CAREERS FOCUS: MEDICAL TECHNOLOGY

The art of being a multidisciplinary scientist

By Sipho Chauke, PhD student in the Biophotonics group, CSIR

My journey in science began when I was young. I was always fascinated by everything around me and curious about why things are the way they are. This curiosity sparked my interest in how science influences my life and the lives of others, particularly in understanding how diseases infect people and how they can be treated. The more questions I asked in my natural science classes, the more fascinated I became with science.

In high school, my interest in science deepened, particularly in drug discovery, biochemistry and microbiology. I completed my high school career with major subjects in mathematics, physical sciences, life sciences, and business studies. These subjects enabled me to apply for a biochemistry undergraduate programme at the University of Pretoria, where I obtained my degree three years later. During my undergraduate studies, I developed a strong interest in plant chemistry, drug discovery and mycotoxins. This inspired me to pursue postgraduate studies in medicinal plant science, completing both my honours and master's degrees at the University of Pretoria.

After completing my master's degree, I briefly worked for an economics research company before joining the CSIR as a laboratory technician in the Next Generation Health department. This role introduced me to techniques that enhanced my molecular biology skills through research on HIV, TB and COVID-19 diagnostics. The knowledge and experience I gained motivated me to further my studies. While exploring opportunities for funded PhD programmes, I came across an advertisement from the Biophotonics group at the CSIR. Although my knowledge of photonics was limited, I applied for the programme, eager to integrate my biology skills and experience into my PhD studies. I am currently a PhD student working on a project focused on TB diagnostics.

If I had to summarise my journey in a sentence, I would say that hard work, perseverance and a willingness to learn have been the keys to reaching where I am today. In my experience, finding opportunities in science requires an openness to learning, as science is an ever-evolving field where new techniques and technologies are discovered daily. One of the most exciting aspects of science is providing insights into new technologies and

solutions to health challenges that impact our everyday lives.

What does it mean to work in biochemistry?

In biochemistry, a biochemist typically collects, analyses, and interprets results from various laboratory tests and studies the molecular mechanisms of plants, animals, and human cells. Depending on their specific duties, some biochemists design and conduct experiments to isolate and analyse the causes of diseases, such as toxins, hormones, enzymes, and foods. Biochemists can work in medicine, veterinary science, food science, pharmaceutical industries, and agricultural fields, among many others.

What careers are there in biochemistry?

Some potential careers in biochemistry include:

- Forensic scientist
- Medicinal chemist
- Pharmacologist
- Academic researcher
- Clinical scientist or research associate
- Research scientist
- Laboratory technician
- Biochemist
- Lecturer
- Biotechnologist

The above-mentioned roles are just a few of the many career opportunities available. Biochemistry also includes different branches focusing on various disciplines:

- **Animal or plant biochemistry**: Studies chemical reactions in plants or animals.
- **Cell biology**: Explores the structure, function, and behaviour of single cells.
- **Molecular biology**: Examines the interactions and modifications of living cells and how they work together.
- **Metabolism**: Analyses how living organisms convert food into energy, store it, and eliminate waste products.
- **Immunology**: Investigates the immune systems of different species and the biochemical processes that keep organisms disease-free.
- **Enzymology**: Focuses on studying enzymes and proteins that facilitate chemical reactions in the body.

Which subjects should a learner choose in high school to qualify to study biochemistry?

To qualify for a degree in biochemistry, students should focus on pure mathematics, life sciences, and physical sciences in high school. These subjects prepare learners to pursue a science-related degree.

For an undergraduate degree, students can consider a BSc in biochemistry, which can be combined with other disciplines such as chemistry, microbiology, genetics, zoology, food science, plant science, and human physiology.

A journey in biophotonics: from rural roots to cutting-edge research

By Dr Charles Maphanga, biophotonics researcher at the CSIR

Background and inspiration

I was born and raised in Ga-Mampuru village in the Sekhukhune District of Limpopo. My schooling journey spanned three primary schools and two high schools. I started sub-A (grade 1) at Nkokoane Primary School in Limpopo in 1992 at the age of five and continued there until grade 4. In 1996, I completed grade 5 at Moruti Makuse Primary School in Witbank. The following year, I returned to Limpopo and attended Legapana Primary School in Stocking village for grade 6. I transitioned to Seokgome Secondary School for grade 8 in July 1997 and completed high school at Kgahlanong Secondary School in Longtill, matriculating in 2002 at the age of 16.

My matric subjects included Sepedi (home language), English, mathematics, physical science, biology, agricultural science and geography. In 2009, I earned a BSc in human physiology, genetics and psychology from the University of Pretoria while working full-time as a waiter, a job I thoroughly enjoyed.

After completing my degree, I undertook an 18-month internship at Inqaba Biotechnical Industries (Pty) Ltd in their DNA sequencing and oligonucleotide synthesis laboratories, funded by BioPAD (a predecessor of the Technology Innovation Agency). Following the internship, I joined AMPATH Laboratories' molecular biology lab, where I performed routine diagnostic work and pursued a fully funded BSc (Hons) in medical virology to qualify as a medical scientist.

While at AMPATH, I became intrigued by research through the work of pathologists. This interest led me to apply for a master's opportunity in biophotonics at the CSIR, which accepted candidates with a background in medical virology. I transitioned into this new field and completed an MSc in physics at UNISA with distinction in 2017. This marked a significant shift, as I had to adapt to designing, aligning and optimising optical systems. With mentorship from senior staff, I eventually succeeded. I later enrolled for a PhD in physics at the University of KwaZulu-Natal, which I completed in 2023.

Throughout my journey, my humble family background has inspired me to persevere, with education serving as my only viable path to success.

Research focus and impact

My research at the CSIR Biophotonics Research Group focuses on developing optical biosensing platforms for TB diagnostics, with the goal of creating point-of-care (POC) systems for regions with high TB prevalence. My work involves designing multiplex immunosensors to detect biomarkers of active TB in sputum samples using custom-built optical systems. This innovation aims to facilitate rapid, non-invasive diagnostics in remote areas with limited access to conventional TB testing.

My background in clinical laboratory diagnostics, gained through my roles at AMPATH Laboratories and Inqaba Biotechnical Industries, has been instrumental in shaping my research. This experience provided a strong foundation in molecular techniques and diagnostic processes, which I have applied to my TB biosensing work. My PhD research contributed to a patent submission and broadened my expertise across molecular biology, biotechnology, biosensing, optics and photonics.

Growing up in a village, I witnessed the challenges of accessing timely TB diagnostics, which often left individuals undiagnosed and increased the risk of infection in communities, especially for those living with HIV. My research aims to close this gap by enabling real-time TB diagnosis, facilitating early treatment, and reducing the spread of TB in resource-limited settings.

Interdisciplinary collaboration

Collaboration is a cornerstone of the CSIR's EPIC values – to pursue Excellence, celebrate People, personify Integrity and welcome Collaboration. In my field, interdisciplinary partnerships – both within the CSIR and with external stakeholders such as universities and diagnostic industry leaders – are vital. Combining expertise in photonics, molecular biology and artificial intelligence can drive innovative developments, such as AI-assisted biosensors, that would be difficult to achieve independently.

Advice for high school learners interested in medicine and technology

The multidisciplinary nature of medicine and technology offers many career paths. High school learners should focus on pure mathematics, physical science and life sciences to prepare for science-related degree programmes.

At university, students can pursue degrees in fields such as human physiology, genetics, microbiology, biochemistry, biotechnology, medical sciences, biological sciences, physics, or biomedical engineering. Universities of technology also offer specialised programmes such as clinical technology, medical technology or medical laboratory science.

Careers in medicine and technology

Medical technologist: Specialises in analysing tissues or bodily fluids to assist in laboratory-based clinical diagnoses. This requires a degree in medical technology, an internship accredited by the Health Professions Council of South Africa (HPCSA), and board certification.

Clinical technologist: Focuses on diagnosing and treating organ-related conditions using specialised equipment. To qualify, candidates must complete a degree, an internship, and board certification through the HPCSA.

Medical scientist: Delivers essential laboratory analyses to aid in disease diagnosis, treatment and prevention. This career path involves earning a BSc (Hons) and obtaining HPCSA registration through a similar process as medical technologists.

Medical physicist: Applies physics principles in diagnosing and treating diseases, particularly in radiotherapy, diagnostic radiology, nuclear medicine and radiation protection. An MSc in medical physics is typically required, along with HPCSA registration.

Biomedical or clinical engineer: Designs and maintains medical equipment to improve patient care. A degree in biomedical engineering, such as the one offered by the University of the Witwatersrand, provides access to careers in hospitals, laboratories, or medical equipment companies.

Researcher: Requires postgraduate qualifications, with a PhD being essential for leading roles. Career opportunities exist in biotechnology, bioinformatics, epidemiology, biophysics and more.

Personal reflections

My role as a biophotonics researcher has provided incredible opportunities. I've presented my work on international platforms, such as the Society for Photo-optical Instrumentation Engineers (SPIE) Photonics West conference in San Francisco, and locally at events like the South African Institute of Physics (SAIP) conference and Stellenbosch University's African Laser Centre (ALC) workshop. I've also received recognition, including awards for presentations and being named one of *Mail & Guardian's* 200 Young South Africans in Health.

Mentoring and skill-sharing are passions of mine. I currently mentor for the CSIR-Youth Employment Services (YES) programme and train junior staff members in the Biophotonics Research Group. Outside of work, I enjoy exploring cuisines (with Indian food being my favourite), cooking, farming, and spending time with family and friends.