microbiology/Molecular and Cell Biology/Chemical and Biological Sciences or similar
**Note:** You need an MSc or PhD for higher positions in lecturing and research

## Where can I find a job as an enzymologist?

Pharmaceutical, food, brewing and agrochemical industries, research organisations, universities, medical research institutes, vaccine producing companies

**Related careers:**
Biochemist, Molecular Biologist, Molecular Geneticist, Microbiologist, Cell Biologist, Bioprocess Engineer

Many biotechnology based inventions with great potential for mankind are now being developed.

## Who can help protect these inventions, and enable the research costs to be recovered so that the South African economy can benefit?

# The Patent Attorney!

**Meet Sandra Clelland,**
Patent Attorney and
partner at Spoor & Fisher
in Johannesburg
**BSc (Biochemistry and Chemistry),**
**BSc Hons (Biochemistry),**
**LLB**

***… the challenge of the job:***
*"You are working with other people's intellectual property – the responsibility can be daunting! Also, it's a job defined by deadlines!"*

***… a common misconception:***
*"That the job is glamorous. It is a desk job, entailing loads of administration and long hours."*

## What does Sandra do?

Sandra helps clients in the biotechnology industry to protect their inventions by means of patenting. A patent is a government approval to an inventor so that he has the sole right to use and make profit from his invention and can prevent others from making, using or selling it for a specific time period (usually 20 years). Sandra usually has an in-depth discussion with the scientist (inventor), for example on how his HIV/Aids vaccine works, so that she can understand the invention. She then starts to write the patent specifications, and if the inventor has enough money, she may also do a local or international patent search to make sure that the idea has not been used before and is not obvious.
Sandra also manages the patent application procedure worldwide, as a patent needs to be filed in every country where the inventor wants protection for his invention. In some cases, protecting a patent also involves preparing a court case for a patent owner who wants to take legal action against a patent "infringer", in which case a lawyer will be hired to work with Sandra.

## What do I need to be a patent attorney?

**Characteristics:** Meticulous, ability to work under pressure, sound communications skills
**Important school subjects:** Biology, Mathematics, Physical Science, English
**Relevant training and qualification:** BSc – Natural Sciences/Biotechnology/Microbiology/Chemical, Molecular & Cellular Sciences/Biochemistry/Biological Sciences, or similar combined with a law degree, such as an LLB

## Where can I get a job as a Patent Attorney?

Major patent law firms with a biotechnology department, universities, biotechnology investment and funding organisations, biotechnology incubators, large pharmaceutical and biotechnology companies

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***… career satisfaction:***
*"Passing the patent attorneys' exams was an absolute highlight, as not everyone passes on their first attempt! The job can be financially rewarding!"*

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