

Measuring regional innovation systems in the Western Cape:  
Biotechnology Sector

Wouter Grove

Tino Ncube

December 2022



## Table of Contents

<b>List of tables</b>	4
<b>List of Figures</b>	5
<b>List of Definitions</b>	6
<b>List of Abbreviations</b>	7
<b>1. Introduction</b>	8
<b>2. Aims &amp; Objectives</b>	8
<b>3. Methodology</b>	9
<b>4. Framework</b>	10
<b>5. The Biotechnology Landscape</b>	12
5.1. Global Perspective	12
5.2. South African Perspective	16
5.3. Key Role of National Government	18
5.4. Funding agencies	22
<b>6. South African Biotechnology Subsectors</b>	23
<b>7. Western Cape Perspective</b>	26
7.1. Agricultural Biotechnology	27
7.1.1. Academic Institutions	28
7.1.2. Public Organisations	30
7.1.3. Private Organisations	30
7.2. Health Biotechnology	32
7.2.1. Academic Institutions	32
7.2.2. Public Organisations	38
7.2.3. Private Organisations	39
7.3. Industrial Biotechnology	46
7.3.1. Academic Institutions	46
7.3.2. Public Organisations	50
7.3.3. Private Organisations	50
<b>8. Innovation Maturity Functions</b>	52
<b>9. Findings (Western Cape)</b>	64
9.1. SWOT Analysis: WC Biotechnology sector	66

<b>9.2. Promotors</b>	68
<b>9.3. Barriers</b>	69
<b>9.4. Recommendations</b>	69
<b>10. Close and future activities/research</b>	70
<b>References</b>	72

## List of tables

---

Table 1: Systems Functions	11
Table 2: National roleplayers in Bioeconomy Strategy (DST)	18
Table 3: Biotechnology sub-sectors in SA	23
Table 4 Bio-economy GDP output and share of total South African GDP - Quantec and Statistics SA - (NACI 2022) - adapted	24
Table 5: South African bio-economy sector employment- Quantec & Stats SA (NACI 2022)- adapted	25
Table 6: Agricultural Biotech - Academic ecosystem	30
Table 7 Agricultural Biotech - Examples of startups	32
Table 8: Health Biotech - Academic ecosystem	38
Table 9 Health Biotech - Selected Firms	40
Table 10: Health Biotech - Selected startups	42
Table 11: Health Biotech - UTF Funded Startups	43
Table 12: Health Biotech- Selected VC funded startups	45
Table 13: Industrial Biotech - Academic ecosystem	50
Table 14: WC Biotech RIS Innovation Maturity	63
Table 15: SWOT analysis of Western Cape Biotechnology industry	68

## List of Figures

---

Figure 1: Analytic framework for an inclusive innovation system (Grobelaar et al., 2016)	10
Figure 2: Readiness towards use, adoption & adaptation of frontier technologies, selected countries (UNCTAD 2021)	13
Figure 3: Key indicator comparison between gene-editing and selected other frontier technologies (UNCTAD 2021)	15
Figure 4: <i>DTIC Innovation and Technology Funding Instruments (DTIC)</i>	22
Figure 5: Biotech sector growth (Deloitte Analysis 2020)	65

## List of Definitions

---

### **Bio-economy**

The term encompasses biotechnological activities and processes that translate into economic outputs, particularly those with industrial application. Within the South African context these may include, but are not limited to, technological and non-technological exploitation of natural resources such as animals, plant biodiversity, micro-organisms and minerals to improve human health, address food security and subsequently contribute to economic growth and improved quality of life (DST, 2013).

### **Biotechnology**

A set of technologies including, but not confined to, tissue culture and recombinant DNA techniques, bioinformatics and genomics, proteomics and structural biology, and all other techniques employed for the genetic modification of living organisms, used to exploit and modify living organisms so as to produce new intellectual property, tools, goods, products and services (Biotechnology Strategy 2001).

### **Gene editing**

Gene editing, also known as genome editing, is a genetic engineering tool to insert, delete or modify the genome in organisms. Potential applications include drought-tolerant crops or new antibiotics (UNCTAD, 2021).

### **Nanotechnology**

A field of applied science and technology dealing with the manufacturing of objects in scales smaller than 1 micrometre. Nanotechnology is used to produce a wide range of useful products such as pharmaceuticals, commercial polymers and protective coatings. It can also be used to design of computer chip layouts (UNCTAD, 2021).

## List of Abbreviations

---

<b>CAGR</b>	Compound Annual Growth Rate
<b>CESTII</b>	Centre of Science, Technology and Innovation Indicators at the HSRC
<b>CPGR</b>	Centre for Proteomic & Genomic Research
<b>COVAX</b>	COVAX is the vaccines pillar of the Access to COVID-19 Tools (ACT) Accelerator of the World Health Organisation
<b>CRISPR</b>	Clustered Regularly Interspaced Short Palindromic Repeats
<b>CSIR</b>	Council for Scientific and Industrial Research
<b>CPUT</b>	Cape Peninsula University of Technology
<b>DHET</b>	Department of Higher Education and Training
<b>DNA</b>	Deoxyribonucleic Acid
<b>DST</b>	Department of Science and Technology – name changed in 2019 to Department of Science and Innovation (DSI)
<b>EU</b>	European Union
<b>GERD</b>	Gross Domestic Expenditure on Research and Development
<b>HSRC</b>	Human Sciences Research Council
<b>IKS</b>	Indigenous Knowledge Systems
<b>mRNA</b>	Messenger RNA is a type of single-stranded RNA involved in protein synthesis
<b>NACI</b>	National Advisory Council on Innovation
<b>NRF</b>	National Research Foundation
<b>PCR</b>	Polymerase Chain Reaction
<b>RNA</b>	Ribonucleic acid is a polymeric molecule essential in various biological roles in coding, decoding, regulation and expression of genes
<b>SAMRC</b>	South African Medical Research Council
<b>SU</b>	Stellenbosch University
<b>STI</b>	Science, Technology and Innovation
<b>TIA</b>	Technology Innovation Agency
<b>THRIP</b>	The Technology and Human Resources for Industry Programme
<b>UTF</b>	The University Technology Fund (UTF)
<b>UCT</b>	University of Cape Town
<b>UWC</b>	University of the Western Cape
<b>WC</b>	Western Cape
<b>WHO</b>	World Health Organisation

## 1. Introduction

---

The Cape Higher Education Consortium (CHEC) and Western Cape Government (WCG) has commissioned the development and study of regional innovation systems (RIS) in the Western Cape. RIS includes more than the geographic clustering of related industries or sectors and calls for an institutional framework that promotes active networking through social and institutional interactions intending to build deep knowledge and excellence in each area of expertise. Knowledge is seen as central to this system, and current literature has identified the importance of the geographical dimensions of knowledge transfer as a key variable shaping regional innovation performance. However, many factors mediate this relationship. These include the strength of the science base and knowledge transfer system; the institutional setting; the financial system; education and training; the availability and mobility of skilled labour (human capital); and public policy measures designed to promote innovation and growth.

This document focuses on the Biotechnology Sector, as an identified Regional Innovation Sub-Sector.

## 2. Aims & Objectives

---

The research undertaken will include the identification of existing networks and role-players, factors that influence regional innovation in these sectors, and any further support required.

The premise is that innovation, in firms, enables improved competitiveness, and that regional development ensues. This, in turn, leads to better outcomes in the social and economic fabric of the region (e.g., increased food security, improved health etc.).

The scope of this report is to assist CHEC to assist in updating the baseline information on the Biotechnology sector in the Western Cape. The scope of work to support CHEC should entail:

- Literature review on the sector with specific emphasis on the Western Cape Province
  - Utilising publicly available literature on the Biotechnology sector
  - Collecting information on Biotechnology initiatives
  - Develop a baseline understanding of the sector landscape, including key players, high level value chain and business models
- Environmental scan using both qualitative and, where possible quantitative, data points
  - Review of domestic and global positioning of the Western Cape Biotechnology sector
  - Inputs from key sectoral players

This report provides an overview of the current Biotechnology ecosystem, which allows other researchers and collaborators to adopt a common frame of reference. It is not a strategy document, nor is it a comprehensive literature review using citation indices or bibliometrics.

### 3. Methodology

---

The following methodology was used to prepare this baseline overview:

- Secondary desk research of relevant research papers, articles and documents on innovation systems
- Secondary desk research of the relevant policies and strategies affecting the WC Biotechnology ecosystem
- Secondary desk research of the relevant models guiding the discourse on the WC Biotechnology ecosystem
- Interviews and other engagements with selected practitioners to add value by corroborating, or contesting, the findings

The generally accepted protocols of conducting secondary research and the appropriate conventions for referencing secondary research data have been followed consistently.

The generally accepted protocols of conducting secondary research and the appropriate conventions for referencing secondary research data have been followed consistently.

The intention of the project was to utilize quantitative methods to build an interactive and visual presentation of the main actors, intermediaries, and their interactions, however access to data proved to be exceedingly difficult and cumbersome. As a result, the current version of the report will capitalize predominantly on qualitative data sources. However, the intention is to supplement the current version of the report with quantitative data. The project also aimed to establish a common measurement framework that can be used by future researchers to enhance and enrich our current understanding of Regional Innovation Systems in the Western Cape Province.

## 4. Framework

The maturity framework developed as part of the study by Grobbelaar et al., (2016) is adopted in this chapter as it is a valuable instrument to structure the baseline information on existing areas of innovation in the WC. Their conceptual framework is illustrated in **Figure 1** below.

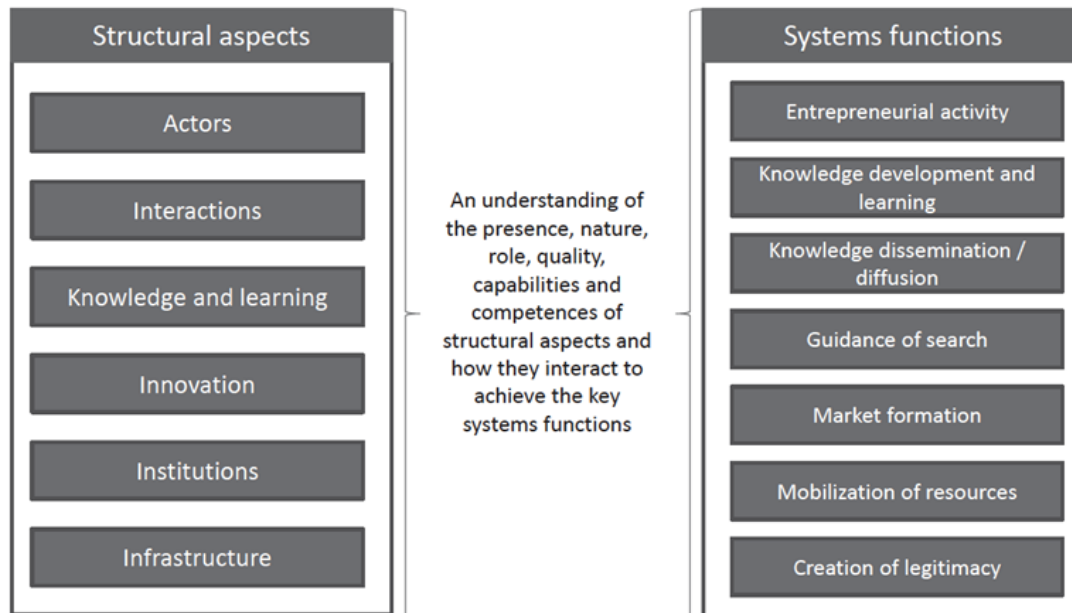


Figure 1: Analytic framework for an inclusive innovation system (Grobbelaar et al., 2016)

The above maturity framework is divided into the structural aspects and the systems functions. The structural aspects or components-based approach allows *“the analyst to acknowledge that the economy is a system with various actors and linkages between them”* (Grobbelaar et al., 2016). While the systems functions or function-based approach helps *“to understand the activities and functions that need to be performed in a system to ensure that the system achieves its goals, i.e., innovations are developed and diffused”* (Grobbelaar et al., 2016). In this chapter, emphasis is placed on the "systems functions". The different functions along with their respective definitions are presented in the **Table 1** below.



<b>Systems Functions</b>	<b>Definition</b>
F1: Entrepreneurial activity:	Functions through which the region could create businesses opportunities to capitalise on ideas - possibly through business-level or sector-level interventions (Grobbelaar et al., 2016).
F2: Knowledge development and learning:	This function defines the processes of knowledge learning and development through formal R&D or informal knowledge production activities (Grobbelaar et al., 2016).
F3: Knowledge dissemination/diffusion:	The role of supporting the dissemination of innovations and ideas - possibly through demand-side, supply-side and support mechanisms (Grobbelaar et al., 2016).
F4: Guidance of Search:	Guidance on relevant investment in technology or projects.
F5: Market formation:	The process through which the region can create a space in which innovations can be developed and introduced to markets – e.g., access to markets (Grobbelaar et al., 2016).
F6: Mobilisation of resources:	Support access to financial and human and resources available for innovation (Grobbelaar et al., 2016).
F7: Creation of legitimacy:	It aims to ensure that enough support is in place to legitimise commitment and resources from the private sector and government to support innovation (Grobbelaar et al., 2016).

*Table 1: Systems Functions*

## 5. The Biotechnology Landscape

---

This report will detail a global perspective on the biotechnology sector, after which the South African environment and context will be investigated. The Western Cape Biotechnology RIS will then be assessed and discussed based on the framework.

### 5.1. Global Perspective

According to the United Nations Conference on Trade and Development:

*“Human development over the past two decades has been accompanied by rapid changes in technology and an increasing proliferation of digitized devices and services. In many respects these have been beneficial. Innovation has driven economic development – and the pace of change seems likely to accelerate as a result of digitalization and advances in “frontier technologies” such as artificial intelligence (AI), robotics, biotechnology, and nanotechnology, all of which could help countries achieve the Sustainable Development Goals (SDGs)” (UNCTAD, 2021).*

Biotechnology includes various highly specialised technologies and techniques, amongst others, Tissue Engineering and Regeneration, Nanobiotechnology, Fermentation, DNA Sequencing, Cell-based Assays, PCR Technology and Chromatography.

The global biotechnology market size is projected to be around US\$ 3.44 trillion by 2030 from being valued at US\$ 852.88 billion in 2020 and is anticipated to grow at a CAGR of 17.83% during the forecast period 2021 to 2030 (Vision Research Reports, 2022) . Key global roleplayers include AstraZeneca, Gilead Sciences, Inc., Celgene Corporation, Biogen, Abbott, Amgen Inc., Novo Nordisk A/S, Merck & Co., Johnson & Johnson Services, Inc., Novartis AG, Sanofi, F. Hoffmann-La Roche Ltd., Pfizer, Inc. and Lonza. Most of these firms have some presence in South Africa with several having an operational presence in the Western Cape.

Historically most biotechnology revenues are generated by commercial leaders (defined here as the companies that generate more than US\$500 million in annual revenue), predominantly based in the US and EU, with China and India emerging as more prominent roleplayers. “In 2021, the 46 commercial leaders generated 86% of the industry’s total revenues. However, within this leading group, an astonishing 22% of all revenues were generated solely by the two companies that pioneered mRNA- based vaccines against COVID-19: BioNTech and Moderna, which collectively generated over US\$40 billion in 2021 revenues” (EY, 2022). The Biotechnology sector exceptionally well in 2021, not in spite of but because of the COVID-19 crisis with biotech revenues hitting US\$216.7 billion in 2021 — a dramatic 35% annual increase on 2020 (EY, 2022).

Within the global context biotechnology should not be viewed in isolation from other so-called “frontier technologies”, such as Artificial Intelligence, Robotics, Nanotechnology, Big Data Internet of Things, 3D Printing, Gene Editing and other ICT and energy-related technologies such as solar power.

Only a few countries are currently producing the bulk of these frontier technologies and in the short run this is unlikely to change. Although the South African biotechnology market is quite small compared to other BRICS countries, its growth potential is high (Patra & Muchie, 2017). South Africa has the potential to grow its share within niche technology sectors and so contribute to its economic and social goals, albeit against facing challenges relating to mainly Skills and ICT readiness, as well as untapped potential in Research and Development. See for example how South Africa readiness towards the use, adoption and adaptation of frontier technologies ranks against selected countries (UNCTAD, 2021) (Figure 1).

Concerningly South Africa in 2020 had the lowest technology readiness index of the BRICS countries. Its main weaknesses were in the areas of skills (where it ranks 84th of 158), industry activity (71st) and ICT deployment (69th). The availability of finance (13th) was highlighted as an area of strength.

Country name	Total ranking	ICT ranking	Skills ranking	R&D ranking	Industry ranking	Finance ranking
<b>Top 10</b>						
United States of America	1	14	17	2	20	2
Switzerland	2	7	13	13	3	3
United Kingdom	3	17	12	6	11	14
Sweden	4	1	7	16	15	16
Singapore	5	4	9	18	4	18
Netherlands	6	6	10	15	8	23
Korea, Republic of	7	19	27	3	9	8
Ireland	8	24	6	21	1	87
Germany	9	23	16	5	10	39
Denmark	10	2	4	25	21	5
<b>Selected transition and developing economies</b>						
China	25	99	96	1	7	6
Russian Federation	27	39	28	11	66	45
Brazil	41	73	53	17	42	60
India	43	93	108	4	28	76
South Africa	54	69	84	39	71	13

Figure 2: Readiness towards use, adoption & adaptation of frontier technologies, selected countries (UNCTAD 2021)

South Africa's knowledge base (based on scholarly publications from the Web of Science (WoS) Medline database is small compared to other countries, however South African papers are very highly cited - often having high international relevance and impact (Patra & Muchie, 2017).

Against the background of the Covid 19 pandemic, gene-editing has been a significant frontier technology with that showed high potential to contribute to healthcare (decreased time-to-market). Its potential to contribute to food security and environmental sustainability also continues to grow as development costs reduce and technologies such as CRISPR become more widely available. See **Figure 2** for key indicator comparison between gene-editing and selected other frontier technologies.



## Key indicators












Technology	 Drones	 Gene editing	 5G	 Nanotechnology	 Solar photovoltaic (Solar PV)
<b>Publications (1996-2018)</b> 	10,979	12,947	6,828	152,359	10,768
<b>Patents (1996-2018)</b> 	10,897	2,899	4,161	4,293	20,074
<b>Price</b> 	Commercial drones: \$50–\$300,000 (high-end: \$1000–\$4000), Military drones: \$14.5 million (MQ-9 Reaper)	Standard in vitro fertilization: over \$20,000/try + \$10,000 or more for tests	\$0–20/month more than 4G network	Anti-cancer drug with nanotechnology: \$4,363/cycle	Residential PV system (6kW): \$16,200–\$21,420
<b>Market size</b> 	\$69 billion (2017) \$141 billion (2023)	\$3.7 billion (2018) \$9.7 billion (2025)	\$608 million (2018) \$277 billion (2025)	\$1 billion (2018) \$2.2 billion (2025)	\$54 billion (2018) \$334 billion (2026)
<b>Major providers</b> 	3D Robotics, DJI Innovations, Parrot, Yuneec (commercial drones) Boeing, Lockheed Martin, Northrop Grumman Corporation (military drones)	CRISPR Therapeutics, Editas Medicine, Horizon Discovery Group, Intellia Therapeutics, Precision BioSciences, Sangamo Therapeutics	Ericsson, Huawei, Nokia, ZTE (network equipment) Huawei, Intel, MediaTek, Qualcomm, Samsung Electronics (chip)	BASF, Apeel Sciences, Agilent, Samsung Electronics, Intel	Jinko Solar, JA Solar, Trina Solar, Canadian Solar, Hanwha Q cells
<b>Major users</b> 	Utilities, construction, discrete manufacturing	Pharma-biotech, academic/ research centre, agrigenomic/ contract research organizations	Energy utilities, manufacturing, public safety	Medicine, manufacturing, energy	Residential, Commercial, Utilities

Figure 3: Key indicator comparison between gene-editing and selected other frontier technologies (UNCTAD 2021)

## 5.2. South African Perspective

This section of the reports provides an overview of literature relevant for the South African and the Western Cape Bio-technology sector and provides a perspective on the current state of the South African sector.

Since the adoption of South Africa's National Biotechnology Strategy in 2001, informed by Biotechnology Sector audits in 2003 and 2007 and the culmination of these initiatives in the *Bio-Economy Strategy* adopted in 2013, the government has identified Biotechnology as a potentially valuable contributor to the South African economy and innovation progress, specifically targeting increased contribution of the bio-economy to GDP through high growth, creation of employment and making the country more internationally competitive.

Developing the bio-economy will however require a range of competencies beyond biotechnology, including information and communications technology (ICT), nanomaterials research and manufacture, bio- entrepreneurship, the social sciences and intellectual property management (DST, 2013). Thus, from an initial focus on biotechnology, the policy focus has broadened to view biotechnology as part of the broader bioeconomy.

From the initial 2001 definition of Biotechnology as the *“set of technologies including, but not confined to, tissue culture and recombinant DNA techniques, bioinformatics and genomics, proteomics and structural biology, and all other techniques employed for the genetic modification of living organisms, used to exploit and modify living organisms so as to produce new intellectual property, tools, goods, products and services”*, the definition broadened.

The term bio-economy is defined as follows:

*“The term “Bio-economy” encompasses biotechnological activities and processes that translate into economic outputs, particularly those with industrial application. Within the South African context these may include, but are not limited to, technological and non-technological exploitation of natural resources such as animals, plant biodiversity, micro-organisms and minerals to improve human health, address food security and subsequently contribute to economic growth and improved quality of life”* (DST, 2013).

The 2013 Bio-economy strategy is positioned within the *National System of Innovation* (NSI) established following the 1996 White Paper on Science and Technology and the subsequent the creation and enablement of the National Government's Science, Technology and Innovation (STI) policies:

*“The NSI concept will be retained as an organising framework, and interactions and partnerships will be encouraged between business, government (including Public Research Institutions), higher education institutions (HEIs) and civil society”* (DST, 2019).

In December 2022 the Science, Technology and Innovation (STI) Decadal Plan has been approved by Cabinet, in a move to advance government's approach to innovation in the country. In terms of the focus areas, the decadal plan prioritises five key elements, namely:

- Modernisation of agricultural, manufacturing and mining sectors.
- Exploitation of new sources of growth, particularly the digital and circular economy.
- Large research and innovation programmes in the areas of health and energy.
- Utilising STI to support a capable state.
- Addressing three societal grand challenges: climate change and environmental sustainability; the future of education, skills development and work; and the future of society.

The expressed 2030 national government vision for the bio-economy can be summarised as follows:

*“The vision is for South Africa’s bio-economy to be a significant contributor to the country’s economy by 2030 in terms of the gross domestic product (GDP). This is to be achieved through the creation and growth of novel industries that generate and develop bio-based services, products and innovations. Such endeavours should translate into a corresponding increase in new companies and growth of existing companies that provide and utilise these solutions. On a macro-economic and developmental level, South Africa’s thriving bio-economy has the potential to make the country more competitive internationally (especially in the industrial and agricultural sectors); create more sustainable jobs; enhance food security; and create a greener economy as the country shifts towards a low-carbon economy” (DST, 2013).*

The economic activity in the bio-economy is driven by research and innovation in the life sciences and biotechnology, and is enabled by technological advances in engineering, manufacturing and computing and information sciences, including fields such as bio-informatics.

South Africa’s biotechnology sector, although highly respected internationally still contributes only a small patent portfolio and “the publication and patent portfolios show that university research output is not readily being translated into commercial products” (Patra & Muchie, 2017).

The convergence between biological and digital technologies is of critical importance to the Western Cape, as the region has a very strong ICT ecosystem, coupled with strong R&D expertise within the bio-economy and bio-technology in particular. Multi-disciplinary enablement of the synergies between these sectors can potentially unlock various benefits, including more focused skill-development initiatives, more shared awareness of market opportunities and more efficient allocation of limited funding.

### 5.3. Key Role of National Government

The key national government roleplayers in the Bio-Economy strategy are as follows (DST, 2013):

	Drive innovation	Priority setting	Human capital development	Implementation of innovative strategies	Funding
Science and Technology	✓		✓	✓	✓
Health	✓	✓	✓	✓	✓
Trade and Industry	✓	✓		✓	✓
Agriculture, Forestry and Fisheries	✓	✓	✓	✓	✓
Environmental Affairs	✓	✓		✓	✓
Higher Education and Training			✓		✓
Economic Development	✓	✓		✓	✓
Energy	✓	✓		✓	✓
Mineral Resources	✓			✓	✓
Rural Development and Land Reform	✓	✓	✓	✓	✓
Water Affairs	✓	✓		✓	✓
Social Development	✓	✓	✓	✓	✓
Human Settlements	✓	✓		✓	✓
Traditional Affairs	✓	✓		✓	
National Treasury	✓	✓			✓

Table 2: National roleplayers in Bioeconomy Strategy (DST)

The entities that are directly involved in innovation within the Biotechnology Industry include:

#### National Advisory Council on Innovation (NACI)

An advisory body to government on science, technology and innovation with the mission to provide evidence-based advice to the Minister of Higher Education, Science and Innovation and, through the Minister, Cabinet on science, technology and innovation matters, through the research expertise and stakeholders engagement.

NACI, situated in the in Department of Science and Innovation (DSI), is responsible for the creation of a well-coordinated, responsive and functioning national system of innovation

- Data Providers: Centre of Science, Technology and Innovation Indicators (CESTII) at the HSRC;
- Department of Higher Education and Training (DHET) through the DST.

## Technology Innovation Agency (TIA)

TIA is one of the primary implementation actors of the Bio-economy Strategy, through its Bio-economy Division, which includes Indigenous Knowledge Systems (IKS). Within the **Technology Innovation Agency (TIA)**, the following initiatives has touchpoints to biotechnology:

- South African Biodesign Initiative
- SABDI is a Department of Science and Innovation (DSI) – contracted fund which supports collaborative and integrative research projects that focus on functional genomics, structural biology, synthetic biology and systems biology. SABDI is particularly interested in bridging the physical, computational, engineering and life science disciplines.
- Technology Platform Programme
- Technology Platform Programme (TPP) exists to facilitate access to cutting edge technological capabilities by investing in and supporting entities to acquire appropriate technologies and expertise that in turn lower the barriers for others to innovate. The programme identifies and co-develops opportunities and funds and supports Technology Platforms to build long-term technological capabilities in the National System of Innovation (NSI).
- Technology Innovation Cluster Programme
- Technology Innovation Cluster Programmes are collaborative programmes aimed at leveraging the strengths of multiple partners to drive a technology solution and alleviate common industry specific pain points, lowering the hurdles to support economic growth.
- Technology Stations Programme
- The goal of the Technology Stations Programme is to contribute towards improving the competitiveness of industry through the application of specialised knowledge and technology, facilitating the interaction between industry and academia, to enable innovation.
  - Of specific relevance is the Agrifood Technology Station ([ATS](#)) - Cape Peninsula University of Technology
  - The Station is a platform that provides an affordable range of interdisciplinary technological services to the Agrifood sector, focusing on existing smaller and medium enterprises, with a view to improving competitiveness, innovation and R&D capacity in a sustainable manner.

### Supporting Institutions: Science Councils

The following Science Councils are particularly relevant as supporting agencies for the Biotechnology Industry and the Bioeconomy strategy:

- Agricultural Research Council
- Council for Scientific and Industrial Research
- National Research Foundation
- South African Medical Research Council
- South African National Biodiversity Institute

### Supporting Instruments

Various instruments have been introduced to expand the research system, including the

- South African Research Chairs Initiative (SARChI)
  - The Department of Science and Innovation's South African Research Chairs Initiative (SARChI) is managed by the National Research Foundation (NRF). The chairs are held by individuals.
  - In Section 9 the depth of the R&D capacity in the Western Cape is illustrated by providing a short summary of key research chairs at the four main universities in the region.
- Centres of Excellence
  - In Section 9 the depth of the R&D capacity in the Western Cape is illustrated by providing a short summary of Centres of Excellence at the four main universities in the region, i.e. Centre of Excellence for Biomedical Tuberculosis (TB) Research (CBTBR) at UCT.
- Sector Innovation Funds (SIF)
  - i.e., SIF support has been given to the Wine Industry Network of Expertise and Technology through WINETECH.

Various key biotechnology actors and institutions are based in the Western Cape, for example:

- Biotechnology innovation centres has been established, including the **Cape Biotech Trust**, BioPAD, , LIFElab and PlantBio, as well as two other structures, the **National Bioinformatics Network** and the **Public Understanding of Biotechnology Programme**.
  - The Cape Biotech Trust has developed into a successful biotechnology company, **CapeBio™ Technologies Pty Ltd** ([Capebio™](#)), a central roleplayer in biotechnology in South Africa and respected internationally.

- The [Centre for Proteomic & Genomic Research](#) (CPGR) is a non-profit company located in Cape Town, South Africa, based on an initiative by the Department of Science and Innovation (DSI), and financially supported by the Technology Innovation Agency (TIA). The CPGR combines state-of-the-art information-rich genomic and proteomic ('omics') technologies with bio-computational pipelines to render services and support projects in the life science and biomedical arena in South Africa, all run in an ISO 9001:2015 certified and ISO 17025 compliant quality management system.
  - Among others, the CPGR has recently launched an accelerator program to stimulate the creation of South African start-ups based on 'omics' technologies and set up Artisan Biomed to develop and implement Precision Medicine solutions in (South) Africa.
  - Specific services focus on Genomics, Proteomics, Training and the Omics Startup Accelerator
  - In December 2017, CPGR entered into a partnership with the Sunflower Fund to enhance stem cell donor typing in Africa.
  - In support of Genomics capacity development in Africa, CPGR has launched the iScan system for high-end genotyping studies in early 2018.
  - CPGR also hosts [DIPLOMICS](#), a large infrastructure program initiated by the DSI.
  
- [Biosafety South Africa](#) (based in Somerset West) Biosafety South Africa is a national technology platform in service of the country's biotech regulators, researchers, technology developers and public. Their mandate is to enable safe, sustainable and compliant research, development, production, use and application of biotechnology - in particular GMOs. They are an initiative of the Department of Science and Innovation.

## 5.4. Funding agencies

Despite the availability of DTIC technology and innovation funding instruments (see Figure 3), (specifically the THRIP programme), as well as various funding instruments provided by the [Technology Innovation Agency](#), raising funding for early-stage biotechnology R&D is still very challenging.

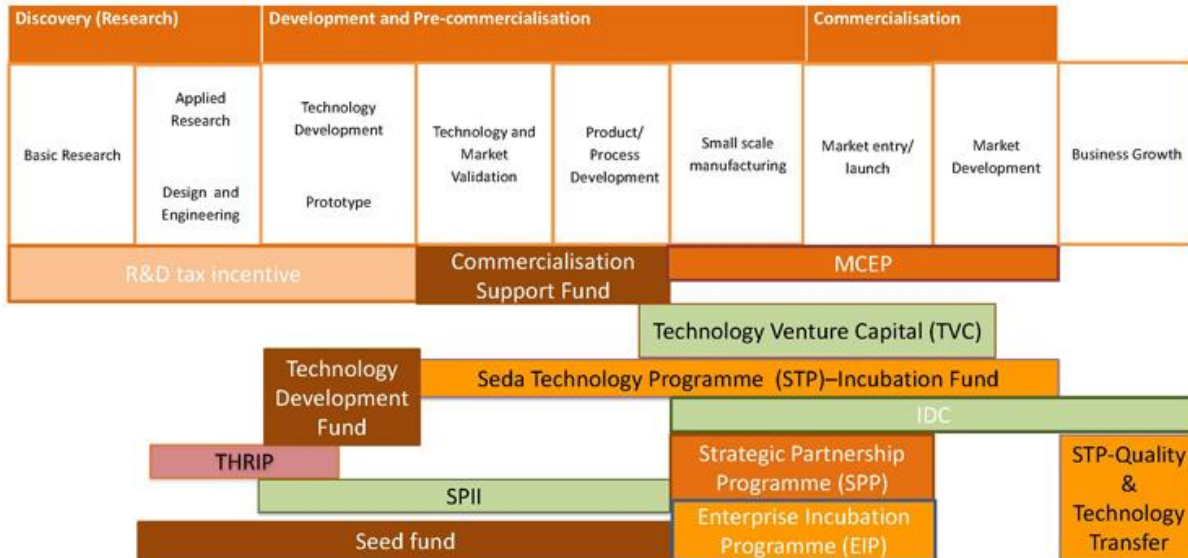


Figure 4: [DTIC Innovation and Technology Funding Instruments \(DTIC\)](#)

The Technology and Human Resources for Industry Programme (THRIP) incentive funds applied research, design and engineering and technology development and is implemented by the National Research Foundation (NRF). The incentive functions according to a 50:50 cost-sharing grant, to a maximum of R8m per annum, across any number of projects.

Specialist funding for biotechnology commercialisation is a challenge, especially due to high upfront cost and long time-to-market timelines. [One Bio Venture Studio](#), a Cape Town-based Venture Capital Firm, is one of the relatively few dedicated early-stage biotechnology funders, having made investments in precision-medicine (i.e., BixBio) as well as a remote patient monitoring. SA and US-based biotech startup [LifeQ](#) has secured \$47-million in Series A funding from One Bio Venture Studio and several other investors.

The [University Technology Fund \(UTF\)](#) is a venture fund specifically focussed on commercialising technology, intellectual property, and research originating from South African Universities. The UTF therefore bridges the gap between technology ideation, research, and intellectual property development at higher education institutions and the commercialisation thereof. Most UTF-funded biotechnology projects are based in the Western Cape.

## 6. South African Biotechnology Subsectors

The Bio-Economy Strategy of South Africa (DST, 2013) identifies four key areas of focus, each of which with specific areas of application and touchpoints with the biotechnology sector:

<b>Agriculture</b>
<ul style="list-style-type: none"> <li>• Crop improvement (focused on i.e., heat resistance and drought tolerance)</li> <li>• Livestock improvement</li> <li>• Food quality and nutritional value</li> <li>• Energy crops</li> <li>• Bio-pesticides and bio-fertilisers</li> <li>• Vaccines and diagnostics</li> </ul>
<b>Health</b>
<ul style="list-style-type: none"> <li>• Active pharmaceutical ingredients</li> <li>• Vaccines</li> <li>• Biopharmaceuticals</li> <li>• Diagnostics</li> <li>• Medical devices</li> </ul>
<b>Industrial &amp; Environmental</b>
<ul style="list-style-type: none"> <li>• Bio-based chemicals</li> <li>• Biomaterials</li> <li>• Bio-energy</li> <li>• Water and waste (water treatment and waste recycling)</li> <li>• Food</li> <li>• Bio-plastics</li> <li>• Paper and pulp</li> </ul>
<b>Indigenous Knowledge Systems (IKS)</b>
<ul style="list-style-type: none"> <li>• Bio-prospecting</li> <li>• Herbal medicine</li> <li>• African traditional medicine</li> </ul>

*Table 3: Biotechnology sub-sectors in SA*

Indigenous Knowledge Systems has also been viewed as a potential cross-cutting focus area as it may have potential application across the Health, Agriculture and Industrial & Environmental Sectors. It is further important to recognise the fact that the impact of bio-technologies in value chains may present on a continuum ranging from more direct impact in fully-bio-based sectors (i.e., agriculture) to partially bio-based sectors (i.e., bio-materials; bio-chemicals).

Biotechnology start-ups in South Africa are mainly focused on development of niche applications in agricultural, animal and human health, chemical, forestry, vaccine, mining, pharmaceutical, beer and wine industries (Esterhuizen & Cladwell, 2021) with a characteristic being a heavy dependence on:

- imported biotechnology
- external funding and
- international collaborations

Commercial applications that created and are in processes of commercialising unique intellectual properties and patents were especially prevalent in the fields of vaccine development and drug delivery systems (Esterhuizen & Cladwell, 2021).

A significant amount of the Technology Innovation Agency (TIA)'s project expenditure in 2019/20 went to the bio-economy portfolio (R187 million, or 41.7%) (NACI, 2022). South Africa's share of biotechnology and applied microbiology publications (articles and reviews) increased from 207 in 2010 to 253 in 2020, representing 0,681 % of the world share (CREST, Stellenbosch University as referenced in (NACI, 2022) with 8 patents granted by the USPTO in 2019.

The Bioeconomy's contribution to GDP output and share of total GDP is indicated below (NACI, 2022):

	<b>Bio-economy GDP output (R million at constant 2015 prices)</b>	<b>Bioeconomy's share of total GDP (%)</b>
2010	300 221	8,31
2018	336 146	8,16
2019	328 956	7,98
2020	321 536	8,29
Base: 2013-15	314 669	8,00

*Table 4 Bio-economy GDP output and share of total South African GDP - Quantec and Statistics SA - (NACI 2022) - adapted*

The share of the bio-economy in total South African employment in 2020 (10,7%) was marginally lower than the yearly average for the period 2013-2015 (10,9%).

	<b>Bio-economy employment</b>	<b>% Total SA employment<sup>1</sup></b>
2010	1 528 282	10,9
2018	1 734 585	10,6
2019	1 727 305	10,6
2020	1 637 054	10,7
Base: 2013 -15	1 673 357	10,9

*Table 5: South African bio-economy sector employment- Quantec & Stats SA (NACI 2022)- adapted*

Over the last decade there has been little increase in the bio-economy share of total exports, both in total value and unit value. In addition to increasing total bio-economy exports, the Bio-economy Strategy aims to increase the sophistication of exports and the unit value added of South Africa's bio-economy exports. As a result of enhanced technological change and innovation, exports should be more sophisticated and hence of higher value (NACI, 2022).

NACI comments that the strong performance of knowledge generation (publications) and moderate performance in terms of technology (patents) contrasts with the weak performance in economic indicators (output, employment, and exports). This contrast is mirrored in the performance of the business sector as a whole (NACI, 2022). This may point to a systemic weakness in translating knowledge generation to commercialisable products and services, which may present opportunities if these inefficiencies in the deployment of the Gross Domestic Expenditure on Research and Development (GERD) can be addressed.

---

<sup>1</sup> Total employment includes both formal and informal employment

## 7. Western Cape Perspective

---

With four leading universities, as well as various research institutes, research councils, research groups and highly innovative industry entrepreneurs, the Western Cape is very well positioned to leverage its expertise and competitive advantages within the biotechnology sector.

Annually US\$3,89bn is spent in R&D within the South African university sector of which US\$207,76m is spent in the Western Cape. HealthTech R&D accounts for the largest portion of that spend (InvestCapeTown, 2022). South Africa is the only SADC member country that meets the World Health Organisation's Good Manufacturing Practice standards and a significant number of genomic research, development and vaccine manufacturing capabilities are centered in the Western Cape.

Key institutions include, amongst others:

### **The African Genomics Centre - Data Centre for Genomics based in Bellville.**

The African Genomics Centre is a partnership between the South African Medical Research Council and the Beijing Genomics Institute, which aims to build the capacity for whole human genome sequencing. The potential impact of better understanding the factors of diseases specific to South Africa and developing informed strategies are essential assets. Two entities driving further development in genetic knowledge with a focus on the African population are Artisan Biomed and Gknomix (InvestCapeTown,2022).

### **The Cape Health Technology Park**

A collaborative venture between the national Department of Science and Technology, the Western Cape Government, business and academia. It aims to be a world-class facility where pharmaceutical companies, research institutes, clinical trial facilities and health-related academic and government programmes are strategically housed in one location (Wesgro, 2022). The economic impact of the proposed health tech park, during its construction phase, could be transformational with R1.5-billion contribution to the economy; 2 000 direct jobs; and 4 165 indirect and induced jobs added to the national economy, based on a construction investment of R757-million. The Cape Health Technology Park is set to contribute more than 13 000 jobs to the economy during its 10-year operational phase (Wesgro, 2022).

### **Stellenbosch Biomedical Research Institute**

Stellenbosch University is launching a billion-rand state-of-the-art Biomedical Research Institute ([BMRI](#)) at its Faculty of Medicine and Health Sciences in Bellville.

*When completed, the Faculty's new Biomedical Research Institute (BMRI) will form a fully integrated, future-focused and superbly organised research complex that matches and in several ways, exceeds the best the world has to offer. The BMRI, which will be based at the University's Tygerberg Campus in the Northern Suburbs of Cape Town, will be dedicated to understanding the genetic and biomolecular basis of disease and will be decidedly African in focus. This research*

*facility will be on par with the most advanced and sophisticated biomedical research facilities in the world. The new facility will allow for the immediate expansion of current research activities, as well as strengthen research and teaching capacity in fields such as bioinformatics, genomics, anatomy, surgery and neurology (Stellenbosch University, 2022).*

The Technology Transfer Office of Stellenbosch University, better known as Innovus, has been highly successful in establishing many health products and spin-out companies from the university. Innovus is responsible for producing the most innovations in South Africa, with 20 spin-out companies with a combined turnover of US\$22,68 million in 2018 and 300 employees (InvestCapeTown, 2022).

Other industry trailblazers include, Afrigen and Biovac (setting up the mRNA vaccine technology transfer hub in Cape Town), groundbreaking, world-first discovery made by Stellenbosch University's Prof Resia Pretorius and her team regarding "long COVID", the role of the South African Medical Research Council in the local and global response to the Covid-19 pandemic (Wesgro, 2022). Various world-class private firms are also emerging, for example Biocode and BioCertica, Strove, NOOSi Health and LIQID Medical (Wesgro, 2022).

Furthermore, 10% of the world's biodiversity is found in South Africa, and with 9 000 plant species, the Western Cape accounts for the bulk thereof. There is significant opportunity for botanical-extract processes for new and specialised products to be developed, as well as for further research and development (InvestCapeTown, 2022).

## **7.1. Agricultural Biotechnology**

South Africa is ranked first in Africa and ninth globally as a mega-biotech country in terms of hectares of biotech crops under cultivation – resulting in economic gains from biotech crops of over US\$218.5 million (Africabio, 2022). Only three biotech crops are currently cultivated in South Africa, namely cotton, soybean and maize (Africabio, 2022). One of the factors that present a barrier to adoption of biotech crops is misperceptions about, or lack of consumer information about, genetically modified foods.

Agriculture has been identified as the sector where the bio-economy can have the highest economic impact and the Bio-economy Strategy's (DST, 2013) objective for agriculture is to strengthen agricultural biosciences innovation to:

- ensure food security
- enhance nutrition
- improve health
- enable job creation through the expansion and intensification of sustainable agricultural production and processing.

The [Agricultural Research Council](#) (ARC) is a key science institution that conducts research, develop partnerships and human capital, to foster innovation for a sustainable agriculture sector. Currently there are already active collaboration between, for example, the ARC, the PGWC Department of Agriculture, Elsberg College and the GreenAgri initiatives of GreenCape.

*“Today, South Africa is among the top-10 largest producers of GE crops in the world and by far the largest in Africa. To date, South Africa has approved 27 GE plant events for commercial production contained in three commodities, namely corn, soybeans, and cotton. The production area of the GE commodities in South Africa is estimated at around 2.8 million hectares. South Africa is in the process of defining a regulatory policy for New Breeding Techniques (NBTs) and is considering regulating genome edited products in terms of its current “GMO” Act. Unnecessarily strict regulations in terms of NBTs could impede innovative research and agricultural trade” (Esterhuizen & Cladwell, 2021).*

Although South Africa has a robust regulatory system for genetically engineered (GE) products, some regulatory changes may inhibit innovation:

*“South Africa is in the process of determining regulatory policies for NBTs and publicly confirmed that it is considering regulating genome edited products under its current “GMO” Act. This means all genome edited products will be treated as GE under South Africa’s “GMO” Act. This approach runs counter to practices taken in several other countries, which have determined that certain genome edited products should be exempt from biotechnology regulations if they do not contain foreign DNA.” (Esterhuizen & Cladwell, 2021)*

### **7.1.1. Academic Institutions**

The following academic institutions are relevant to the Western Cape Biotechnology ecosystem.



<b>Category</b>	<b>Institution</b>	<b>Academic Unit/Chair/Centre of Excellence</b>
Agriculture	Stellenbosch: SARChI Chairs	<b>SA Research Chair in Integrated Wine Sciences</b> The Chair, linked to the Institute for Wine Biotechnology, focuses on a better understanding of the microbiological transformation of natural raw materials into value added products such as wine. The Chair uses an extensive international network of collaborators to support a multidisciplinary research programme. This programme is more specifically tuned to the needs of the SA wine industry, but also investigates fundamental cellular and molecular processes of relevance to the broader life sciences. The assessment and exploitation of natural microbial biodiversity, the understanding of population dynamics within natural and industrial ecosystems, and the application of evolutionary engineering to individual organisms or ecosystems are also researched.
		<b>Prof Florian Bauer</b>
Agriculture	Stellenbosch: SARChI Chairs	<b>Agricol Chair in Agronomy</b> This Chair, based in the Department of Agronomy, addresses the shortage in talented plant breeders and agriculturists in South Africa and on the rest of the continent. The Chair helps to expand research and development in the seed industry and increases product knowledge and opportunities for further training.
		<b>Prof Nick Kotzé</b>
Agriculture		<b>SA Research Chair in Animal Tuberculosis (TB)</b>



	Stellenbosch: SARChI Chairs	<p>The Chair leads the Animal TB Group in investigating various aspects of animal tuberculosis affecting livestock and wildlife. The research programme aims to increase knowledge and develop tools to understand comparative disease pathogenesis and host immune responses, identify novel biomarkers for detection of infection and disease, improve diagnostic techniques, and explore the diversity, epidemiology, and the implications and role of TB in ecosystems and at animal-human interfaces. One major focus is the development of molecular and cellular techniques that can detect infection and disease in animals. Strategies to effectively prevent the spread of disease are lacking for most species and require advanced accurate diagnostic tools.</p> <p><b>Prof Michele Miller</b></p>
Agriculture	US: Faculty of Science	<a href="#">Institute for Plant Biotechnology - Stellenbosch University</a>
Agriculture	US: Faculty of AgriSciences	<a href="#">Institute for Wine Biotechnology (IWBT) - Stellenbosch University</a>

Table 6: Agricultural Biotech - Academic ecosystem

### 7.1.2. Public Organisations

[AfricaBio](#) is an independent non-profit stakeholders' association representing the interests of all stakeholders involved in the biotechnology sector throughout Africa and promote the use of biotechnology to upliftment. AfricaBio focuses on agriculture, health, industrial, environmental and marine biotech.

### 7.1.3. Private Organisations

The Agri-biotechnology startup environment is mainly centred around the Stellenbosch areas SU Launchlab ([www.launchlab.africa/](http://www.launchlab.africa/)), as well as BioCiti ([www.citi.org.za/biociti/](http://www.citi.org.za/biociti/)) which provides shared laboratory space for biotechnology start-ups, within a supportive ecosystem and national and international network of partnerships.

High potential start-ups include:

<p><b>Immobazyme</b> <a href="http://immobazyme.com/">http://immobazyme.com/</a></p>	<p>Immobazyme (Pty) Ltd is a proudly South African biotechnology innovation company which focuses on biocatalysis and immobilized enzyme engineering. The technology at Immobazyme involves a novel protocol to immobilize enzymes in a simple and affordable manner, allowing for the application of industrially important enzymes at a large scale.</p> <p>Immobazyme is a biotechnology spin-out company of Stellenbosch University that utilizes precision fermentation to produce high-value active protein ingredients.</p> <p>Immobazyme specializes in the application of precision fermentation, a biotech process that uses microorganisms to produce high-value biological products, like growth factors and enzymes.</p> <p>Immobazyme has harnessed these microscopic factories to produce solutions to revolutionize the cultivated meat and sugar industries.</p> <p><b>Investment Stage:</b> Seed funding</p>
<p><b>MariHealth Solutions</b> <a href="http://www.marihealthsolutions.com">www.marihealthsolutions.com</a></p>	<p>A LaunchLab-linked firm, this Cape-Town based biotech company developing diagnostic solutions for improved aquaculture practices and overall farm health, to ensure sustained and improved annual yields for farmers and long-term food security on a global scale.</p> <p>We are developing an animal health monitoring service that utilizes a proteomic workflow to assess chronic stress and metabolism in farmed fish and shellfish.</p> <p>Our service will offer aquaculture farmers, veterinarians and feed companies a greater understanding of the health of their produce, and the impact feeds and farming practices have on farmed animals.</p> <p><b>Investment Stage:</b> Seed Funding</p>

<p><b>Biotikum</b> <a href="https://www.biotikum.com/">https://www.biotikum.com/</a></p>	<p>Biotikum, a LaunchLab-linked firm, solves the bacterial pathogen threat in animals by using host-specific probiotics to promote the development of the gut microbiome, which in turn protects against pathogen, alleviating the need for antibiotics.</p> <p>We research and develop cutting-edge microbial solutions for animals and the agricultural industry to promote sustainable farming practices while improving profitability.</p>
--	--

Table 7 Agricultural Biotech - Examples of startups

## 7.2. Health Biotechnology

The Western Cape has a robust and strong health technology ecosystem, including outstanding universities in the field of biomedicine, biopharming, biomedical engineering, mechanobiology, neuroscience and vibrant Healthtech industry, including two globally recognised and research-driven medical schools and associated teaching hospitals (InvestCapeTown, 2022). The South African Medical Research Council (MRC) is based in Cape Town.

According to InvestCapeTown the Western Cape health technology sector currently contributes an estimated US\$117,73m to the Western Cape economy and creates approximately 2 500 full-time jobs. The Western Cape has spent more than US\$400m on healthcare capital infrastructure in the last 10 years, positioning the sector well for growth.

### 7.2.1. Academic Institutions

The following academic institutions are relevant to the Western Cape Biotechnology ecosystem.

<u>Category</u>	<u>Institution</u>	<u>Academic Unit/Chair/Centre of Excellence</u>
Health	UCT: Health Sciences Faculty	<a href="#">UCT Node of the DST/NRF Centre for Excellence for Biomedical TB Research</a>
Health	UCT: Health Sciences Faculty	<b>Institute of Infectious Disease and Molecular Medicine</b> was established 2004 as a cross-faculty postgraduate research institute based within the University of Cape Town (UCT). It is physically and administratively located within the Faculty of Health Sciences.



Health	UCT: Health Sciences Faculty	Biomedical Engineering Research Centre (BMERC)
Health	UCT: Health Sciences Faculty	<a href="#">Brain-Behaviour Unit</a>
Health	UCT: Health Sciences Faculty	<a href="#">Cape Heart Institute (CHI)</a>
Health	UCT: Health Sciences Faculty	<a href="#">Cardiovascular Research Unit (CRU)</a>
Health	UCT: Health Sciences Faculty	<a href="#">Centre for Infectious Diseases Research in Africa (CIDRI-Africa)</a>
Health	UCT: Health Sciences Faculty	<a href="#">Centre for Infectious Disease Epidemiology Research (CIDER)</a>
Health	UCT: Health Sciences Faculty	<a href="#">Centre for Lung Infection and Immunity (CLII) (hosts the MRC Flagship NeXT RCT and the MRC Anti-Microbial Resistance Extramural Unit)</a>
Health	UCT: Health Sciences Faculty	<a href="#">Desmond Tutu HIV Centre (hosts the UCT/Medical Research Council (MRC) flagship project: Tuberculosis Transmission Host, Bacterium and Environment)</a>
Health	UCT: Health Sciences Faculty	<a href="#">Human Genetics Research Unit</a>
Health	UCT: Health Sciences Faculty	<a href="#">Immunology of Infectious Diseases Research Unit</a>
Health	UCT: Health Sciences Faculty	<a href="#">Institute of Infectious Disease and Molecular Medicine (IDM)</a>
Health	UCT: Health Sciences Faculty	<a href="#">Kidney Disease and Hypertension Research Unit</a>
Health	UCT: Health Sciences Faculty	Medical Biotechnology and Immunotherapy Unit (MB&I)
Health	UCT: Health Sciences Faculty	<a href="#">MRC/UCT Drug Discovery and Development Research Unit (H-3D)</a>
Health	UCT: Health Sciences Faculty	<a href="#">MRC/UCT Gynaecological Cancer Research Centre</a>
Health	UCT: Health Sciences Faculty	<a href="#">Molecular Mycobacteriology Research Unit</a>
Health	UCT: Health Sciences Faculty	<a href="#">MRC/UCT Precision and Genomic Medicine Research Unit</a>
Health	UCT: Health Sciences Faculty	<a href="#">MRC/UCT/SU Unit on Risk &amp; Resilience in Mental Disorders</a>



Health	UCT: Health Sciences Faculty	<a href="#">Neuroscience Institute</a>
Health	UCT: Health Sciences Faculty	<a href="#">Receptor Biology Research Unit</a>
Health	UCT: Health Sciences Faculty	<a href="#">South African Tuberculosis Vaccine Initiative (SATVI)</a>
Health	UCT: Health Sciences Faculty	<a href="#">MRC/UCT Platform for Pharmacogenomics Research &amp; Translation Research Unit</a>
Health	UCT: Health Sciences Faculty	<a href="#">MRC/UCT Intersection of Noncommunicable Disease and Infectious Diseases Research Unit</a>
Health	UCT: Faculty of Science	<a href="#">Artificial Intelligence Research Unit (AIRU) - CAIR UCT node</a>
Health	UCT: Faculty of Science	<a href="#">Biopharming Research Unit (BRU)</a>
Health	UCT: Faculty of Science	<a href="#">Human Evolution Research Institute (HERI)</a>
Health	UCT: Faculty of Science	<a href="#">Scientific Computing Research Unit (SCRU)</a>
Health	UCT: Faculty of Science	<a href="#">MRC/UCT Drug Discovery and Development Research Unit (H3-D)</a>
Health	UCT: Faculty of Science	<a href="#">Institute of Infectious Disease and Molecular Medicine (IDM)</a>
Health	UCT: SARChI Chairs	<a href="#">Applied proteomics and chemical biology – Professor Jonathan Blackburn</a>
Health	UCT: SARChI Chairs	Biomedical engineering and innovation – Interim Chair, Associate Professor Tinashe Mutsvangwa
Health	UCT: SARChI Chairs	<a href="#">Cancer biology – Professor Stefan Barth</a>
Health	UCT: SARChI Chairs	<a href="#">Clinical neuroscience research – Professor Anthony Figaji</a>
Health	UCT: SARChI Chairs	<a href="#">Dermatology and toxicology – Professor Nonhlanhla Khumalo</a>
Health	UCT: SARChI Chairs	<a href="#">Immunology of infectious diseases in Africa – Professor Frank Brombacher</a>
Health	UCT: SARChI Chairs	<a href="#">Lung infection and immunity of poverty-related diseases – Professor Graeme Meintjes</a>
Health	UCT: SARChI Chairs	<a href="#">Vaccinology – Professor Anna-Lise Williamson</a>
Health		<b>SA Research Chair in TB Biomarkers</b>



	Stellenbosch: SARChI Chairs	<p>The main focus of the research is to identify immune biomarkers that can be taken into future trials for novel diagnostics and vaccines. The group is part of several international consortia that identify - together with several US, European and African partners - large cohorts of participants with well-characterised MTB infection and disease phenotypes to search for biomarkers of TB. The laboratory work entails a range of modern immunological and molecular biology techniques. It spans the divide between clinical and basic sciences in a high TB prevalence area. The group has worked as an immunology specialist laboratory on subcontracts for IMPAACT and ACGT network studies and is performing the immunology tests for the phase IIa TB vaccine trials in infants.</p>
		<b>Prof Gerhard Walzl</b>
Health	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Paediatric Tuberculosis (TB)</b></p> <p>This Chair will focus on the evaluation of improved and safe TB preventive and treatment strategies in HIV-infected and uninfected children. Evaluation of novel drug regimens for MDR-TB prevention and treatment will be a key priority. Other research focus areas include improved TB diagnosis in children, including novel diagnostics and biomarkers, evaluation of novel TB vaccine strategies and implementation of science research to improve the care, recording and reporting of TB in children.</p>
		<b>Prof Anneke Hesselning</b>
Health	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Integrative Skeletal Muscle Physiology, Biology and Biotechnology</b></p>



		<p>This Chair, situated in the Department of Physiology, aims to close the gap between an in-depth understanding of the biological effects of trauma, inflammation and disease on skeletal muscle cells and the well-known ability of muscle to gain strength and regenerate from injury. Postgraduate students and postdoctoral fellows study these aspects of skeletal muscle at three complementary levels: whole body physiology (real humans), cellular and molecular biology (tissue and cells in culture dishes), and biotechnology (manipulation and regeneration). This multi-layered combination of expertise is unique in South Africa and uncommon worldwide.</p> <p><a href="#">Click here to visit the website</a></p> <p><b>Prof Kathy Myburgh</b></p>
Health	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Mathematical and Theoretical Physical Biosciences</b></p> <p>This Chair aims to establish the multidisciplinary field of mathematical and theoretical physical biosciences as a distinct research strength in South Africa. This would support the existing research activities in this field at SU and the African Institute for Mathematical Sciences (AIMS SA), and would also stimulate interaction. The group aims to quantify emerging ecological patterns and investigate their hidden mechanisms by relying on the simplicity of mathematical language.</p> <p><a href="http://math.sun.ac.za/hui/">Visit: http://math.sun.ac.za/hui/</a></p> <p><b>Prof Cang Hui</b></p>
Health	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Mechanistic Modelling of Health and Epidemiology</b></p> <p>The focus of this Chair, linked to the South African Centre for Epidemiological Modelling and Analysis (SACEMA), is to provide a mechanistic modelling approach with more predictive strength to pharmaceutical drug and intervention steps, for individual and public health.</p> <p><a href="#">Click here to visit the website.</a></p> <p><b>Prof Jacky Snoep</b></p>



Health	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Mycobactomics</b></p> <p>The research aim of this Chair is to perform an in-depth characterisation of clinical strains of <i>M. tuberculosis</i> and other mycobacterial species isolated from humans and animals on the African continent. Knowledge gained will support the goal of an improved understanding of mycobacterial biology, aiding the design of effective tuberculosis vaccines, diagnostics and therapeutics.</p> <p><b>Prof Samantha Sampson</b></p>
Health	UWC: SARChI Chairs	<p><b>SARChI Chair in Microbial Genomics</b></p> <p>The Institute for Microbial Biotechnology and Metagenomics (IMBM) hosts the DST/NRF SARChI Research Chair in Microbial Genomics, held since 2014 by IMBM Director - and Distinguished Young Woman Scientist Award winner - Professor Marla Trindade. The Chair's major research focus is to use high-throughput and metagenomic technologies to directly access all microbial genomes in any given environment, from the viruses inhabiting human skin to the extremophiles found in environments too hot, salty or otherwise inhospitable for other life. These will enable the exploration of all information and data that microorganisms can offer biotechnology and present infinite bioprospecting possibilities. Prof Trindade's research interest is not only in viruses and bacteria on a microscopic level, but in using the genetic information of viruses and other microorganisms in useful real-world applications.</p>
Health	UWC: SARChI Chairs	<p><b>SARChI Chair in Bioinformatics and Human Health Genomics</b></p>



		<p>Professor Alan Christoffels is the Director of the South African National Bioinformatics Institute (<a href="#">SANBI</a>) at UWC, and a recipient of the Hamilton Naki Special Award, recognising his outstanding efforts to build a distinguished academic career and conduct world-class research in the face of considerable equity challenges. Since 2009, he has occupied this SARChI Chair, which focuses on public health genomics, addressing the needs of South African public health research while simultaneously addressing the national imperative to enhance quality research and teaching in science and technology. Its research activities address the development and implementation of high-throughput screening methods to prioritize biomarkers for health intervention. The research activities are centred around tuberculosis genomics research, malaria and trypanosomiasis or sleeping sickness.</p>
Health	US: Faculty of Medicine and Health Sciences	<a href="#">Department of Biomedical Sciences - Stellenbosch University</a>
Health	UWC: Faculty of Science	<a href="#">Department of Biotechnology - UWC</a>
Health	UWC: Faculty of Science	<a href="#">Department of Medical Biosciences</a>
Health	UWC: Faculty of Science	<a href="#">Institute for Microbial Biotechnology and Metagenomics</a>
Health	UWC: Faculty of Science	<a href="#">South African National Bioinformatics Institute (SANBI)</a>
Health	CPUT: SARChI Chairs	<a href="#">Cardiometabolic Health- Prof Tandi Matsha-Erasmus</a>
Health/IKS	CPUT: Research Chair	<a href="#">Biotechnology -Prof Jeanine Marnewick</a>

Table 8: Health Biotech - Academic ecosystem

### 7.2.2. Public Organisations

Various industry organisations, on and above academic-discipline specific organisations, serve to increase awareness and knowledge sharing around biotechnology, for example:

- The Innovative Pharmaceutical Association South Africa ([IPASA](#))
- Public Health Association of South Africa ([PHASA](#))
- Pharmaceutical Society of South Africa ([PSSA](#))

### 7.2.3. Private Organisations

The Western Cape is home to three of the four largest vaccine manufacturers in South Africa. Key roleplayers within this ecosystem include for example:

<p><b>Afrigen Biologics &amp; Vaccines</b> <a href="#">Website</a></p>	<p>The South African node of the World Health Organisation’s mRNA vaccine technology hub was announced on 21 June 2021. The hub is located at Afrigen, Cape Town, South Africa, and works with a network of technology recipients (spokes) in low- and middle-income countries. The objective of the technology transfer hub is to build capacity in low- and middle-income countries to produce mRNA vaccines through a centre of excellence and training.</p> <p>The initiative is supported by WHO, the Medicines Patent Pool and the Access to COVID-19 Tools (ACT) Accelerator/COVAX. The South African hub comprises Afrigen Biologics, the South African Medical Research Council (SAMRC) and Biovac, a South African vaccine producer. Within this consortium, Afrigen is the entity mandated to establish mRNA vaccine production technology, SAMRC is providing the research and Biovac is the first manufacturing spoke.</p>
<p><b>Biovac</b> <a href="#">Website</a></p>	<p>Biovac is a bio-pharmaceutical company based in Cape Town that is the result of a partnership formed with the South African government in 2003 to establish local vaccine manufacturing capability for the provision of vaccines for national health management and security.</p> <p>To date, Biovac has invested over R800 million in infrastructure and skills development with an economic benefit of over R500 million per year to the South African economy.</p> <p>Biovac have partnered with research organisations like the University of Cape Town, Council for Scientific and Industrial Research – CSIR, international organisations (World Health Organisation – WHO, Program for Applied Technologies in Health – PATH), industry (Sanofi Pasteur of France, BioFarma of Indonesia, Pfizer of USA) and funding organisations (The Industrial Development Corporation). Through these partnerships, they have set up the infrastructure described above and are in-sourcing technologies. Biovac has also developed its own vaccine manufacturing technologies and out-licensed these to international partners.</p> <p>Currently, Biovac employs over 320 employees; 85% of whom obtained their tertiary education through universities, trade</p>

	schools and colleges whilst the remaining 15% predominantly have a bachelor's degree or higher qualification.
<p><b>NantSA</b> <a href="https://nantworks.com/">https://nantworks.com/</a></p>	<p>NantSA, a division of Nantworks LLC – together with the CSIR, Centre for Epidemic Response and Innovation (CERI), Universities of Cape Town, - Witwatersrand, - Stellenbosch, - KwaZulu-Natal and Network for Genomic Surveillance in South Africa partnered on the establishment of the NantSA facility located in Brackenfell, Western Cape, that would be manufacturing second generation vaccines.</p> <p>Working with universities and healthcare facilities countrywide, the partnership expects to accelerate the development of next-generation vaccines for infectious diseases across Africa. These vaccines include treatment for cancer, Covid-19, tuberculosis and HIV.</p> <p>NantAfrica, NantSA, and Nant Botswana, established by South African-born NantWorks founder Dr Patrick Soon-Shiong, want to manufacture a billion doses of Covid-19 vaccines in South Africa by 2025.</p> <p>The event in January 2022 also included the launch of the Africa's Access to Advanced Healthcare (AAAH) Coalition. NantSA and the AAAH Coalition want to accelerate the production of pharmaceuticals, biologics and vaccines on the continent.</p> <p>According to Soon-Shiong, the vaccine manufacturing initiative hopes to employ 400 to 600 people.</p>

*Table 9 Health Biotech - Selected Firms*

The Health Biotechnology ecosystem is vibrant and includes some large and sustainable exits from university ecosystems to commercialisation. The start-up ecosystem is mainly centred around the universities, as well as the [BioCiti](#) programme and shared laboratory infrastructure created.

BioCiTi was established by the [Cape Information Technology Initiative](#) (CiTi) in 2019, as a specialised biotech incubator that provides African entrepreneurs a platform where science, business and investment can come together. They aim to create a bridge between research and commercialisation of ideas based on the application of technology to broad biological sciences. Examples of biotechnology start-ups in the Western Cape include:



<p><b>Cape Bio Pharms (Pty) Ltd</b> <a href="#">Website</a></p>	<p>Cape Bio Pharms was started up to produce proteins in transiently modified tobacco plants at commercial scale. The proteins can be used as reagents, incorporated in diagnostics and even as vaccines. UCT has drawn together a partnership with a company that will undertake the purification and marketing of the proteins into their current market base. The products have been selected based on a NIPMO-funded strategic review and TIA Seed Funding support to the Biopharming Research Unit (Molecular &amp; Cell Biology) was used to further developed of the products. These will create a pipeline of products that will be commercialised by the company.</p> <p>Cape Bio Pharms uses a plant-based expression platform to produce high-value and custom proteins for biomedical research. The company is majority woman-owned and is a spin- off from the University of Cape Town (UCT). Investment stage: Series Seed &amp; Series A</p>
<p><b>Azargen</b> <a href="https://azargen.com/">https://azargen.com/</a></p>	<p>AzarGen is a biotechnology company focused on developing human therapeutic proteins using advanced genetic engineering and synthetic biology techniques in plants.</p> <p>The AzarGen management team is supported by an experienced advisory board for strategic guidance and intellectual property management. Based in Stellenbosch, South Africa, AzarGen is supported by South Africa's Industrial Development Corporation (IDC). AzarGen has established a successful technical and business collaboration with iBio, Inc. (NYSE MKT: IBIO), a leader in developing plant-based biopharmaceuticals, providing a range of product and process development, analytical, and manufacturing services at the large-scale development and manufacturing facility of its subsidiary iBio CDMO LLC in Bryan, Texas.</p>
<p><b>CURIT Biotech South Africa (Pty) Ltd</b></p>	<p>This biotech start-up will focus on the development and marketing of medical biotechnology products related to the IP that has and is being created by Prof Stefan Barth, UCT SARChI Chair in Cancer Biotechnology. The company will access patents from his former institution (Fraunhofer), as well as other third-party IP in order to develop recombinant immunodiagnostics and targeted therapeutics.</p>
<p><b>AngioDesign (Pty) Ltd</b></p>	<p>Together with his UCT colleague Sylva Schwager and Professor Ravi Acharya and Dr Ramanathan Natesh based at Bath University, Prof Edward Sturrock published the first three-dimensional structure of Angiotensin Converting Enzyme (ACE) in Nature in 2003. Their breakthrough created enormous interest</p>

	<p>from the international scientific and medical communities at the time, as over the years numerous high-profile research teams had tried – and failed – to map the enigmatic enzyme. This work will now be pursued by AngioDesign, who purchased Bath University’s interests in the crystal structure patents as well as IP and entered into an assignment agreement for the UCT IP. Although the company has been established in the UK, where funders were able to be found, some of the drug development and discovery activity will continue at UCT. Prof Edward Sturrock is the lead inventor on 4 patent families relating to the crystal structures of the N and C domains, C-selective ketomethylene ACE inhibitors and C-selective lisinopril-Trp derivatives. The C-domain applications have been granted in 11 European countries, the United States, South Africa and Australia. In addition, a US divisional application has also been granted. The N-domain applications have been granted in 6 European countries, in addition to Australia, the United States and South Africa; a Canadian application is pending as well as a US continuation-in-part. The Inhibitor 1 family has been granted in Europe (5 countries), the USA, Australia, Canada and South Africa. The Inhibitor 2 family has granted patents in 5 European countries, Australia, Europe, the USA, Canada and South Africa. <a href="http://www.angiodesign.com">www.angiodesign.com</a></p>
<p><b>Antrum Biotech (Pty) Ltd</b> <a href="#">Website</a></p>	<p>A license agreement was signed with Antrum Biotech (Pty) Ltd for the commercialisation of an extrapulmonary TB diagnostic test based on IP that was created by Prof Keertan Dheda (Lung Infection and Immunity Unit). The early-stage prototype development was supported by the UCT PreSeed Fund and the company has gone on to secure IDC funding to pursue further development.</p>

Table 10: Health Biotech - Selected startups

Various Western Cape biotechnology startups received funding support from the University Technology Fund (UTF), for example:

<p><b>Hyrax Biosciences</b> <a href="https://hyraxbio.com/">https://hyraxbio.com/</a></p>	<p>Cloud-based software platform that aims to transform the cost, accuracy and scalability of genetic diagnostics. Exatype, a leading bioinformatics software platform, combines scalable tech and unique algorithms to deliver</p>
---	---



	<p>detailed and accurate genotype reports, without the need for human intervention or the threat of human error. This company has two-woman co-founders on the team and is a spin-out from the University of the Western Cape (UWC).</p> <p><b>Investment stage:</b> Series-A Investment</p>
<p><b>BioCODE™</b> <a href="http://www.biocode.co.za/">www.biocode.co.za/</a></p>	<p>BioCODE™ is a Stellenbosch-based nanobiosensor technology that is used for early identification of cardiovascular disease. BioCODE™ detects inflammatory biomarker levels from a drop of blood.</p> <p><b>Investment Stage:</b> Seed &amp; Series Seed</p>
<p><b>Phagoflux</b></p>	<p>The developer of a device that is designed to accurately monitor the activity of autophagy, which is the self-cleansing activity of body cells. Phagoflux aims to provide solutions for the <b>quantification and monitoring of autophagy</b> to be applied in the <b>research &amp; pharmaceutical/drug screening industry, the diagnostics</b> (Alzheimer's Disease &amp; Neurodegeneration) and <b>wellness arena</b>. Wellness, since high autophagy favours longevity and healthy cells, thereby counteracting the molecular processes that drive aging.</p> <p>The Phagoflux team, with its Stellenbosch-based founding members <b>Prof Ben Loos, Prof Jannie Hofmeyr, Dr Andre Du Toit, Prof Willie Perold and Prof Pieter Fourie</b>, is an interdisciplinary lineup of experts with a wealth of experience, knowhow and passion in the fields of life science, engineering, computational modelling and the clinical application thereof.</p> <p><b>Investment Stage:</b> Seed funding &amp; Series Seed</p>
<p><b>Stellenbosch Nanofiber Company (SNC)</b> <a href="https://sncfibers.com/">https://sncfibers.com/</a></p>	<p>The Stellenbosch Nanofiber Company develops and manufactures nanofiber-based materials for advanced wound care and regenerative medicine applications. SNC has successfully worked with clients in the biomedical industry to develop nanofiber based materials and products.</p> <p><b>Investment Stage:</b> Series A</p>

Table 11: Health Biotech - UTF Funded Startups

Private investments in Western Cape health biotechnology start-ups includes:

<p><b>BixBio</b> <a href="https://www.bixbio.com/">https://www.bixbio.com/</a></p>	<p>Supported by One Bio Ventures Studio and founded in 2020 by entrepreneurial duo bioinformatician, James Ross and molecular biologist, Tyronne McCrindle, BixBio is a biotech startup that is focused on unlocking the potential of diverse genetic data to further develop and grow the sector of precision medicine.</p> <p>BioBix utilises its proprietary AI platform to curate and establish large genetic data sets which will assist and improve the identification of disease-causing genetic variants and novel drug targets.</p> <p>This provides an effective solution to the existing tedious search for disease-causing genetic variants and novel drug targets. This solution helps pharma companies develop drugs. Not only has the tech startup secured an investment but it has also been selected as one of seven new genomic companies to join the third global funding cycle of the Illumina Accelerator. The accelerator is focused on supporting entrepreneurs and startups that are focused on establishing innovative products and solutions in the genomic medical sector.</p> <p>As part of the accelerator, the selected seven genomic companies receive access to seed investment funding and access to Illumina sequencing systems and reagents. In addition, they are provided with business guidance, genomics expertise, and fully operational lab space adjacent to Illumina's campuses in Cambridge, UK or the San Francisco Bay Area.</p>
<p><b>LifeQ</b> <a href="https://www.lifeq.com/">https://www.lifeq.com/</a></p>	<p>SA and US-based biotech startup <a href="#">LifeQ</a> has secured \$47-million in Series A funding from <a href="#">One Bio Venture Studio</a>, a Cape Town-based VC and several other investors.</p> <p>Founded in 2014 by South African entrepreneur duo Riaan Conradie and Laurie Olivier, LifeQ provides users with access to biometric and health information derived from wearable devices using computational biology.</p> <p>LifeQ's firmware and permanent software which has been programmed into hardware devices can provide early warning and detection by tracking factors such as sleep patterns, heart rate, and exercise routines. The innovative technology is able to send out an alert if something is wrong and uses the data collected to generate health and wellness solutions for consumer, business, and clinical applications.</p>

	<p>Businesses that have partnered with LifeQ's innovative software offering include Fossil Group Inc., Samsung Electronics Co, and more.</p> <p>According to reports, the biotech's startup's first remote patient monitoring solution will be piloted at both hospitals and general physician applications near the end of this year. The service will enable hospitals to track vitals such as heart rate and breathing rate in wards beyond the intensive care unit.</p> <p><b>Investment Stage:</b> Series A</p>
--	--

*Table 12: Health Biotech- Selected VC funded startups*



### 7.3. Industrial Biotechnology

The industrial biotechnology industry in the Western Cape is centred around the agriculture industry.

#### 7.3.1. Academic Institutions

The following academic institutions are relevant to the Western Cape Biotechnology ecosystem.

<u>Category</u>	<u>Institution</u>	<u>Academic Unit/Chair/Centre of Excellence</u>
Industrial	UWC: SARChI Chairs	<b>SARChI Chair in Analytical Systems and Processes for Priority and Emerging Contaminants (ASPPEC)</b>
		The SARChI Chair in Analytical Systems and Processes for Priority and Emerging Contaminants, awarded to Prof Priscilla Baker in 2018, is geared towards measurement and monitoring of a wide range of environmental contaminants, related to the chemical transformations that results in contamination. These chemical transformations include highly specific binding reactions, electrolysis, energy efficient catalytic conversion of chemical reactants, adsorption reactions, diffusion-controlled reactions and coupled chemical reactions. A recipient of the prestigious Women In Science Award, Prof Baker is co-head of UWC's SensorLab (alongside fellow SARChI Chair Emmanuel Iwuoha) and specialises in the application of frequency-modulated electrochemical techniques that can be applied in water analysis and treatment, bio- and industrial catalysis, as well as in energy-related applications.
Industrial	Stellenbosch: SARChI Chairs	<b>Sasol Chair in Analytical Polymer Science</b>
		This research group focuses on the development of multidimensional analytical techniques for complex polymers. This includes the coupling of different separation methods to each other (two-dimensional chromatography) and the hyphenation of separation methods with information-rich detectors like FTIR, NMR, and mass spectrometry.



		<p><a href="#">Click here to visit the website</a></p> <p><b>Prof Harald Pasch</b></p>
Industrial	UWC: SARChI Chairs	<p><b>SARChI Chair in Nano-Electrochemistry and Sensor Technology (NEST)</b></p> <p>Established in 2012, the SARChI Chair in Nano-Electrochemistry and Sensor Technology is held by Senior Chemistry Professor Emmanuel Iwuoha, co-head (along with fellow SARChI Chair Prof Priscilla Baker) of UWC's SensorLab, which focuses on research in smart materials, electrocatalysis, sensors and electrochemical energy. The Chair's focus is on designing 'smart' nanomaterials (polymeric, dendritic, graphenated and carbon nanotube composite systems). Professor Iwuoha has coordinated the National Nanoscience Postgraduate Teaching and Training Platform, an inter-university initiative offering a Master's degree in nanoscience. He leads a research project on sensors, which aims to produce easy-to-use tools for point-of-care clinical applications, and the acquisition of data necessary for setting quality standards for priority pollutants in food, drinking water and the environment, as well as for monitoring compliance to set such standards.</p>
Industrial	UCT: SARChI Chairs	<p><a href="#">Bilateral Chair: Environmental health – Professor Aqiel Dalvie</a></p>
Industrial	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Genetic Tailoring of Biopolymers</b></p>



		<p>The focus of this Chair is on gene discovery for the biosynthesis of polymers and the use of those genes in different biological expression systems to synthesise novel biomaterials for all kinds of industrial applications. In addition to optimising biopolymer synthesis through reverse genetics in crops to make cell wall or starch more suitable as advanced bio-materials or as substrates for bio-ethanol production, the group also seeks to produce novel polysaccharides with diverse (including pharmaceutical) applications from simple disaccharides. Furthermore, the group aims to establish structure-function relationships between genes, respective encoded enzymes and the resulting biopolymer in biofilms which are causing human disease such as periodontitis or cardiovascular diseases. The aim is to develop diagnostic or therapeutic tools based on functional screening and metagenomic bacterial libraries and in-depth characterisation of biopolymer producing enzymes encoded by isolated genes.</p>
Industrial	Stellenbosch: SARChI Chairs	<p><b>Prof Jens Kossmann</b></p> <p><b>SA Research Chair in Nanostructured Functional Materials</b></p> <p>This Chair encompasses the study of structure-property relationships in synthetic crystals. The research involves the design of molecules that pack in the solid state such that their relative arrangements give rise to interesting and useful functionality. It also focuses on the design and assembly of these materials, and studies their structures at the molecular level with a view to understanding the direct link between form and function.</p> <p><a href="#">Click here to visit the website</a></p> <p><b>Prof Leonard Barbour</b></p>
Industrial	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Energy Research</b></p> <p>This chair aims to establish second-generation technologies for the production of biofuels, specifically through microbial hydrolysis and fermentation, pyrolysis and gasification of lignocellulose. The Chair has initiated interaction with role players in SA to</p>



		<p>develop partnerships to strengthen the South African biofuels initiative.</p> <p><a href="#">Click here to visit the website</a></p> <p><b>Prof Emile van Zyl</b></p>
Industrial	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair on Advanced Macromolecular Architectures</b></p> <p>The focus of the Chair is the synthesis and characterisation of advanced macromolecular architecture and the control of morphology and functionality on the nanometer length scale. The kinetics and mechanisms of polymerisation reactions are also investigated. One of the new research directions is the study of polymer-peptide conjugates for targeted treatment of specific diseases. The research is at the interface among polymer science, chemistry, biochemistry, physiology and in some cases, microbiology.</p> <p><a href="#">Click here to visit the website.</a></p> <p><b>Prof Bert Klumperman</b></p>
Industrial	Stellenbosch: SARChI Chairs	<p><b>SA Research Chair in Meat Science: Genomics to Nutrinomics</b></p> <p>This Chair works on the interaction between three focus areas: production/animal, fresh meat and processed meat/products. This research not only has the potential to produce higher quality meat products for the average consumer but will also focus on lower socio-economic groups. The Chair is co-hosted by the University of Fort Hare.</p> <p><b>Prof Louw Hoffman</b></p>
Industrial	UCT: Faculty of Science	<a href="#">Centre for Statistics in Ecology, Environment and Conservation (SEEC)</a>
Industrial	UCT: Faculty of Science	<a href="#">Centre for Supramolecular Chemistry Research (CSCR)</a>
Industrial	UCT: Faculty of Science	<a href="#">Marine and Antarctic Research centre for Innovation and Sustainability (MARIS)</a>
Industrial	UCT: Faculty of Science	UCT: Centre for Bioprocess Engineering Research ( <a href="#">CeBER</a> )



		<a href="#">Bioprocess engineering – Interim chair Associate Professor Jennifer Broadhurst</a>
Industrial	UWC: Faculty of Science	<p>Nano-Science Platform: Since 2012 a Master's programme in nanoscience and nanotechnology has been offered in collaboration with the University of Johannesburg (UJ), Nelson Mandela University (NMU), the University of the Free State (UFS) and the University of the Western Cape (UWC).</p> <p>The study of nanomaterials, nanoscience and nanotechnology exists at the overlap between biology, chemistry and physics, students from all these fields will register for the same degree - a new concept in advanced research in South Africa.</p>

Table 13: Industrial Biotech - Academic ecosystem

### 7.3.2. Public Organisations

The Biotechnology Innovation Organization is the world's largest biotech trade organisation (<https://www.bio.org>).

The Council for Scientific and Industrial Research (CSIR) is promoting industrial biotechnology in South Africa, both in terms of industrial processes and products, and as an enabling factor in the growth of the country's bio-economy.

### 7.3.3. Private Organisations

Various other biotechnology innovations (at Technology Readiness Levels 6 to 9) are being developed and are in the process of commercialisation, for example:

- **Biosurfactants**
  - The Institute for Microbial Biotechnology and Metagenomics (IMBM) at the University of the Western Cape is developing a portfolio of biosurfactants (microbially produced surface-active compounds) for use in various industrial processes as well as in the food, biomedical and pharmaceutical industries. The Institute for Microbial Biotechnology and Metagenomics (IMBM) at the University of the Western Cape is developing a portfolio of biosurfactants (microbially

produced surface-active compounds) for use in various industrial processes as well as in the food, biomedical and pharmaceutical industries.

- **DNA Sample storage solutions**

- The Forensic DNA lab at the University of the Western Cape has developed a novel, proprietary DNA storage buffer to store samples at ambient temperatures. The collection and preservation of biological material for further DNA and RNA analysis are critical to many biomedical fields, from medical diagnostics to forensics and biodiversity conservation. The research team has successfully stored human saliva samples at ambient temperatures for several years, and they have shown little to no degradation of the DNA extracted from these samples. They have also shown that one can successfully store human blood in this buffer, at ambient temperatures, for a considerable amount of time. DNA extracted from the stored blood, and the human saliva samples were of good quality and quantity and suitable for various downstream molecular assays. Being able to safely store valuable DNA samples, without concerns of sample degradation, at ambient temperatures is very important, especially in developing country contexts where resources are constrained, and access to cold-chain storage is limited.
- In addition to the above mentioned, the team has developed a novel saliva collection device which aims to simplify saliva collection. The collected saliva is then to be stored in the proprietary buffer mentioned above.

- **DNA identification kit tailored for Africa**

- UWC developed the UniQTyper® is a Y-STR CY-chromosome short tandem repeat) male-specific DNA identification kit tailored for Africa. It is an improvement to current test kits that do not account for the genetic diversity of African males, and offers a highly discriminatory and rapid profiling system crucial for improving conviction rates, exoneration of innocent men accused of rape, and alleviation of the backlog of casework in South Africa and neighbouring countries.
- The kit is accompanied by a unique database of collected DNA profiles from African populations that is continuously updated, improving the predictive capabilities of the kit.

## 8. Innovation Maturity Functions

---

The innovation maturity is used in this chapter to identify where the Biotechnology sector currently are in terms of their adoption by companies in the WC. The proposed model consists of five maturity indicators which are Birth, Growth, Maturity, and Decline. The definition of each maturity indicator is further explained below:

**Birth:** This is the first phase of the maturity framework. It refers to introduction of new product to the market, in the case of this paper it refers to the introduction of Biotechnology to the market. During this stage, companies release their innovative technologies into the market for the very first time. The company at this stage is at high stake but does not decide whether their disruptive technologies will be successful or not. Furthermore, a lot of capital is needed and is pooled so that the companies' technologies reach the consumers. Thus, many firms need a lot of promotional and marketing activities to be undertaken.

**Growth:** In this stage, consumers start to act. The market for the innovative technologies expands and it may also be tweaked at this stage to ensure some features or functionalities are improved. The knowledge on the technologies is easily accessible. They become popular and results in increased sales. Thus, many investment organisations are growing and ready to provide finances. Other companies also notice these disruptive technologies.

**Maturity:** It is the stage the market has begun to reach saturation. This is also one of the stages when the competition increases.

**Decline:** When a disruptive technology is in the decline stage, the sales of companies that offer them drop due to a change in consumer behaviour and demand. This stage is a turnaround stage where companies go back to their survival mode and they make the transition to new business models.

The table below shows that Biotechnology in the WC is mainly in its growth stage. The Health and Agricultural sub-sectors are in stronger Growth phases, with Industrial and IKS sub-sectors being less mature, but also showing potential for increased growth.



Indicator			Birth	Growth	Maturity	Decline	Comments including reference to Barriers and Promoters
F1	Entrepreneurial activity	Number of new entrepreneurs / entrants	A low number of new enterprises. Enterprises are not innovation-focused.	A rapid increase of new enterprises. Few established innovation-focused enterprises.	Continuous introduction of new enterprises. Most enterprises are innovation-focused.	It is difficult for newer enterprises to compete due to too many large corporations . Enterprises do not focus on innovation.	Significant growth in the demand for specifically Health Biotechnology, fuelled primarily by the Covid 19 pandemic. Health and Agri sub-sectors of the market are in Growth Stage, with Industrial and IKS in Birth phases, with some Niche areas growing (i.e. CPUT Rooibos/Honeybush projects)
		Private vs public sector enterprises	The sector is made up of a small number of private enterprises and is majorly made up of public enterprises.	The sector has a growing number of private enterprises that build healthy relationships with public enterprises.	The sector is majorly made up of private enterprises but works in synergy with the public enterprises present.	The relationship between private and public enterprises deteriorates. A large number of enterprises leave the system in a shake-out event.	The sector is only composed of private enterprises. The sector is supported by the public sector through incentives and training programmes and most private enterprises are linked to Universities.



		<p><b>Number of entrepreneurs/ enterprises</b></p>	<p>A low number of enterprises. Enterprises are not innovation-focused.</p>	<p>An increased number of enterprises. Few established innovation focus enterprises.</p>	<p>A large number of enterprises. Most enterprises are innovation-focused.</p>	<p>Multiple large corporations dominate the market. Enterprises do not focus on innovation.</p>	<p>The sector is driven strongly by academic research and research councils (i.e MRC/ARC) with strongly emerging private sector actors- both local and international. The sector is supported by the public sector through incentives and training programmes. There is not a large number of biotech enterprises active and new entrants are not wide-based innovation, but are very niche-focused.</p>
		<p><b>The entrance vs churn rate of entrepreneurs</b></p>	<p>There is a slightly higher entrance ratio than the churn rate of entrepreneurs.</p>	<p>There is a continuous increase in the entrepreneur entrance ratio compared to the churn rate of entrepreneurs.</p>	<p>There is little to no difference in the entrepreneur entrance ratio and the churn rate of entrepreneurs.</p>	<p>There is a continuous increase in the churn rate of entrepreneurs compared to the entrepreneur entrance ratio.</p>	<p>No data available on entrepreneur churn rate in the industry</p>
		<p><b>The intensity of the competition</b></p>	<p>There is no or minimal competition in the IS. There is a small number of actors that compete.</p>	<p>There is increasing competition among a growing actor base. The marketplace is competitive.</p>	<p>There is a large amount of competition in the IS. The market is moderately concentrated.</p>	<p>The market is highly concentrated or is dominated by few market leaders decreasing the intensity of competition.</p>	<p>I am not aware of much competition: The WC biotech startups are still sparse- therefore very little direct competition.</p>



F2	<b>Knowledge development</b>	<b>Sources and intensity of knowledge development</b>	Minimal or no knowledge creation occurs from sector participants. No clear R&D efforts from enterprises.	Continuous increase of knowledge created. An academic institution in the sector's region has an increasing amount of knowledge production. A small number of enterprises are involved in producing R&D contributions.	A large amount of knowledge is constantly generated. Academic institutes produce large volumes of multi-topic knowledge. Enterprises are aiding in knowledge creation through published R&D efforts.	There is a decreasing amount of knowledge generation. The academic institute associated with the sector has a much lower output than usual. Enterprises have shifted their focus away from performing R&D.	The rate of spin-offs from universities is driving biotechnology innovation in the region and need to be increased.
		<b>Who finances the knowledge development ?</b>	There is minimal or no funding for knowledge development .	There is an increasing number of well-known funding sources for knowledge development.	It is clear where to obtain finances, private or public, for knowledge development.	There is a decrease in the number of sources of funding for knowledge development .	Funding of innovation-type research is dwindling right now - and it is not clear to ecosystem actors where, apart from possibly TIA, more funding will come.
		<b>Who leads research and development ?</b>	There are no leaders in research and development .	There is an increasing number of prominent leaders in research and development	There is a large number of prominent leaders in research and development	Leaders start decreasing their contributions and/ or start leaving the system.	There is a risk that due to lack of funding of research groups and increasing age a diminution of senior researchers takes place.
		<b>Relevance of knowledge produced</b>	A small amount of academic knowledge produced is relevant to the sector's priorities.	There is a growing level of activity of academic knowledge produced relevant to the sector's priorities.	More sector-relevant knowledge is produced from academia and the private sector.	The knowledge produced has shifted focus away from the sector and is developed more for other sectors.	Most research is published by academic institutions and research councils, with high scientific rigour. Active private sector R&D is taking place, however access to funding remains challenging.



		<b>Who collaborates to produce published knowledge?</b>	There is no to minimal collaboration among actors of published knowledge.	Actors collaborating to produce published knowledge increases rapidly.	There is clear evidence of who collaborates when producing published knowledge.	Collaboration efforts, among actors, to produce published knowledge decrease.	Extensive collaborations evident from joint publications and joint projects. A significant number of Research Chairs are funded by National Government and Academic Institutions.
		<b>Who collaborates to produce knowledge from R&amp;D?</b>	There is no to minimal collaboration among actors of R&D knowledge.	Actors collaborate to produce R&D knowledge increases rapidly.	There is clear evidence of who collaborates when producing R&D knowledge.	Collaboration efforts, among actors, to produce R&D knowledge decrease.	A large number of established researchers in the field are based in the Western Cape and have extensive international collaboration networks
		<b>Are there partnerships or collaborations?</b>	No clear partnerships between enterprises.	There are some collaborations among enterprises and between academic institutes.	Clear collaboration among enterprises and between academic institutes.	A decreasing number of collaborations among enterprises and academic institutes.	Active collaboration between Academic and Private Sector takes place, specifically in Health and Agri Sectors. Further possibilities exist to Industrial and IKS sub-sectors. Further possibilities exist to Industrial and IKS sub-sectors-specifically in terms of unlocking rich biodiversity assets in WC.
F3	<b>Knowledge diffusion</b>	<b>How is knowledge shared?</b>	Minimal or no knowledge diffusion attempts or events occur in the sector.	Knowledge is mostly shared unintentionally, intentional knowledge events, and sharing are increasing in the sector.	Continuous formal events occur between various innovation-related parties related to the sector.	A decreasing number of formal events focused on previous innovations occur in the sector.	Existing take-up of Health and Agri sector knowledge shows high relevance of knowledge produced. Further possibilities exist to expand





		<b>Do clear targets/goals exist?</b>	No innovation-orientated sector-focused targets and goals are set.	Innovation-orientated sector-focused targets and goals are being set and achieved.	Innovation-orientated sector-focused targets and goals have been achieved in the region.	Innovation-orientated sector-focused targets or goals are not revised when met or failed to be achieved.	No clear target setting across the broader biotechnology sector in WC. Cross-sectoral sharing may assist in clarifying of combined offer and positioning Western Cape as Biotech region of choice in Africa.
F4	<b>Guidance of search</b>	<b>Do the goals cause government involvement?</b>	The government is not or is minimally involved with goal setting or contributing to achieving the sector-focused goals.	The government is increasingly involved with goal setting or contributing to achieving sector- focused goals.	The government is steadily involved with goal setting or contributing to achieving the sector-focused goals.	The government decreases its support for goal setting or contributing to achieving the sector-focused goals.	Targets and goals informed by Bio-economy Strategy 2013 (and Decadal Plan of DSI), however there is room for clarifying provincial level strategic goals and targets.
		<b>Does existing or new legislation/regulation act as a barrier or an enabler?</b>	Current legislation acts as a strong barrier to innovation in the IS.	Impeding legislation is relaxed and/ or new legislation is introduced to aid innovation in the IS.	Impeding legislation is minimal and/ or new legislation strongly aids innovation in the IS.	Current legislation is outdated and hinders innovation, it needs to be updated again.	IP protection may limit knowledge sharing. Highly regulated environments presents barrier to entry to new entrants.
		<b>Articulation of interest by leading customers</b>	There is minimal to no interest articulated by leading customers in the innovation system. The IS actor's demand is not clear.	Leading customers increasingly articulate their interests showing the IS participant's demand.	It is clear what the IS's interest is and it is well articulated. All actors understand each other's demands.	The interest is not articulated well and the customer's interest has shifted to other innovations or sectors.	High level of National, Provincial and Local Government support- Integration of effort required to ensure more effective WC positioning



		<b>Are their policies, or incentives for the market?</b>	No policies or incentives exist to promote innovation or innovative related solutions.	Policies or incentives to support innovation are introduced and utilised by various entities.	The market is well- formed and self-sufficient. Policies or incentives do not have a large effect on the market's growth.	The policies or incentives in place don't have any impact and the market is beginning to decrease in size due to other markets.	Multiple national initiatives to grow Bioeconomy, with more limited provincial and municipal government incentives. IP regulations and highly complex regulatory frameworks viewed as sectoral barrier. i.e. Some misalignment between SA Regulatory Framework and international frameworks seen as challenging to Agri sector.
		<b>The market size of a specific sector</b>	The sector's market is non-existent/tiny and would require work to develop.	The sector's market is growing rapidly and receives increasing growth.	The sector's market has slowed, but it is receiving a sustaining amount of support.	The sector's market is decreasing in size and needs to pivot to accept newer innovations.	Covid pandemic focused articulation in Health sub-sector. Other sectoral articulation aligned around SDGs, but less clear. Opportunity to unlock further Food Security-related opportunities within Agri-subsector, Blue Biotechnology.
F5	<b>Market formation</b>	<b>Who are the sector's market leaders?</b>	It is not easy to identify the sector leaders. The market is still for new entrants to succeed.	Clear sector leader(s) emerge and can be easily identified. There is still space in the market for new entrants.	Sector leaders are easily identifiable, they dominate the market making it difficult for new entrants to succeed.	The sector's market starts to lose its relevance and the sector leaders withdraw or shift their focus from the sector.	Most incentives focus on Knowledge creation and early-stage financing. There are still niches to occupy.



	<b>What lifecycle stage is the market in?</b>	The market is a niche market and has limited structural elements.	The market is bridging and welcomes more elements. The elements find it easy to grow.	The market is mature, it is large and well-established. Structural elements are comfortable and there is minimal change.	The market is declining and is either left to phase out or renewed by aiming to grow again.	The market gap between biotechnology startups and large international actors is still significant, but this market is growing and increasing innovation networks between ecosystem actors in the WC RIS is observed - which need to be nurtured and expanded upon.
	<b>Nature of financial resources</b>	There are few funding resources or mechanisms available.	There is an increasing number of different funding resources or mechanisms available.	There is a large variety of types of funding resources or mechanisms available.	There is a limited number of types of funding resources or mechanisms available.	Very difficult to get funding right now due to limited investor pool.
	<b>Accessibility of financial resources</b>	Financial resources are not available or are difficult to obtain.	Financial resource access is increasingly easier and investors are showing increased interest.	Established financial resources exist (i.e. established banks, venture capital firms and angel investors).	Financial resources are withdrawing their support from the sector.	There is access to multiple financial institutions including venture capital and private equity firms in Cape Town, yet the Biotechnology funding space is still perceived as very niche. Big challenges in funding the upstream of biotech right now: it is very difficult to fund early development activities, which severely limits the downstream activities and applications



		<b>Accessibility of seed and venture capital (VC)</b>	Seed and venture capital are not available or are difficult to obtain.	Seed and venture capital access is increasingly easier and investors are showing increased interest.	Established access to seed and venture capital exists (i.e. established venture capital firms and angel investors).	Financial resources are withdrawing their support and leaving the system.	Very high setup costs of Biotechnology industry is stifling innovation. BioCiti has played a key role in stimulating more Biotech startups through shared lab-space model. However, no Shared Production/Scale-up facilities exist yet, hampering growth trajectory of some high potential startups. Limited VC funding is focused on Biotechnology industry (i.e., OneBio) and more specialist finance may be required to bridge the R&D to Market gap.
F6	<b>Resource mobilisation</b>	<b>Accessibility of infrastructure to provide basic needs (business-facing as well)</b>	The infrastructure to meet basic needs is mediocre or non-existent.	The infrastructure to meet basic needs is improving and is accessible.	The infrastructure to meet basic needs is well developed and stable.	No further investments into the infrastructure to meet basic needs are made, and they start to deteriorate.	Although most operators are energy resilient, load shedding is a concern; transport is a security and cost issue
		<b>Availability of appropriately skilled workforce</b>	There are minimal or no appropriately skilled workers available.	There is a large increase of appropriately skilled workers to employ.	There are plenty of appropriately skilled workers in the region.	There is a decreasing number of appropriately skilled workers	Majority of workers are appropriately skilled with 4 Universities producing qualified people
		<b>Availability of a high-skill workforce</b>	There are minimal or no high skilled workers available.	There is a large increase of high skilled workers to employ.	There are plenty of high-skill workers in the region.	There is a decreasing number of high-skill workers	There is a shortage of high skilled workers at the management level as there is not enough of a



					history of employment in biotech yet, although it is increasing right now	
	<b>Strength of resistance to change for a specific sector?</b>	The sector's participants are resistant to change and are not open to innovative ideologies or influences.	The sector's participants are opening up to different innovations and are starting to welcome them into their everyday lives	The sector's participants are accepting of innovative solutions and continuous change. There are plenty of examples of what innovation does for the sector. A clear buy-in can be seen by prominent entities.	The sector's participants are starting to lose trust in new innovations and what innovation does for the sector.	Some of the biotechnology niche areas, such as plant molecular farming is complex to create understanding and buy-in for because of its innovative nature.
	<b>Is there recognised actor support?</b>	There are no recognisable brands or enterprises supporting innovation.	Large enterprises are starting to support and fund innovation activities and actors within an area.	There is consistent and committed support from recognised enterprises for innovation activities and actors within an area.	Large enterprises are withdrawing their funds and support for innovative activities.	Various sub-sectoral actor support initiatives are provided through the NRF, ARC, DSI (Bio-Economy Unit) and initiatives such as BioCiti.
	<b>Are there mechanisms to engage with the community?</b>	There is no to little way for innovation driving actors to engage with the community.	There is an ever-growing number of ways to engage with the community on innovation topics.	There are established mechanisms to engage with the community.	Current engagement mechanisms are overused and the communities focus shifts while participation decreases.	Various sub-sectoral actor support initiatives are provided through the NRF, ARC, DSI (Bio-Economy Unit) and initiatives such as BioCiti. However, there is perceived room for improvement on provincial and local level.



		<b>Do actors lobby for sector support? (Are there resources or formal structures to empower lobbying for actor support? )</b>	Actors do not or barely lobby for support from the appropriate support actors in the IS. There are no formal processes to follow to lobby.	Actors are increasingly lobbying for their required resources, changes to legislation, and implementation of goals.	There is a continuous group lobbying for required resources, changes to legislation, and implementation of goals.	Lobbying groups' presence is diminished and there is decreased lobbying activity. Formal processes become difficult to navigate.	Various sub-sectoral actor support initiatives are provided through the NRF, ARC, DSI (Bio-Economy Unit) and initiatives such as BioCiti. However, there is perceived room for improvement on provincial and local level.
F7	<b>Creation of legitimacy</b>	<b>Are the benefits of innovation marketed effectively?</b>	No to minimal effort to market innovation is performed.	The benefits of innovation are increasingly marketed more and made clearer to actors in the IS.	The benefits of innovation are marketed effectively and are understood by actors in the IS.	There is confusion regarding the benefits of innovation, some of the benefits expressed are outdated and should be revised.	Biotechnology information on the PGWC website is quite outdated and there is a multiplicity of different actors across the sub-sectors that are positioning innovation in the Biotech industry. An opportunity exists to clarify a single innovation vision around biotechnology for the province.

Table 14: WC Biotech RIS Innovation Maturity

## 9. Findings (Western Cape)

---

The Western Cape Biotechnology Industry's maturity can be described as follows:

- **Health and Agri sub-sectors** of the market are in very early phases of the Growth Stage. In this phase the market for the innovative technologies expands and it may also be tweaked at this stage to ensure some features or functionalities are improved. The knowledge on the technologies is more easily accessible. They become popular and results in increased sales. Thus, many investment organisations are growing and ready to provide finances. Other companies also notice these disruptive technologies, thus attracting competition. However, growth in the Biotechnology sector is capital-intensive, therefore access to funding and facilities to scale is crucial in this phase.
- **Industrial Sector and IKS** in the Birth phases, with some Niche areas growing. During this stage, companies release their innovative technologies into the market for the very first time. The company at this stage is at high risk and a lot of capital is needed so that the companies' technologies reach the consumers. Thus, many firms need a lot of promotional and marketing activities to be undertaken.

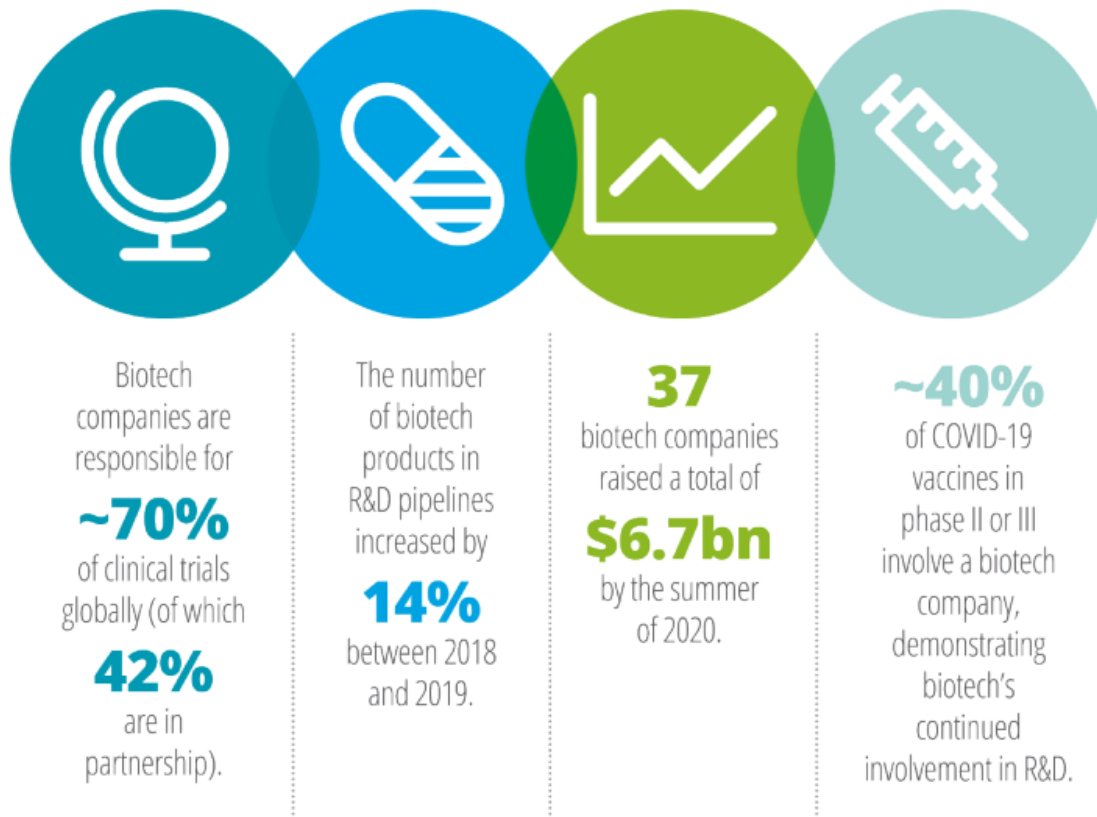
Bio-technology market success and scaling requires collaboration – on average, between 30 and 40 per cent of health-related trials are conducted in collaboration with other players at both IPO and maturity stages (Deloitte Analysis, 2020). Therefore, building stronger links and collaborations between ecosystem actors is a key to unlocking market value. There is potential for the Western Cape to strengthen its role in this regard – especially to also foster and incentivise inter-institutional collaborations, but also collaborations across the health, agriculture, industrial, environmental and IKS sub-sectors of the industry in the Western Cape.

Globally, the Biotechnology industry, despite the economic disruptions caused by the COVID-19 pandemic, continued to grow and attract high investment. According to Deloitte<sup>2</sup>, by summer of

---

<sup>2</sup> <https://www2.deloitte.com/za/en/insights/industry/life-sciences/scale-up-strategy-for-early-stage-biotech-companies.html>

2020, 37 biotech companies raised a total of \$6.7 billion through US IPOs, compared to \$5 billion in all of 2019 across 51 IPOs. The Nasdaq biotechnology index rose to a five-year high in December 2020 – up more than 25 per cent since the start of that year.



Source: Deloitte analysis, 2020.

Deloitte Insights | [deloitte.com/insights](https://deloitte.com/insights)

Figure 5: Biotech sector growth (Deloitte Analysis 2020)

The importance of biotechnology as driver of new products (see Figure 5) within the global pharmaceutical industry, in particular, has also been expanding:

*“In 2019, the number of biotech products in the R&D pipeline increased by 14 per cent from a year earlier – from 4,751 products to 5,422. In particular, more than 300 next-generation therapies, such as gene and cell therapies, are currently in biotech’s late-stage pipeline, three times more than in 2009, and between 2018 and 2019 the number of these therapies in pipelines rose by more than 20 per cent. In addition, biotech companies continue to play a leading role in developing, alone or in collaboration with other players, COVID-19 vaccines or treatments.” (Deloitte Analysis, 2020)*

One of the (unintended) consequences of the prominence of biotechnology in the Covid-19 pandemic has been the fact that valuations of small and medium biotech start-ups have been increasing markedly, ironically making it more difficult for them to raise funding or be acquired by larger industry firms<sup>3</sup> (E&Y).

There is a market opportunity for the Western Cape to leverage its well-positioned underlying drivers for growth in the Bio-economy to achieve a larger share of bio-economy exports, both in total value and unit value. This can also result in creation of employment opportunities, especially in the Health Biotechnology Sector, but also Agriculture.

## **9.1. SWOT Analysis: WC Biotechnology sector**

Ana analysis of the strengths, weaknesses, opportunities and threats for the Western Cape Biotechnology sector can be summarised as follows (Table 15):

---

<sup>3</sup> E&Y: [https://www.ey.com/en\\_us/life-sciences/5-ways-for-emerging-biotechs-to-launch-smarter](https://www.ey.com/en_us/life-sciences/5-ways-for-emerging-biotechs-to-launch-smarter)

Strengths <sup>4</sup>	Weaknesses
<ul style="list-style-type: none"> <li>• Multiple academic institutions with specialised biotechnology niche focus areas</li> <li>• Very strong industry presence</li> <li>• World class Research &amp; Development infrastructure (Agri; Health; Industrial and IKS) through HEIs, Medical Institutions and Research Institutions &amp; Private sector</li> <li>• Strong community through HEIs collaborations with industry and BioCiti and other key roleplayers</li> <li>• Local and Provincial government support.</li> <li>• Local investment incentives.</li> <li>• Quality of life and living standards.</li> </ul>	<ul style="list-style-type: none"> <li>• Supportive environment for next-generation researchers can be optimised</li> <li>• Talent pipeline can be better integrated</li> <li>• Industry bodies specifically focused on Western Cape lacking</li> <li>• Significant challenges with funding the upstream of health biotech right now: it is still very difficult to fund early development activities, which severely limits the downstream activities and applications</li> <li>• Small pool of specialist biotechnology funders (funders do not always have appetite for industry they struggle to understand)</li> <li>• The Western Cape at present lacks a dedicated biotechnology sectoral vision that focuses on health, agriculture, industrial and IKS biotechnologies in an integrated and geographically focused manner.</li> </ul>

<sup>4</sup> By definition, Strengths/Opportunities are promoters a sector and Weaknesses/Threats are inhibitors in a sector. This can be extended to innovation in the sector, but other factors may also influence innovation.

Opportunities	Threats
<ul style="list-style-type: none"> <li>• Opportunities to raise international funding through various structures (Equity funding; M&amp;A; Joint Ventures)</li> <li>• Linking various academic knowledge generation nodes in HEIs to each other and to industry opportunities (cross-sectoral awareness)</li> <li>• Diversification to towns beyond Cape Town, particularly IKS-related</li> <li>• Blue Biotechnology as food security source requires more focus</li> </ul>	<ul style="list-style-type: none"> <li>• High Dependencies on external IP and imported equipment (currency risk)</li> <li>• High setup and maintenance costs</li> <li>• Competing South African locations</li> <li>• Load shedding</li> <li>• Crime</li> <li>• Challenging IP Regulatory Environment</li> </ul>

*Table 15: SWOT analysis of Western Cape Biotechnology industry*

## 9.2. Promotors

- Raised level of awareness around South African biotechnology innovation due to its role in the global and local Covid-19 pandemic response.
- Very mature and advanced Research and Development expertise centred around the four universities, the Medical Research Council, the Agricultural Research Council and their respective ecosystems.
- Healthy start-up support ecosystem (BioCiti and the University Incubator Ecosystem) developing. A strong City of Cape Town and Provincial focus on innovation support initially for mainly the ICT industry is being leveraged to provide innovative approaches to Biotechnology innovation, especially through shared infrastructure and collective fund-raising. This ecosystem is very flexible and innovative in terms of how they are supporting specialised product development and commercialisation, but can benefit from a clearer Western Cape vision for the biotechnology sector.
- Large multi-national and national biotechnology market actors that can cost-effectively leverage the WC's significant knowledge and talent pool in bio-technology.

- The integration of an entrepreneurial ecosystem, with clear regional support and a shared vision can benefit innovation in the Biotechnology sector.

### 9.3. Barriers

- Lack of cross-sectoral focus on biotechnology hampers the identification of opportunities that may benefit from existing knowledge sources in the province.
- Lack of integrated biotechnology opportunity definition and provincial vision that crosses sectoral niches.
- Lack of funding of upstream biotechnology research pipeline.
- Lack of shared scale-up bio-manufacturing capacity.
- Negative economic climate due to rises in energy prices, loadshedding and lack of economic growth
- Challenges to attract and retain local talent in the biotechnology sector.

### 9.4. Recommendations

The convergence between the Western Cape's strengths in advanced digital technologies (such as Artificial Intelligence, Bioinformatics) and the Life Sciences presents an opportunity to the Western Cape to re-focus its "Digital Technology Capital" moniker to clarify its unique value proposition as a "Bio-Digital Capital" on the continent.

It will benefit the Biotechnology sector if increased international awareness is created of the Western Cape Biotechnology sector as an advanced centre of knowledge creation that can support commercialisation and growth in not only the Health Biotechnology centre, but across the domains of Health, Agriculture, Industrial and Environmental biotechnology.

Although there are many examples of university spin-off firms, there is a need for stronger university-industry relationships to encourage innovation for entrepreneurial start-ups" (Patra & Muchie, 2017).

The prohibitive costs of starting bio-technology companies are coming down significantly as technologies mature, although currency risks still present a significant challenge to sourcing of equipment and materials- mainly imported.

Internationally, the “shared infrastructure” model of scaling biotechnology innovation has proven to be successful, for example YCombinator.com, a leading hard technology incubator state:

*“Companies like [Science Exchange](#) make access to CROs and scientific supplies instantaneous and cost effective to small companies. It’s easy to rent [fully equipped lab space](#) by the bench, and there are [companies](#) to help you [stock it](#). Affordable lab robots from companies like [OpenTrons](#) make it possible to automate batch experiments, and computational drug discovery from companies like [Atomwise](#) allows some experiments to be done completely in silico. Companies like [Cognition IP](#) are bringing down the cost of filing patents, and companies like [Enzyme](#) are streamlining FDA submission.”*

While the Western Cape is increasingly becoming the home of some very promising new biotech startups there is perceived to be relatively limited direct and strategic engagement by the WC government in developing the sector.

Comparisons of Cape Town with San Diego or Tel Aviv as a prospective home for hi-tech biotech keep being made, but ecosystem actors mentioned a lack of any distinct incentives for development of a "Green" or "Biotech Valley" locally. Incentives could include targeting developments for assistance, whether by funding or provision of land or facilities, and partnering with particular initiatives in order to develop faster and with more assurance of success. Further incentives can include creation of mechanisms for funding upstream activities, such as industry-oriented research at universities.

## 10. Close and future activities/research

---

This report analysed at high level the RIS ecosystem of the Biotechnology sector in the Western Cape. The sector’s Health and Agri sub-sectors are at a high level of readiness for future growth. The Industrial Sector and IKS are in the Birth phases, with some Niche areas growing. However,

more focused support and strategic engagement from the Western Cape Government may enhance the sectoral growth trajectories.

A further, thus far largely underexplored opportunity is the field of Blue Biotechnology:

Blue biotechnology considers the non-traditionally commercially exploited groups of marine organisms and their biomass applications, including economic activity associated with the use of renewable aquatic biological biomass, e.g., food additives, animal feeds, pharmaceuticals, cosmetics, energy, etc. Important marine resources include algae (macro- and micro-), bacteria, fungi and invertebrates and this biomass can be used for a variety of commercial applications including food and food supplements, feed, cosmetics, fertilisers and plant biostimulants, and innovative commercial uses as biomaterials, bioremediation or biofuels (EU, 2022).

Blue Biotechnology can assist in addressing provincial priorities such as carbon neutrality, innovative, healthy and sustainable food systems and a sustainable and circular bioeconomy.

## References

---

- Africabio. (2022). *AGRICULTURE* | africabio. <https://www.africabio.com/agriculture>
- DST. (2013). *Bioeconomy strategy*. <https://www.switchtogreen.eu/a-sustainable-bioeconomy-for-europe-strengthening-the-connection-between-economy-society-and-the-environment/>
- DST. (2019). White Paper on Science , Technology and Innovation. In *DST* (Issue March).
- Esterhuizen, D., & Cladwell, A. (2021). *Agricultural Biotechnology Annual (Report SF2021-0060)*.
- EU. (2022). The 2022 EU Blue Economy Report. In *European Union* (Vol. 19, Issue 3). [https://drive.google.com/file/d/13t6DZHeSCEBcBuP7EhIb\\_ZvfHEp2\\_ANv/view?usp=sharing](https://drive.google.com/file/d/13t6DZHeSCEBcBuP7EhIb_ZvfHEp2_ANv/view?usp=sharing)
- EY. (2022). *How do biotechs stay the course in uncharted waters? Beyond borders: EY biotechnology report 2022*. [https://www.ey.com/en\\_us/life-sciences/beyond-borders-biotechnology-report-2022](https://www.ey.com/en_us/life-sciences/beyond-borders-biotechnology-report-2022).
- Grobbelaar, S. S., Gwynne-Evans, N., & Brent, A. C. (2016). From enterprise development to inclusive innovation-A systemic instruments framework for regional innovation support. *African Journal of Science, Technology, Innovation and Development*, 8(2), 233–246. <https://doi.org/10.1080/20421338.2016.1159401>
- InvestCapeTown. (2022). Open for tech, healthtech, biotech and digitech. *Invest Cape Town*. <https://www.investcapetown.com/wp-content/uploads/2020/10/Investor-Confidence-Health-Tec-Sector-brochure.pdf>
- NACI. (2022). *South African Science, Technology and Innovation Indicators 2022*.
- Patra, S. K., & Muchie, M. (2017). Role of innovation system in development of biotechnology in South Africa. *Asian Biotechnology and Development Review*, 19(1), 3–30.
- Stellenbosch University. (2022). *Home*. <http://www.sun.ac.za/english/faculty/healthsciences/biomedical-research-institute>
- UNCTAD. (2021). *Technology and Innovation Report 2021- Catching technological waves:*



*Innovation with equity.*

Vision Research Reports. (2022). *Biotechnology Market Size, Share, Growth, Trends (Report 2022-2030)*. <https://www.visionresearchreports.com/biotechnology-market/37875>