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Wits
UNIVERSITY

2020 Research Report

COVID-19:
The first year

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

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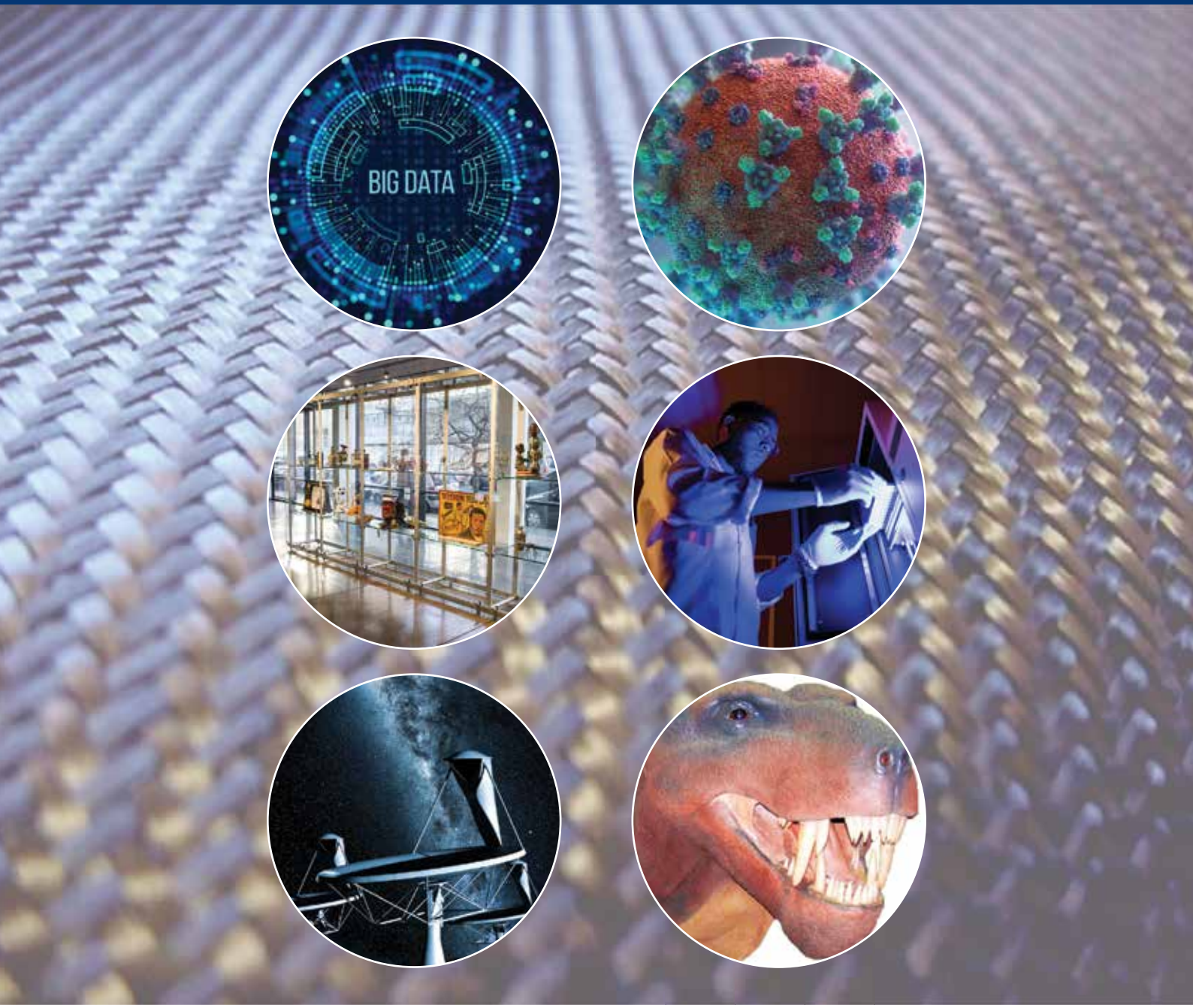
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

1922 2022

Wits Research Office

CELEBRATING RESEARCH EXCELLENCE AT WITS



Empowering our researchers to conduct world-leading, innovative research.

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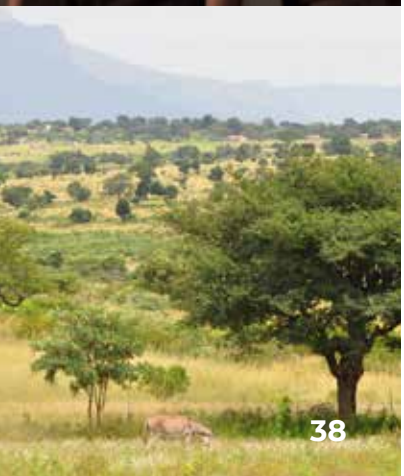


A World-Class University

Wits is a leading African university that is ranked in the top **1%** of universities in the world. In 2022, Wits celebrates 100 years of academic and research excellence, social justice and the advancement of the public good. Our history is inextricably linked to that of mining, the City, and civic and political activism. Wits compares to the:

Top **10** in Canada & Australia

Top **65** in the EU & US

Top **30** in the UK

Located in the Economic Hub of Africa

- **400** buildings, **7** campuses, including the Wits Rural Facility
- **11** Libraries, **18** Residences, **2** commercial companies – Wits Health Consortium and Wits Enterprise
- Wits owns the Sterkfontein Caves in the Cradle of Humankind World Heritage Site and a private teaching hospital – the Wits Donald Gordon Medical Centre

The Home of Talented Scholars

41 100 students

- **57%** female
- Almost **50%** are first in their family to attend a university
- **5** Faculties, **33** Schools, **3 000** courses
- **1 665** academics, **6 582** employees, **2 170** joint staff
- Postgraduate students now make up almost **40%** of Wits students

Wits administers R1 billion in student financial aid, scholarships and bursaries annually. There are numerous services available for students.

Developing Employable Graduates

About **10 000** highly employable students graduate annually

↓

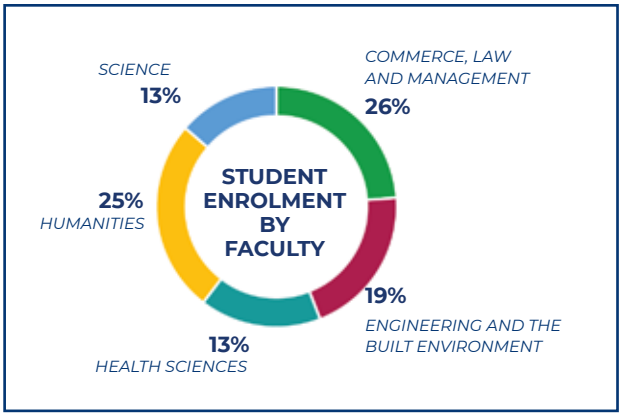
Of those employed, **93% find jobs within 6 months of graduating**

+200 000 **graduates in 100 years**

Ranked 98th in the world for Alumni Employability (CWUR)

FORTUNE GLOBAL 500

Ranked 54th in the world based on the number of Fortune Global 500 CEOs (THE Alma Mater Index 2017)



REPORT FROM THE VICE-CHANCELLOR AND PRINCIPAL

Professor Zeblon Vilakazi

As South Africa entered its first hard lockdown in 2020, I served as the Deputy Vice-Chancellor: Research and Postgraduate Affairs and the Vice-Chancellor and Principal Elect, during a period of uncertainty, but also a period of great advancement and progress, despite the pandemic.

The first year of the Covid-19 pandemic dramatically impacted on how we interact, conduct research, teach, and learn. Some of the disruption was positive, as we realised the importance of human connectedness, scientific research, and how to adapt to the changing nature of teaching, learning, and work. The pandemic also demonstrated the digital divides experienced worldwide, the alarming prevalence of gender-based harm, the mental health challenges experienced by many, the devastation of economies and livelihoods, the dangerous reality of misinformation, and the lives lost to Covid-19.

This 2020 Research Report focuses predominantly on Covid-19-related research at Wits and is themed *Covid-19: The first year.* Despite the pandemic, Wits was able to transcend many latitudes and ultimately to impact on society for good. The year under review shows the steady growth of Wits' publication units over seven years from 2011. This positive trend seems to have been re-established over the last three years with a peak of nearly 2 000 units at the end of the reporting period.

Wits remains in the top 1% in the world (from amongst approximately 25 000 universities worldwide), our Humanities and Arts programmes are rated the best in Africa, and we are ranked in the top 100 in the world in clinical medicine, public health, mining engineering, and other disciplines. We have the most highly cited researchers in Africa and continue to publish predominantly in high-impact international journals.

None of these achievements would have been possible without Wits' talented staff, researchers, postdoctoral fellows, postgraduate students, funders, donors, and others, and I would like to express my appreciation to all those who continue to conduct globally competitive research, from our vantage point in the Global South.

The 2020 Research Report features the work of committed and brilliant Wits scientists, researchers, and academics during a tumultuous and challenging year. The research necessarily pivoted to focus on understanding and interpreting the pandemic and to address the crises that it caused in public health, mental health, education, and society. From leading South Africa and the continent's first Covid-19 vaccine trials and advancing Covid-19 testing, treatments, genomic sequencing, through to modelling the pandemic and people's behaviour, Witsies are at the forefront.

Wits' research in 2020 made a significant contribution for good in a strange new world. Our researchers are helping us to understand the implications of climate change, the impact of Covid-19 on economies, on people and politics, and the importance of the arts, in helping us better understand humanity.

In November 2020, the World Health Organization's Director-General, Tedros Adhanom Ghebreyesus said, "We might be tired of Covid-19. But it is not tired of us." And this remains true. By taking personal responsibility for our health, and through the tireless and committed research of the Wits scientists, scholars, and postgraduate researchers featured here, as well as those unseen and unsung, we're in good hands. I salute you all.

Professor Zeblon Vilakazi
Vice-Chancellor and Principal
University of the Witwatersrand, Johannesburg

REPORT FROM THE DIRECTOR: RESEARCH AND INNOVATION,

Dr Robin Drennan

Research by the Numbers

DR ROBIN DRENNAN
DIRECTOR: RESEARCH & INNOVATION

A DESCRIPTION OF WITS RESEARCH

It is impossible to adequately and comprehensively describe the research conducted by a research-intensive university, such as Wits, in a year. What is presented here, therefore, is a brief but broad overview of the contributions made by Wits-affiliated authors in 2020 that is by no means complete, and only provides a hint of what happened.

Quantity

A simple measure of research quantity is the number of accredited units awarded by the Department of Higher Education and Training (DHET) for research publications. These publication units are calculated using the fractional author counting system, so that an article published in an accredited journal and authored by two people attracts each author half a unit. The system also distinguishes between journal articles, books and chapters in books and conference proceedings.

Figure 1 shows an interesting pattern characterised by a steady growth of Wits' publication units over seven years from 2011. This positive trend seems to have been re-established over the last three years with a peak of nearly 2 000 units submitted to the Department in May 2021.

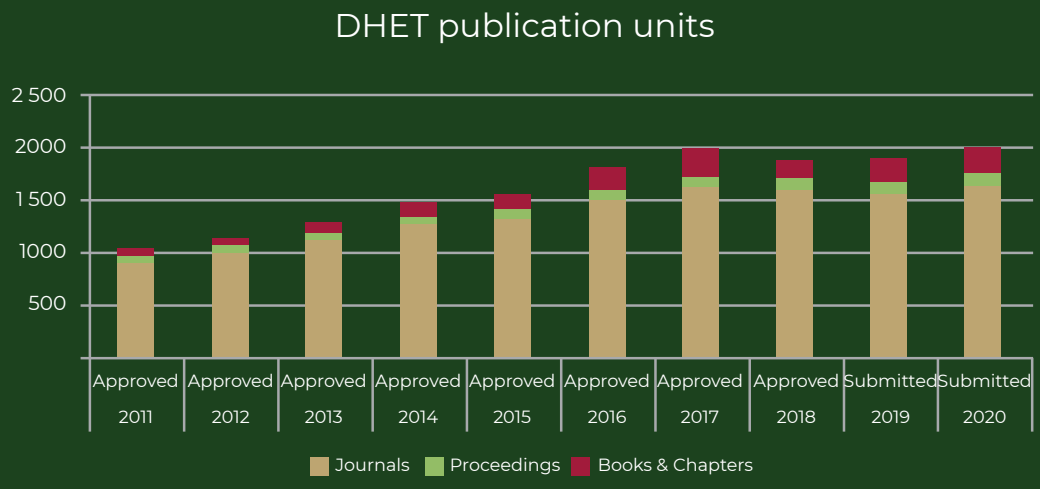


Figure 1: DHET units for research publications

Another objective way to measure the quantity of research output in the form of peer reviewed publications, which are not impacted by fractional author counts, is to report the number of publications by Wits affiliated authors indexed by various bibliometric data companies, like Elsevier and Clarivate.

Figure 2 shows the Wits authored publications, of all types, and specifically peer reviewed journal articles in the Scopus index (operated by Elsevier). This index includes some 23 000 peer reviewed journals and therefore reflects a wide range of disciplines. The plot shows a clear growth trend with a year-on-year growth rate of 16% in 2020.

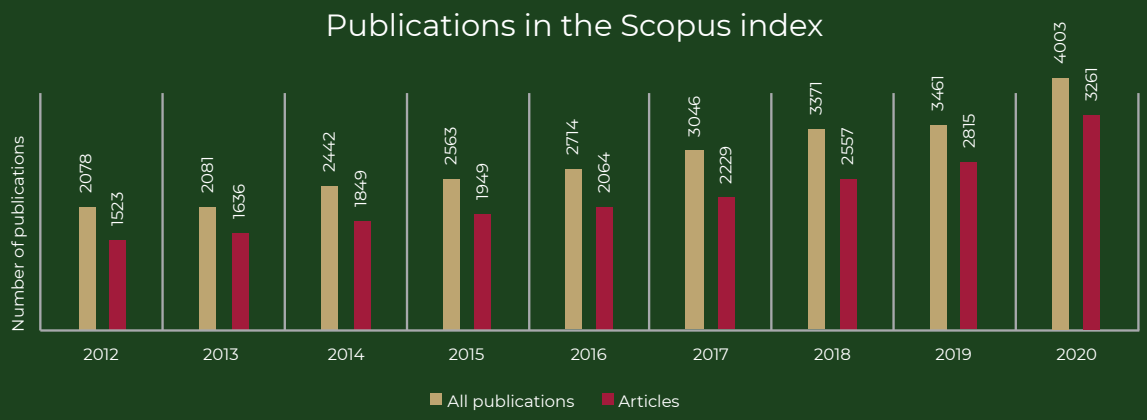


Figure 2: Trend of Wits authored publications indexed by Scopus

Figure 3 reflects a 7% annual growth rate of journal articles authored by Wits scholars in the Web of Science index (managed by Clarivate, the new name for Clarivate Analytics since 2020). This smaller index, also known by its historic name, the ISI (Institute for Scientific Information) index, arguably contains on average higher quality journals and is used within Wits as the true benchmark of excellence.

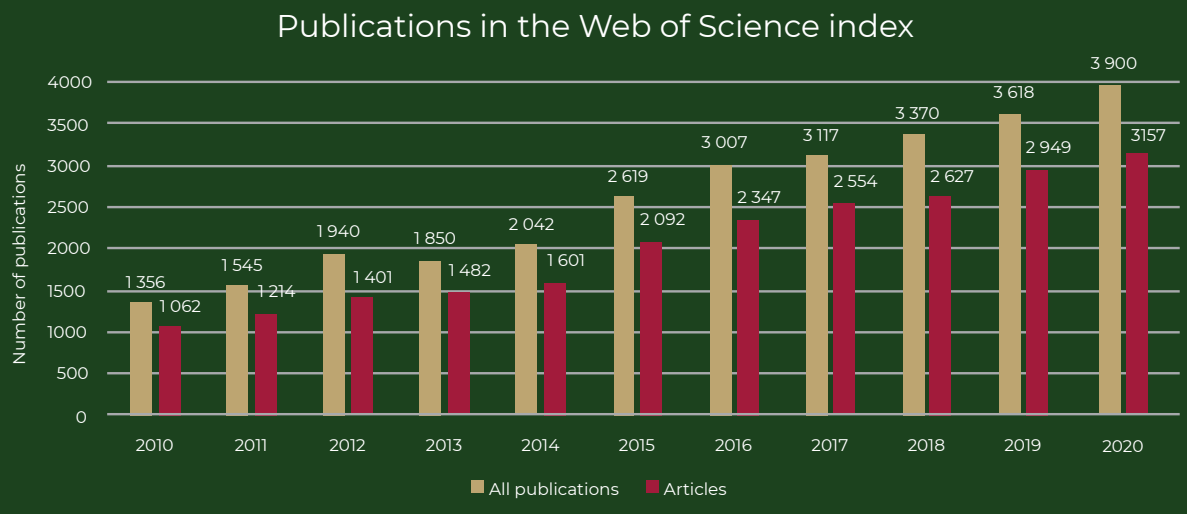


Figure 3: Trend of Wits authored publications indexed by Web of Science (ISI)

Productivity

Figure 4 shows Wits' productivity data based on the so-called weighted research output per capita. These are the DHET data and include units for postgraduate student completions (three units per PhD completion and up to one unit per master's student completion) with the publication units discussed previously. Based on submitted data, which are yet to be confirmed by the Department, there is a 4% growth in 2020.

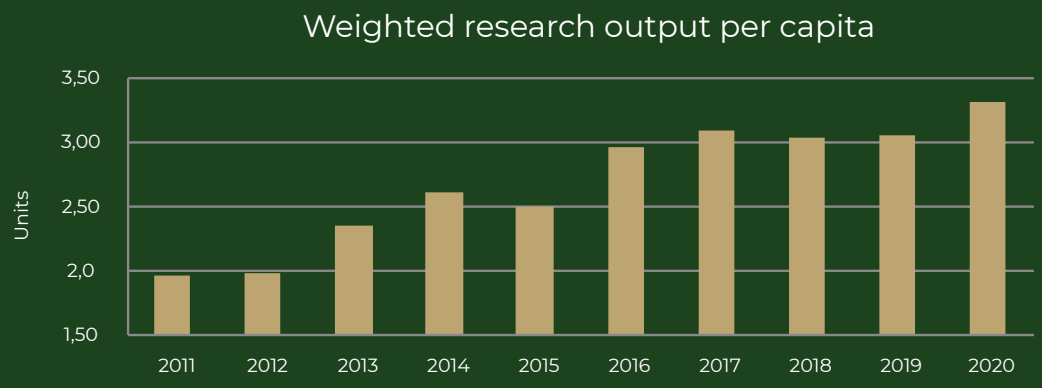
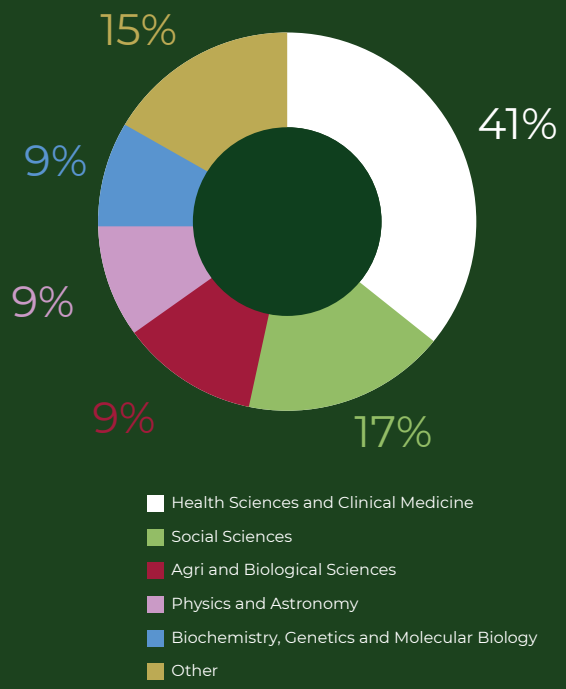


Figure 4: Trend of productivity data for weighted research outputs

Fields of Research

It is interesting to consider the fields in which these publications were located. As in previous years, the Wits research is dominated by the health sciences and clinical medicine. Thereafter, most research is published in the social sciences, life sciences, physics and astronomy, and molecular biology and related areas. The proportion of publications in these fields are shown in Figure 5. Given that the 'other' conglomeration of fields makes up 17% of the research output, after health sciences, Wits has a wide distribution of research interests embracing most areas of knowledge.



THE TOP FIVE JOURNALS IN WHICH WITS AUTHORS PUBLISHED IN 2020 WERE:

01 *The South African Journal of Medicine* (81 articles, Impact Factor = 1.6)

02 *PLoS One* (79 articles, IF = 3.2)

03 *The Southern African Journal of Anaesthesia and Analgesia* (41 articles, IF = 0.29)

04 *The Journal of High Energy Physics* (40 articles, IF = 5.8)

05 *Scientific Reports* (38 articles, IF = 4.4)

Figure 5: Fields of research extracted from the 2020 Scopus indexed research

Quality

No description of research would be complete without an assessment of the quality of the publications. There are multiple ways of assessing quality, all of which have strengths and weaknesses. Some are shown in Figure 6. The publication of monographs that contain sustained evidence-based arguments are a particular indicator of excellent scholarship. Wits authored publications in journals with the highest Impact Factors (IF) is another useful indicator. Shown in Figure 6 are the number of research based books and articles in the *New England Journal of Medicine* (IF = 91.2), *Nature* (IF = 50.0) or *Science* (IF = 47.7) journals, published in 2020.

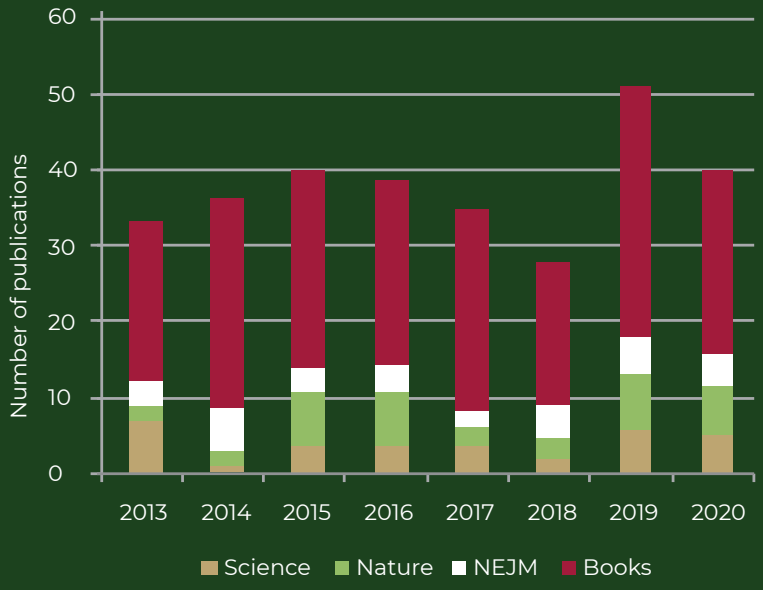


Figure 6: Number of Wits authored journal articles in high impact factor journals

The Nature Index offers one way of assessing the quality of research, in the physical and health sciences, by comparing the number of articles published by various universities in a set period and in a preselected list of 68 high quality journals. In the period 1 December 2019 to 30 November 2020 the Wits article count was 122, up from 112 in the same period last year. By way of comparison, Stellenbosch University and the University of KwaZulu-Natal publish three times less than Wits, respectively, and the University of Cape Town published 162 articles.

A further measure of quality is the ISI Category Normalised Citation Impact score. This metric indexes citation counts for disciplinary fields against the global average, which is set at a score of one. Figure 7 shows Wits' performance since 2010. Three features are worth noting in this plot. First, during the period, Wits' research has always been well above the global norm of one. Second, the spike in 2012 is due largely to a single journal article from physics that has been cited nearly 100 000 times. Finally, the downward trend from 2017 is an artefact of the time lag suffered by the citation process.

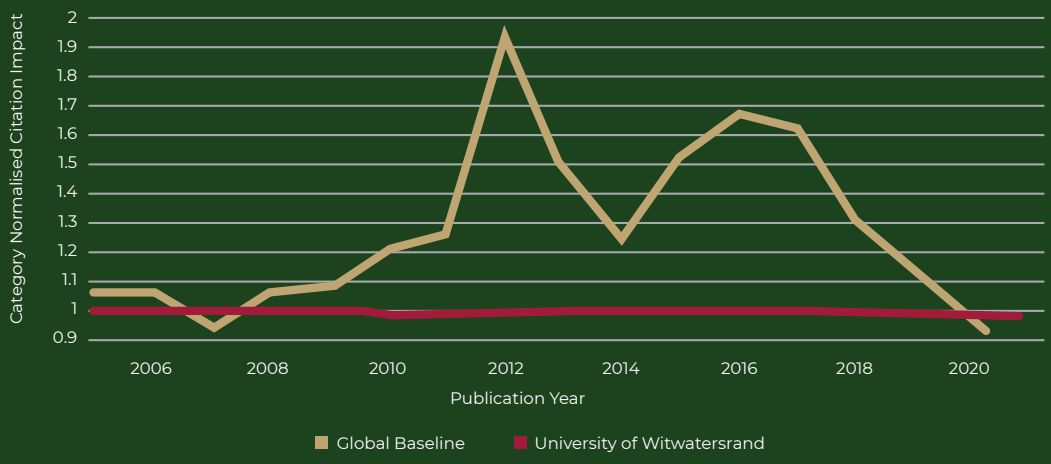


Figure 7: The Category Normalised Citation Impact score for Wits

A final assessment of quality is the number of Highly Cited journal articles and Hot Papers published by Wits authors in 2020 in ISI indexed journals. Highly Cited and Hot Papers are ranked in the top 1% and 0.1% of all articles by number of citations respectively. In 2020, Wits published 35 and four Highly Cited and Hot Papers, respectively – this trend is reflected in Figure 8. As with other citation-based metrics, these scores continue to improve over time.

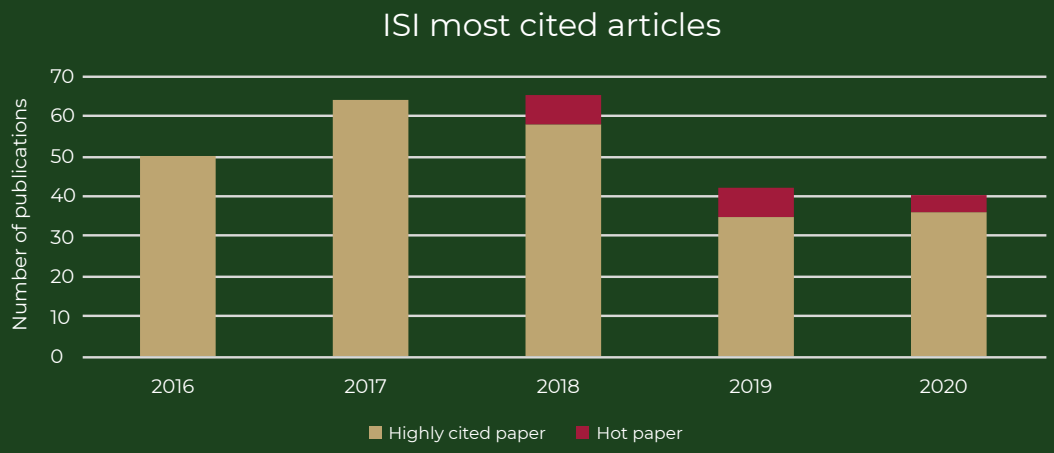


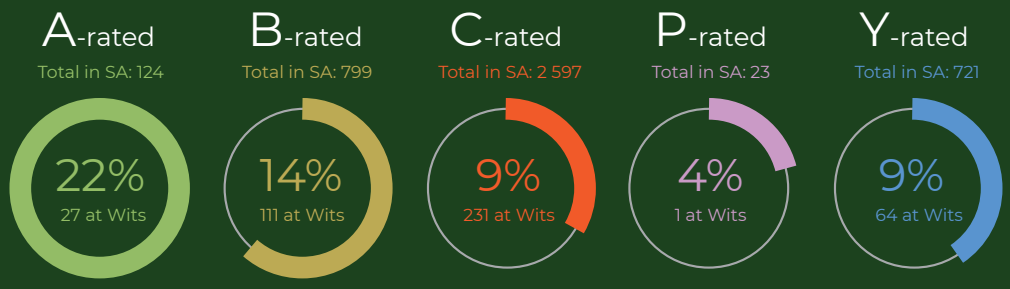
Figure 8: Number of Wits authored Highly Cited (top 1%) and Hot Papers (top 0.1%) per year since 2016

The Authors of this Research

ACADEMICS

Research excellence depends strongly on the talent base within the University. Again, it is difficult to find a single indicator of aggregate researcher quality and so the following indicators provide just a view of quality. However, it is important to recognise that the research contribution comes from a broad base of researchers.

Amongst these many researchers, the following may be especially noted. Wits, including its joint appointees, have 434 National Research Foundation (NRF) rated researchers in 2020, including 27 A-rated academics. The infographic below reflects the number of rated scholars in the country and the proportion of them at Wits. Given that the top five universities host 54% of all the rated academics in the NRF system in 2020, Wits should expect a 10.8% share of all the categories. The table clearly shows that Wits exceeds its 'normalised share' at the higher levels (A-rating and B-rating).



Infographic 1: NRF rating information

POSTDOCTORAL FELLOWS AND POSTGRADUATE STUDENTS

No description of the authors of research would be complete without consideration of the postdoctoral fellows and postgraduate students who contribute to the generation of new knowledge. At the end of 2020, there were 185 active postdoctoral fellows at Wits of which 64 (35%) were South Africans and 158 (85%) were within their first year of what is normally a two-year fellowship – four fellows were in year three or above. Most of the fellows were hosted in the Faculty of Science (68), with diminishing numbers in the faculties of Health Sciences (45), Humanities (43), Engineering and the Built Environment (EBE) (14), and Commerce, Law and Management (CLM) (12). Wits postdoctoral fellows published on average 1.2 items each in 2020 and this equated to 0.4 DHET units of research per fellow.

For postgraduate student completions, on the other hand, one unit is awarded for the completion of a master's degree by research (MR) or a fraction of a unit for a master's degree by coursework and research (MC), depending on the fraction of time spent on research. Three units are awarded for the completion of a PhD degree. Figure 9 shows the consistent growth of postgraduate degree completions in all three categories since 2010.

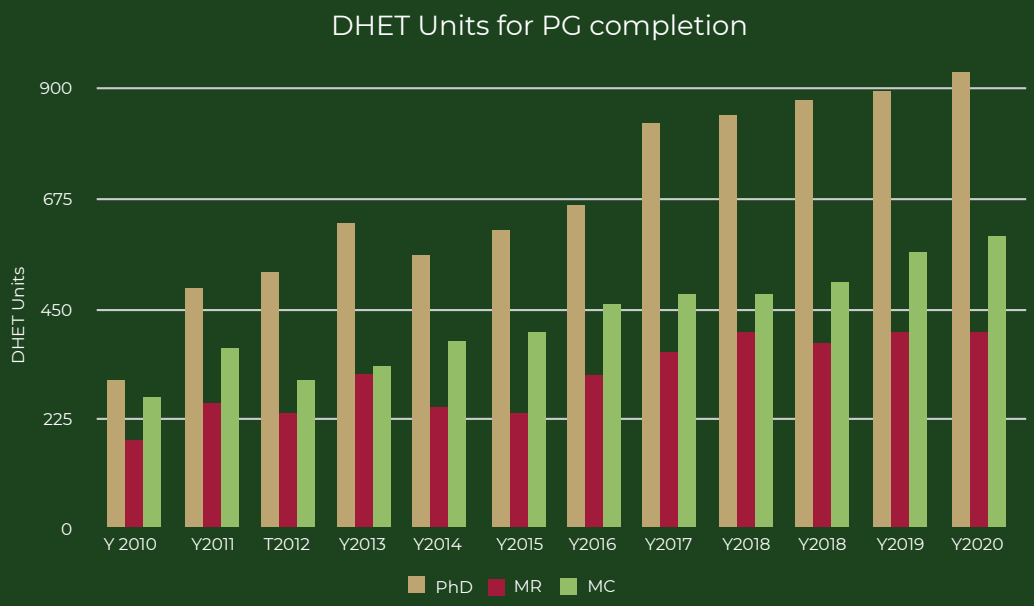


Figure 9: DHET Units for postgraduate degree completions

FACULTY OF

Commerce, Law and Management

The impact of research is reflected in how Wits is increasing its African footprint, influencing public policy, informing judgments made by the courts, and transferring new knowledge to the Faculty's curricula.

1
SOUTH AFRICAN RESEARCH CHAIRS

11
RESEARCH CHAIRS

45
NRF-RATED RESEARCHERS

39
PHDS

498
MASTERS

282
HONOURS

938
POSTGRADUATE DIPLOMAS

PROFESSOR IMRAAN VALODIA

DEAN: FACULTY OF COMMERCE, LAW AND MANAGEMENT

Research with impact has always been a priority for the Faculty of Commerce, Law and Management (CLM) and the 2020 pandemic illustrated the importance and necessity of this objective. By placing a strong focus on the practical value of the Faculty's applied and professional research, CLM staff members provided invaluable insights and expertise in finding solutions to the devastating socioeconomic impacts of the pandemic.

In times when expert advice was needed, CLM staff members tirelessly engaged with policymakers and the public, organised webinars, wrote for the public press and looked for innovative ways to gather information when our society moved into lockdown.

A number of CLM staff members were instrumental in the design, management and analysis of initiatives like the Coronavirus Rapid Mobile (CRAM) survey, which provided us with the first reliable understandings of the magnitude of the devastating impacts of the lockdown on the wellbeing of households, as well as the Covid-19 Economists Group, a network of economists including David Francis (CLM/ Southern Centre for Equality Studies – SCIS), Professor Alex van den Heever (Wits School of Governance), Professor Mzukisi Qobo (Wits School of Governance), Professor Michael Sachs (CLM/ SCIS), and I, who together supported efforts to address the economic impact of the Covid-19 pandemic in South Africa.

Our research entities, including the Southern Centre for Inequality Studies; the Centre for Applied Legal Studies (CALS); the Mandela Institute; and the Centre for Learning on Evaluation and Results (CLEAR AA), continued to provide services to practitioners, and intellectual guidance to policy makers.

Even with a practical and applied focus, the Faculty's research is grounded in rigorous academic research and remains internationally visible. We continue to grow Wits' reputation and collaborative networks in the areas of economics, finance, business, law, governance, and public administration.

In 2020, the Faculty increased its output of journal articles. Much effort has been focused on building research capacity and productivity at the School level. For 2020, the Faculty research footprint included over 200 journal articles of which 84% were published in internationally accredited journals.

Individual schools continue to make significant progress and seek to cement their positions as knowledge leaders. Across the Schools, the Faculty boasts 45 National Research Foundation (NRF)-rated researchers; the NRF South African Research Chair in Equality, Law and Social Justice; and 11 research chairs.

A total of 1 757 postgraduate students graduated from the Faculty in 2020, including 39 PhDs, 498 Masters, 282 Honours, and 938 Postgraduate Diploma candidates. With close to 54% of the 9 676 enrolled students in CLM being postgraduate students, our Faculty is a significant skills provider to the South African industry and government sectors.

As was evident in 2020, the Faculty continues to draw on its unique combination of expertise, to grapple with and contribute solutions to the economic and social challenges facing South Africa and, more broadly, the developing world.

The impact of research is reflected in how Wits is increasing its African footprint, influencing public policy, informing judgments made by the courts, and transferring new knowledge to the Faculty's curricula to ensure that Wits students are at the leading edge of their professions.

INTEGRATED REPORTING DURING A CRISIS

and the rise of the Chief Value Officer

In 2020, the CCAAR explored the relevance of Covid-19 as an enabler of integrated thinking and as a stark warning of the dangers of ignoring environmental and social irresponsibility.

If organisations are going to have any hope of continuing as going concerns, urgent steps must be taken to mitigate the risks resulting from neglecting the impact that business activity has on people and the planet.

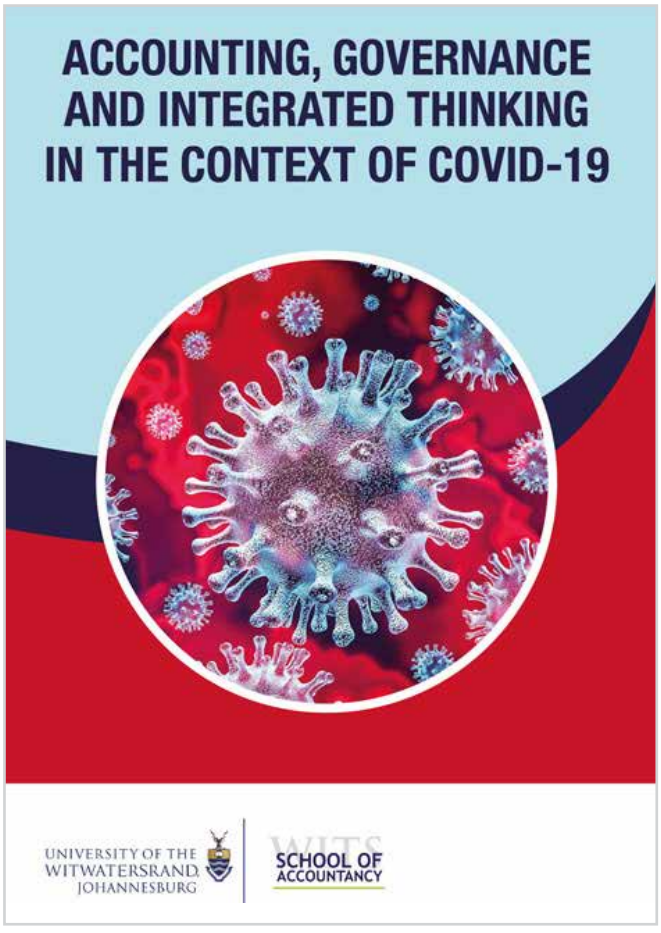
This is the logic driving a shift from one-dimensional reporting on financial performance, to providing a holistic account of the different types of capitals on which organisations depend. These include financial, manufactured, human, social and relational, intellectual, and natural capital.

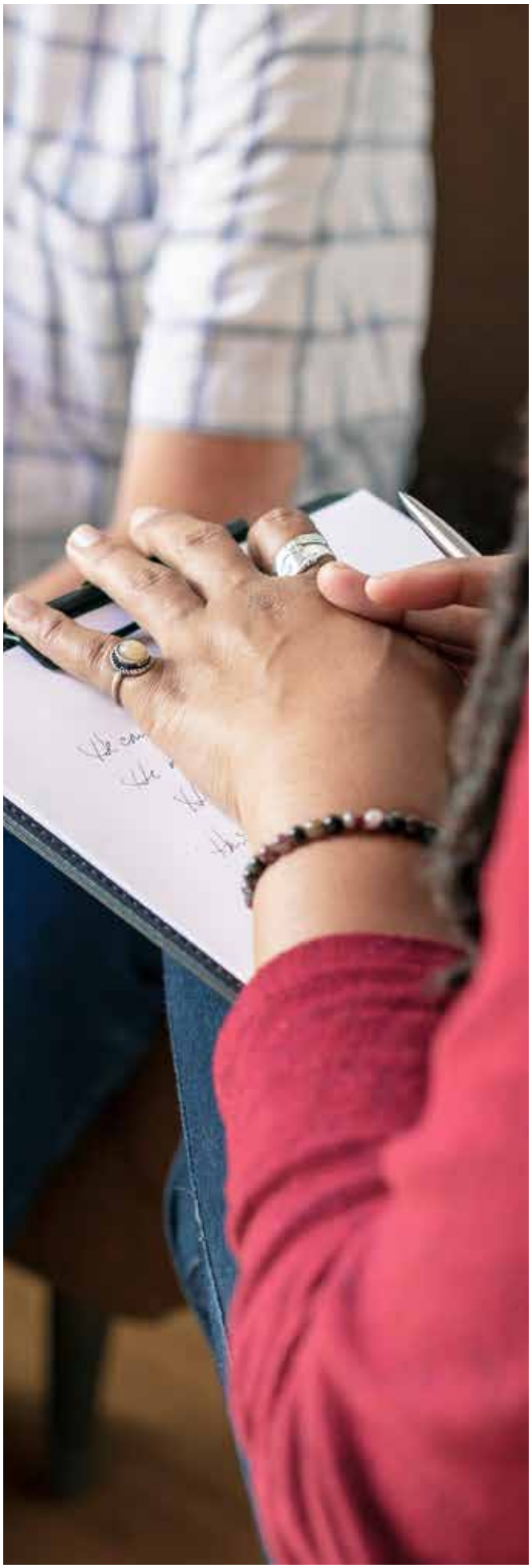
Driven largely by the efforts of the King Committee, South Africa has made significant progress in integrated reporting and thinking. This approach to strategy, risk-management and reporting is intended to make organisations more aware of the importance of managing the triple context –economic, environmental, and social considerations – that are essential for long-term sustainable development.

The integrated approach is also resulting in Chief Financial Officers becoming Chief Value Officers (CVO) who are tasked with driving the responsible generation of value for investors and other key stakeholders.

The Wits School of Accountancy has been researching integrated reporting and the emergence of the CVO since 2010. The School's Centre for Critical Accounting and Auditing Research (CCAAR) led by Professor Warren Maroun has produced a wealth of related research. In 2020, the CCAAR explored the relevance of Covid-19 as an enabler of integrated thinking and as a stark warning of the dangers of ignoring environmental and social irresponsibility.

Accounting, Governance, and Integrated Thinking in the Context of COVID-19 outlines the areas that those who are charged with an organisation's governance should be





considering. These include business continuity, reassessment of strategy, balancing flexibility with monitoring and control, managing risks and opportunities, governing financial metrics, and ensuring active stakeholder engagement. The report made a case for a more holistic approach to business management followed by practical recommendations on how to promote an integrated thinking mindset.

Additional research is required to assess the impact of Covid-19 on the South African economy and to evaluate how companies have responded to the pandemic. The CCAAR report will be useful to those responsible for an organisation's governance in discharging their fiduciary duties.

THE CORONAVIRUS RAPID MOBILE SURVEY

> The exposure in government and the media has shone a spotlight on how the pandemic has exacerbated gender inequality and affected mental health in South African households, drawing attention to the urgent need for policy to redress these effects.

The National Income Dynamics Study – the Coronavirus Rapid Mobile Survey (NIDS-CRAM) is a nationally-representative panel survey of 10 000 South Africans conducted every month. It exists to provide monthly nationally representative data on key outcomes such as unemployment, household income, child hunger, and access to government grants.

In collaboration with researchers from the University of Cape Town and Stellenbosch University and others, numerous CLM staff members were involved in the design and management of the NIDS-CRAM survey. Researchers in the School of Economics and Finance wrote influential papers to inform policy makers of the devastating socioeconomic and mental health effects of the pandemic on households. The research was presented at five high-profile NIDS-CRAM events, at numerous outreach and advocacy events with National Treasury, the Department of Social Development, Anglo American, the Banking Association of South Africa, amongst others, and in several invited webinars.

"I was invited to speak to this work as a panellist alongside the European Union Ambassador in an event organised by the EU Delegation to South Africa for Women's Month in August 2020."

– Professor Daniela Casale

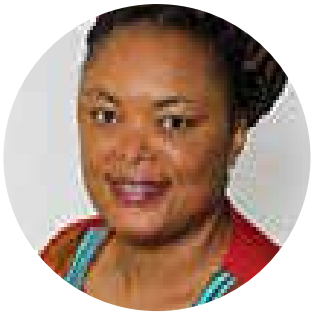
PROFESSOR **DANIELA CASALE**

PROFESSOR **DORI POSEL**

Professor Daniela Casale with co-authors Wits Professor Dori Posel and Debra Shepherd (Stellenbosch University) tracked the gendered impacts of the pandemic. Casale showed that:

- women were more likely than men to lose their jobs and have their work hours cut back when the lockdown was first introduced;
- the recovery since the relaxation of restrictions has been slower for women;
- women were less likely than men to receive government income support because of the gender-blind design of the policy, and
- the burden of school closures fell disproportionately on women, with negative implications for their labour market prospects.

PROFESSOR **PRUDENCE MAGEJO**



PROFESSOR **MIRACLE BENHURA**

Professor Prudence Magejo and Professor Miracle Benhura studied why South African workers are unable to work from home. The research showed that the structural configuration of occupations and industries of employment is an inhibiting factor for working from home and called for interventions that minimise the risk of exposure to Covid-19 among workers more likely to be unable to work from home. The work informed plans for a partnership between the government and business to distribute vaccines through work-based programmes.

DR **LAURA ROSSOUW**

Dr Laura Rossouw and researchers from Stellenbosch University showed that non-pharmaceutical interventions (NPIs) such as physical and social distancing, mask-wearing and handwashing were the most efficient way to curb Covid-19 infection before vaccination. But to be impactful, the NPIs require high levels of public adherence. The results demonstrated that as the crisis deepened, perceived infection risks increased, as did mask-wearing adherence.

PROFESSOR **UMA KOLLAMPARAMBILL**

DR **ADEOLA OYENUBI**

Professor Uma Kollamparambil and Dr Adeola Oyenubi explored the 'silent pandemic' of deepening mental distress. They found that the nature of mental distress was starkly different from the pre-pandemic literature due to new drivers such as the risk perceptions of contracting the virus and social isolation. As such, the mental health of those on the higher segments of the income distribution were found to be most impacted under the pandemic.

Furthermore, income-related physical health inequalities worsened under the pandemic and the self-assessed health of the poor was lower than that of the rich and had declined further compared to the pre-pandemic situation.

Mental distress was found to be related to vaccine behaviour, via vaccine distrust and risk perception. Individuals at high risk of depression were more concerned about the safety of vaccines, which in turn feeds into vaccine hesitancy.

Conversely, depressive symptoms have an opposite effect via risk perception. Risk perception is a negative predictor of vaccine hesitancy. Thus, enhanced risk perception leads to lower vaccine hesitancy.

The study also found significant feedback effects of mental distress with vaccine distrust as well as risk perception. Therefore, improved vaccine trust can lead to increased vaccine acceptance and reduced risk perception, and to better mental health.

FACULTY OF

Engineering and the Built Environment

The Faculty is contributing to the technological performance and/or innovation activities of the country as evidenced by four innovation disclosures, 19 active innovations and four spin-out companies.

4
SOUTH AFRICAN RESEARCH CHAIRS

2
RECOGNISED RESEARCH INSTITUTES

50
NRF-RATED RESEARCHERS

32
PHDS

337
MASTERS

953
POSTGRADUATE DIPLOMAS

6
RESEARCH ENTITIES

PROFESSOR **IAN JANDRELL**

DEAN OF THE FACULTY OF
ENGINEERING AND THE BUILT ENVIRONMENT

The Faculty of Engineering and the Built Environment (FEBE) includes seven schools and is home to four South African Research Chairs. At the end of 2020, the Faculty hosted two institutes recognised by the University's Research and Innovation Committee and boasted six externally funded research entities.

Faculty researchers have found their niche in basic and applied research respectively. This implies that the Faculty is engaged in advancing knowledge, the theoretical understanding of the relationship among variables, discovery, interpretation, the development of methods and systems for advancement of knowledge, as well as commercialisation, to benefit South Africa, in particular, and the world, in general.

The Faculty recognises that in order to produce cutting-edge research, scholars have to draw on research leadership, teamwork, communication and social skills, display independence, and collaborate and network nationally and globally. In this regard, Faculty researchers have made outstanding contributions to the research base and knowledge exchange across our various disciplines.

Despite having researchers who are up to the task in the Faculty, the year 2020 was the most challenging to date, not only in South Africa, but globally. The countrywide lockdown and the introduction of online teaching from the first half of 2020 made it difficult for researchers to carry out their work.

As a result of reduced research activities due to Covid-19, the number of Department of Higher Education and Training (DHET) research outputs – which stood at 169.90 units – was at its lowest since 2015 when the research outputs were 162.69 units. The decline is expected to continue into 2021. However, the Faculty is devising alternative research approaches that do not require executing experiments in laboratories, for the Schools that rely on physical experiments.

The pandemic also saw a reduction in postgraduate enrolments in 2020, at 15.0% less than the target. However, the number of completions of postgraduate students increased slightly, except for Masters through dissertation. In 2020, the Faculty graduated 32 PhD, 65 Masters by dissertation and 272 Masters by coursework and research candidates.

The Faculty has several flourishing researchers including internationally renowned individuals. In 2020, the number of National Research Foundation (NRF)-rated researchers increased by eight to 50. There is no doubt that the NRF rating is a valuable tool for benchmarking the quality of South African researchers against the best in the world.

The Faculty boasts a cohort of academics and researchers who are at the centre of training exemplary postdoctoral fellows, and who, over the years, have been contributing to society and addressing socioeconomic challenges through their work. The productivity of postdoctoral fellows in the Faculty stood at 1.0 unit/postdoctoral fellow (or 1.4 papers/postdoctoral fellow). The 1.0 unit/ postdoctoral fellow in our Faculty was higher than in any of the other four faculties. More specifically, the productivity of postdoctoral fellows in the Faculty in 2020 was higher than the average productivity of postdoctoral fellows in the University of 0.4 units/postdoctoral fellow and was also higher in terms of actual papers (1.2 papers/postdoctoral fellow).

The Faculty is contributing to the technological performance and/or innovation activities of the country as evidenced by four innovation disclosures, 19 active innovations and four spin-out companies. There are also several funding offers for technology development and commercialisation. However, external funding has reduced significantly for the following reasons: first, there has been a shrinkage in industrial activities due to unstable power supply and the global economic downturn. Second, the respective levels of funding from state enterprises such as the power utility Eskom and the Passenger Rail Authority of South Africa (PRASA) have shifted significantly. Historically, state enterprises provided a far greater share of funding than industry – for example, the Faculty has hosted Eskom and PRASA-funded research entities. Third, the pandemic has had an adverse effect on research activities, which led to a decline in funding from various state and industry partners. In 2020, researchers at the Faculty were able to secure R23.9 million from external funding for research purposes, compared to R24.3 million in 2019.

Despite expectations of increased postgraduate research, significant growth in undergraduate student numbers continued to place enormous pressure on the physical resources and time available for academics to teach and conduct research. Therefore, the sustenance and growth of the Faculty's contributions to the University and national research and development remains a major challenge.

REPURPOSING KIDNEY DIALYSIS DEVICES as blood oxygenators

The device could indeed provide a meaningful percentage of an adult's oxygen requirements – enough to avoid mechanical ventilation in a significant number of patients.

As the Covid-19 pandemic swept the world, images of patients gasping for air in overwhelmed medical facilities caused a scramble to produce low-cost ventilators. At the same time, there was growing evidence that mechanical ventilation was making a bad situation worse for some patients and, therefore, when possible, the ventilators should be replaced by less invasive techniques such as high-flow nasal oxygen and continuous positive airway pressure.

Some critically ill Covid-19 patients were treated by passing their blood through an external device in a process known as extracorporeal membrane oxygenation (ECMO). However, one of the problems with ECMO is that it is very expensive and requires high-level expertise to operate the system, and thus its availability is very limited.

In 2020, a team of eight researchers from Wits University tested an approach where blood was passed through a kidney hollow fibre polysulfone membrane dialyser, with oxygen flowing through the device in the opposite direction. This technique allows a transfer of oxygen through the hollow fibre membrane into the blood.

The team initially tested the approach using distilled water instead of blood. This was fraught with technical problems, mainly because of the limited solubility of oxygen in water. Nonetheless, on the eve of the South African lockdown in March 2020, the team cobbled together equipment and performed the experiments. While not as efficient as dedicated ECMO, the results suggested that the oxygen transfer rate would be sufficient to provide a meaningful percentage of an adult patient's oxygen requirements.

A hollow-fibre membrane dialysis cartridge is shown with dark deoxygenated blood entering the device at the top and bright red oxygenated blood exiting from the bottom of the device.

The team subsequently tested the approach using blood. Remarkably, the results aligned very closely with the results from the water experiments and demonstrated that the device could indeed provide a meaningful percentage of an adult's oxygen requirements – enough to avoid mechanical ventilation in a significant number of patients. Most importantly, the team was also able to demonstrate that the device could adequately remove carbon dioxide. This research was published in the *Journal of Healthcare Engineering* in November 2020.

The advantage of repurposing dialysis equipment as blood oxygenators is that the device has already been extensively tested and deemed to be safe for use in humans, while at the same time representing a relatively low-cost, yet effective alternative to ECMO. While further safety tests are needed in this application, it holds the promise of a clinical solution.

The cross-faculty and interdisciplinary team included Professor David Rubin, School of Electrical and Information Engineering; Dr Neil Stacey, School of Chemical and Metallurgical Engineering; Dr Mervyn Mer and Dr Tracy Snyman, School of Clinical Medicine; and Professor Diane Hildebrandt and Dr Tonderayi Matambo, chemical engineers from UNISA. Clinician team members in private practice included cardiothoracic surgeon Dr Martin Sussman, Milpark Hospital, and nephrologist Dr Claudia Do Vale at Morningside Clinic.

Green alchemy to liberate gold

A Jetleach reactor rig was constructed, tested and found to yield gold recoveries higher than what is currently obtained in industry.

PROFESSOR **SEHLISELO NDLOVU**

DEPARTMENT OF SCIENCE AND INNOVATION
SOUTH AFRICAN RESEARCH CHAIR IN HYDROMETALLURGY AND SUSTAINABLE DEVELOPMENT, SCHOOL OF CHEMICAL AND METALLURGICAL ENGINEERING

PROFESSOR **HENRY SIMONSEN**

VISITING ADJUNCT PROFESSOR, SCHOOL OF CHEMICAL AND METALLURGICAL ENGINEERING

The drive towards green technology coupled with the depletion of primary sources and mineral complexity has created a supply risk for some elements that are critical to developed and emerging economies. This has prompted industry to look at reprocessing metal-bearing secondary materials to meet supply and mitigate primary material dependency, preserve primary resources, and protect the environment and ecosystems.

The Hydromet research group, led by Professor Sehliselo Ndlovu from the School of Chemical and Metallurgical Engineering, is researching the recovery of valuable elements from alternative waste streams. The streams include secondary materials like gold tailings, platinum group metal-bearing auto catalysts, electronic waste (e-waste), and cemented tungsten carbide composite materials. Tailings are the materials left over after the process of separating the valuable fraction from the uneconomic fraction (gangue) of an ore.

A project in the School co-supervised by Professor Henry Simonsen entailed the use of a Jetleach reactor to liberate encapsulated gold from refractory gold tailing particles. A Jetleach reactor is a device designed to create and propagate micro-cavitation by impacting two pulp streams against each other at high velocity.

Cavitation is a process based on a mechanism wherein bubbles (cavities), through differential pressure via a constricted channel, are caused to form, expand, and collapse.

The collapse of the bubbles propagates stress at the bubble-particle interface and increases the local temperature and pressure. This impacts and breaks ore particles liberating the encapsulated gold, and substantially increases leaching kinetics and enhances gold recovery.

Based on this principle, a Jetleach reactor rig, shown in Figure 1, was constructed, tested, and found to yield gold recoveries higher than what is currently obtained in industry. From the encouraging results obtained from experimental tests, it is envisaged that the reactor will be pilot tested on other types of tailing material and possibly commercialised in due course.

Two pulps (slurry) pass through two constrictions (nozzles) at a high velocity that generate the formation of micro-bubbles (micro-cavitation) in the pulp.

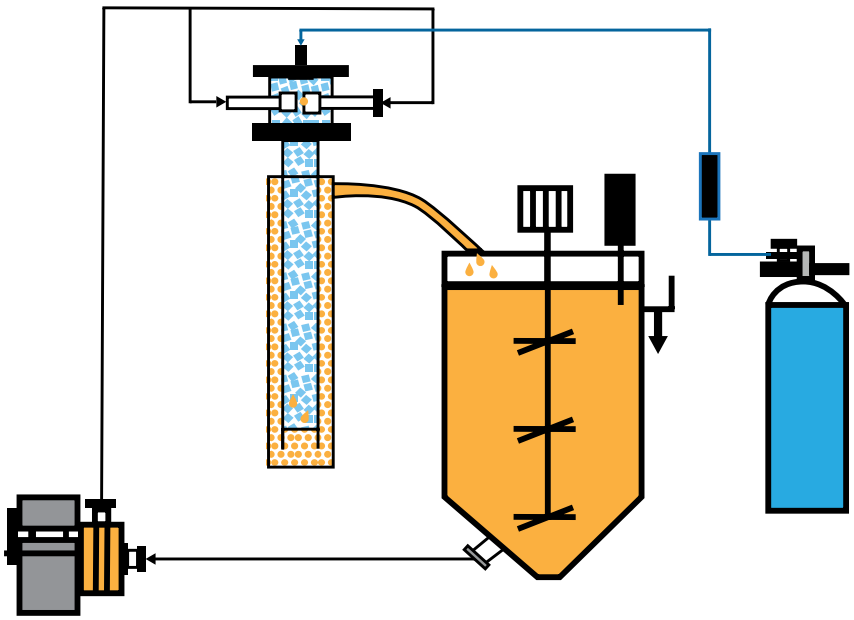


Figure 1

FACULTY OF

Health Sciences

The Faculty continues to be the largest in South Africa and was ranked 76-100 in Public Health, and 101-150 in Clinical Medicine in the Academic Ranking of World Universities Shanghai Global Ranking of Academic Subjects 2020.

8
SA RESEARCH CHAIRS

4
CENTRES OF EXCELLENCE

6
SOUTH AFRICAN MEDICAL RESEARCH COUNCIL RESEARCH UNITS

24
RESEARCH AND INNOVATION COMMITTEE - RECOGNISED RESEARCH ENTITIES

98
NRF-RATED RESEARCHERS

3
MD's GRADUATES

71
PHD's

364
MASTERS

178
BHSC HONS

31
POSTGRADUATE DIPLOMAS

PROFESSOR **MARTIN VELLER**

DEAN OF THE FACULTY
OF HEALTH SCIENCES

The year under review was arguably one of the most challenging and defining periods in modern history. The Covid-19 pandemic impacted on every facet of daily life, including the Faculty of Health Sciences' research agenda. Despite this, the year brought with it significant achievements and successes. During the crisis, our community continued to work unabated to ensure that the teaching and training programme was able to continue, as well as the focus on research, discovery, public health impact and service delivery.

We recognise the extraordinary efforts of healthcare workers - the frontline staff tending to critically ill patients, the clinical trial staff conducting Covid-19 vaccine trials, the laboratory staff who developed standards for and conducted SARS-CoV-2 testing, the researchers who provide data on vaccine effectiveness against novel variants, amongst others, and our students who volunteered in hospitals and clinics.

The research excellence of numerous staff and postgraduate students was acknowledged through various international and national grants, awards, and prizes in 2020. For example, Professor Shabir Madhi led Africa's first Covid-19 vaccine trial, Professor Johnny Mahlangu was the recipient of the Vice-Chancellor's Research Award, Professor Karen Hofman received the inaugural Vice-Chancellor's Social Impact Research Award, and Professor Michèle Ramsay received the 2020 National Science and Technology Forum-South32 Lifetime Award for her pioneering genomic medicine approaches in Africa.

For a second year running, Faculty researchers secured grant funding of approximately R2.7 billion for research and development aid work purposes. Our researchers continue to make remarkable progress through outstanding work. In 2020, these ranged from conducting the first clinical trial of a Covid-19 vaccine in South Africa, the development of the Intubox, which protects hospital workers and other critical care patients from SARS-CoV-2 infected patients' virus-spreading particles during any intubation, extubation or aerolising procedure; to producing South Africa's first clinical data on the coronavirus with the Covid-19 Special Issue of the *Wits Journal of Clinical Medicine*.

Ground breaking studies included research that informs African population history, environmental adaptation, and susceptibility to disease; a multinational, multicentre study on the first Respiratory Syncytial Virus (RSV) vaccine to provide evidence that the immunisation of pregnant women could protect infants under six months old against severe RSV lower respiratory tract infection; and a longitudinal study to determine how many people in individual households in rural and urban South Africa become infected with SARS-CoV-2. Several of these research investigations informed the national government's response to the coronavirus pandemic, and guided critical decision-making processes.

During 2020, the Faculty housed eight Department of Science and Technology/National Research Foundation South African Research Chairs, four Centres of Excellence, six South African Medical Research Council research units, and 24 recognised research entities. Ninety-eight members of Faculty were recognised as National Research Foundation (NRF)-rated researchers during 2020, of whom 10 are A-rated.

During 2020, the total Department of Higher Education and Training (DHET) research output units allocated to the Faculty were 927,78. There was a decrease in the number of publication outputs and postgraduate completions during 2020 compared to 2019. The Faculty contributed 580,78 verified DHET publication units in 2020 – a 2,91% decrease from 2019. However, not all publications were submitted to the DHET, which would have translated into a significant increase in publication research units.

A total of 647 postgraduate students completed qualifications in 2020, including three MDs, 71 PhDs, 79 Masters by research, 285 Masters by coursework and research, 31 Postgraduate Diplomas, and 178 Bachelor of Health Sciences Honours candidates, marking an overall decrease of 5.82% from 2019.

The Faculty continues to be the largest in South Africa and was ranked 76-100 in Public Health, and 101-150 in Clinical Medicine in the Academic Ranking of World Universities (ARWU) Shanghai Global Ranking of Academic Subjects in 2020. The 2020 Times Higher Education World University Rankings placed the Faculty at 85 for clinical, preclinical and health subjects.

WITS UNIVERSITY LEADS SOUTH AFRICA

and the continent's first Covid-19 vaccine trial

On 15 February 2021, the WHO listed two versions of the Oxford Covid-19 vaccine for emergency use, giving the green light for these vaccines to be rolled out globally through COVAX.

The first clinical trial in South Africa and on the continent for a Covid-19 vaccine was announced on 23 June 2020 at a virtual press conference hosted by Wits.

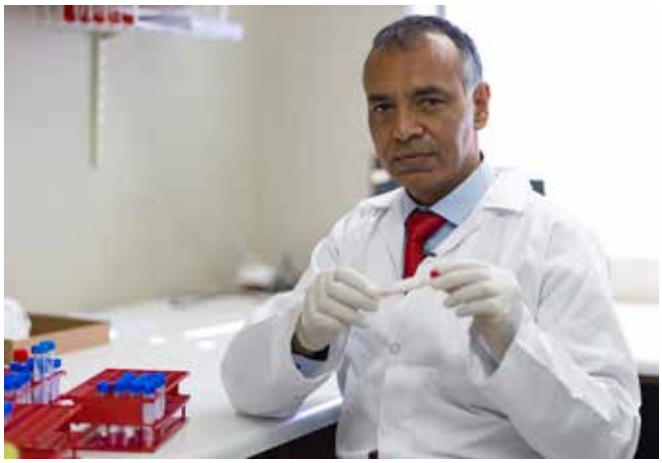
The South African Ox1Cov-19 Vaccine VIDA-Trial ('the Oxford trial') aimed to find a vaccine that would prevent infection by SARS-CoV-2, the virus that causes coronavirus disease (Covid-19).

Representatives from the Wits Faculty of Health Sciences, the National Department of Health, the South African Medical Research Council, and the South African Health Products Regulatory Council were panellists.

At this time in South Africa, some 80 000 people had already been diagnosed with Covid-19 and more than 1 674 had died from the virus, when the President declared a state of disaster and national lockdown.

Shabir Madhi, Professor of Vaccinology at Wits University and Director of the South Africa Medical Research Council (SAMRC) Vaccines and Infectious Diseases Analytics Research Unit (Wits VIDA) (formerly the Respiratory and Meningeal Pathogens Research Unit – RMPRU), led the Oxford Trial, which was conducted in collaboration with the University of Oxford and AstraZeneca.

Professor Martin Veller, Dean of the Faculty of Health Sciences at Wits in 2020, volunteers for the Oxford-AstraZeneca Covid-19 vaccine trial, South Africa and the continent's first, led by Wits.



Professor of Vaccinology Shabir Madhi led South Africa and Africa's first Covid-19 vaccine trial in June 2020 in collaboration with the University of Oxford and AstraZeneca.

The trial tested if the vaccine known as ChAdOx1 nCoV-19 was safe and able to protect people from developing Covid-19. The trial also aimed to provide data on whether the body generates good immune responses against the virus. The study aimed to enroll 2 020 participants at seven sites in Gauteng and the Western Cape. In Gauteng, the sites were in Hillbrow, Soweto, and Tshwane. In the Western Cape, the sites were in Cape Town and Stellenbosch.

By 9 September 2020, 1 814 of the required 2 020 volunteers were enrolled. One thousand eight hundred out of 1 970 were HIV negative (91%) and 15 out of 50 (20%) were HIV positive.

Wits University scientists were amongst the co-authors who published the first peer-reviewed results of phase 3 human trials of the Oxford/AstraZeneca Covid-19 vaccine, in the prestigious scientific journal *The Lancet*, on 8 December 2020.

On 15 February 2021, the World Health Organization listed two versions of the AstraZeneca/Oxford COVID-19 vaccine for emergency use, giving the green light for these vaccines to be rolled out globally through COVAX.

MAJOR NEW AFRICAN GENOME STUDY FINDS VARIETIES THAT inform African history, migration and immunity

The study contributes a new major source of African genomic data, which showcases the complex and vast diversity of African genetic variation and which will support research for decades to come.

Wits geneticists and partners published a groundbreaking study that informs African population history, environmental adaptation, and susceptibility to disease. More than three million new genetic variants were uncovered in one of the most extensive studies of high-depth-sequenced African genomes reported to date.

The study, published on 28 November 2020 as the cover story in *Nature*, provided insights into ancient migrations along the routes of populations who speak Bantu languages. The beadwork featured on the cover of Nature was inspired by visualisations of population mixture in the individuals from this study. Each line of beadwork represents an individual and the different colours represent different contributions that make up that individual's genomic ancestry.

Analyses of the whole genomes of 426 individuals from 13 African countries, whose ancestries represent 50 ethnolinguistic groups from across the continent, inform these findings. The study showed that these newly discovered variants were found mostly among newly sampled ethnolinguistic groups. Researchers also identified new evidence for natural selection in and around 62 previously unreported genes associated with viral immunity, DNA repair and metabolism.

These findings improve the current understanding of migration across the continent and identify responses to human disease and gene flow as strong determinants of population variation. The study contributes a new major source of African genomic data, which showcases the complex and vast diversity of African genetic variation, and which will support research for decades to come.

Clockwise from bottom left: Shaun Aron, Michèle Ramsay, Zané Lombard, Ananyo Choudhury, Scott Hazelhurst and Dhriti Sengupta.

FACULTY OF

Humanities

The Faculty's submission of 510 Department of Higher Education and Training (DHET) units in 2020 represents a 10% increase in year-on-year output and the highest number ever recorded in the history of the Faculty.

8
RESEARCH CHAIRS

6
RESEARCH ENTITIES

75
NRF-RATED RESEARCHERS

79
PHDS

325
MASTERS

515
HONOURS

265
POSTGRADUATE DIPLOMAS

PROFESSOR **GARTH STEVENS**

DEAN OF THE FACULTY
OF HUMANITIES

As one of the leading intellectual hubs on the African continent, the Faculty of Humanities is not only a formidable producer of new knowledge that harnesses the scholarly lessons of the past in the service of the promises of new analytic technologies of the present, but is also a meaningful social actor in forging and developing the society in which we are globally and locally embedded.

Renowned for its distinguished academics and scholars, the Faculty offers a cosmopolitan mix of international and local staff working in several disciplines that are highly ranked across a range of global higher education measures. It is home to some 75 researchers rated by the South African National Research Foundation, with 20 of these being A- and B-rated, and 55 being C- and Y-rated.

Our scholars are innovating at the leading edge of research across a range of fields, answering old questions with new insights and methodologies that span horizons of knowledge. African art; area studies; cities and housing; human migration; diversity and difference; critical race studies; violence, gender, and sexuality; cultural studies; translanguaging; narrative inquiry; and labour feature amongst our key collective strengths.

Many of these foci are anchored in our prestigious research entities including the Society, Work and Politics Institute (SWOP); the Wits Institute for Social and Economic Research (WiSER); the Centre for Researching Education and Labour (REAL); the History Workshop; the African Centre for Migration and Society (ACMS); and the Wits Centre for Diversity Studies (WiCDS). To complement these research entities, we host eight prestigious research chairs. Through these we are growing knowledge and the future research pipeline in globally impactful and locally imperative development areas, such as mathematics education, political theory, migration, local history-making, critical diversity scholarship, skills development and labour, and teacher education for diversity and development.

The national lockdown initiated to contain the pandemic implied significant constraints on research productivity for many of the disciplines in the Faculty, which traditionally depend on methodologies that require face-to-face interaction as the primary mode of data collection and analysis. However, through the provision of a demonstrably effective suite of catalytic funding instruments, the Faculty proved resilient, and continued to conceptualise and disseminate high-impact research through the publication of books, journal publications and creative research, whilst also pivoting to ensure the continuity of globally sought-after postgraduate programmes. In so doing, it maintained its widely recognised leadership in several areas of humanities research and research-led pedagogy. Indeed, the Faculty of Humanities at Wits remains one of the top-ranked in Africa, with special recognition of the quality of our research and teaching.

The Faculty's submission of 510 Department of Higher Education and Training (DHET) units in 2020 represents a 10% increase in year-on-year output and the highest number ever recorded in the history of the Faculty. Our proportion of articles published in internationally accredited journals increased across all staff ranks and now comprises 80% of indexed publications, and just under 60% of these represent outputs in ISI-accredited titles. Our investment in book publishing as a marker of quality in the Humanities appears to be producing positive results, with over 100 units yielded by book publications in the reporting year.

In keeping with our emphasis on growing the numbers and scholarly contributions of our postgraduate students, the Faculty graduated more than 1 000 Diploma, Honours, Masters, and PhD students during 2020.

The adaptations and innovations to the knowledge project in the Humanities necessitated by Covid-19 have been formidable. In some cases, entirely novel approaches to participant-based research involving digitally mediated data collection have been conceptualised by researchers in the Faculty. The course of the pandemic has clearly demonstrated that the Humanities has much to offer by way of understanding the human factors that underlie its transmission and severity. In addition, disciplines in our Faculty will be instrumental in conceptualising and theorising the dilemmas and opportunities that will characterise a post-Covid world. This will require ongoing investments in new architectures of knowledge and funding, which, if not carefully checked could potentially further epistemic inequality in an increasingly virtually connected higher education environment across the globe.

SOCIAL MEDIA AMPLIFICATION ADDS UP FOR pandemic mathematics education

PROFESSOR LYNNE BOWIE

OLICO MATHEMATICS EDUCATION CO-ORDINATOR

> On the hotline learners can access skilled tutors, many of them Wits students, throughout the day and into the evening for help with mathematics questions.

Collaboration between two South African Research Chairs in the Wits School of Education and the NGO, OLICO (which supports disadvantaged learners with mathematics), produced innovative solutions to provide access to learning during the pandemic's disruptions to schooling.

OLICO is led by Wits Associate Dr Lynn Bowie in her capacity as OLICO's Mathematics Coordinator. The relationship between OLICO, and research within the Chair's Wits Maths Connect Primary and Wits Maths Connect Secondary projects, has supported the identification of core mathematical concepts and skills required to succeed in secondary school mathematics. OLICO has translated these findings into a curriculum for their after-school programme and in a free-to-use online programme: **http://learn.olico.org**

The closure of schools during the pandemic in 2020 hit poorer schools and learners particularly hard. In response, OLICO adapted their online learning platform for use on mobile phones and negotiated a zero-rating for the platform, ensuring that learners could access materials without data costs. The online platform is complemented by a WhatsApp hotline for grade 7 – 9 mathematics learners. Via the hotline learners can access skilled tutors, many of whom are Wits students, throughout the day and into the evening for help with mathematics questions. On average 150 to 200 learners access the hotline per day. Learners and tutors have exchanged more than 300 000 messages since the start of the hotline.

OLICO's work on the ground suggested lack of fluency in basic number facts as a key barrier to learners being able to access early high school mathematics. Drawing on findings from the Wits Maths Connect Primary project, OLICO created a set of exercises for developing number fluencies. With the help of Wits third-year Computer Science student, Tristen Paul, a user-friendly app was developed that supports learners through this activity sequence.

Importantly, this app works well offline on a basic smartphone as well as on browsers in school labs, with teachers and tutors being able to track the progress of their group of learners. In 2020, OLICO hosted a 4-week timetable challenge using the app. The challenge was completed by 1 308 learners from 159 different schools and NGOs with a total of 1 050 120 correct answers submitted.

DECOLONISING
Shakespeare

Understanding Shakespearean histories and contemporary practices in different national contexts around the world by situating Shakespeare outside of limited 'English' paradigms.

The Tsikinya-Chaka Centre for the Study of Shakespeare, Transnationalism and Multilingualism is a new research centre established in 2020 in the School of Literature, Language and Media. Directed by Professor Chris Thurman, the Tsikinya-Chaka Centre (TCC) seeks to promote scholarship, teaching and performance that engages with Shakespeare as a multilingual phenomenon. This focus is complemented by an emphasis on transnationalism - that is, understanding Shakespearean histories and contemporary practices in different national contexts around the world by situating Shakespeare outside of limited 'English' paradigms (and vice versa).

The Centre takes its name from Solomon T. Plaatje's contribution to the 1916 *Book of Homage to Shakespeare*. Plaatje – a political activist, journalist, historian, novelist, and linguist – is recognised as producing the first published translations of Shakespeare's plays into an African language. As Plaatje himself noted, however, he was working within an already established practice of translating Shakespeare. He cites the reference of a Motswana court chieftain to "William Tsikinya-Chaka", or "William Shake-the-Sword" (a Setswana translation, Plaatje tells us, that is "perhaps more free than literal").

The TCC's research agenda was seeded and shared through developing existing collaborations within and between the School of Literature, Language and Media and the Wits School of Arts. Such partnerships have laid the foundations for shared postgraduate supervision and knowledge advancement, as have an extensive international network of collaborators. Together, these local and international collaborations bode well for building a strong postgraduate pipeline and funding base for growing the TCC into the future.

PROFESSOR **CHRIS THURMAN**

DIRECTOR OF THE TCC

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG | SLLM SCHOOL OF LITERATURE LANGUAGE AND MEDIA

The Tsikinya-Chaka Centre

Shakespeare | Transnationalism | Multilingualism

FACULTY OF Science

In 2020, the Faculty of Science produced a record number of 493,17 publication units — up from the previous record of 463,30 publication units in 2017.

10
SOUTH AFRICAN RESEARCH CHAIRS

3
CENTRES OF EXCELLENCE

34
NRF-RATED RESEARCHERS

15
RECOGNISED RESEARCH ENTITIES

PROFESSOR **NITHAYA CHETTY**

DEAN OF THE FACULTY
OF SCIENCE

The Faculty of Science is home to 11 Distinguished Professors, 10 South African Research Chairs and 12 National Research Foundation (NRF) A-rated scholars.

The Faculty boasts 15 University Research and Innovation Committee and Faculty Research Committee-recognised entities. The Institute for Collider Particle Physics and the Wits Centre for Astrophysics were established in 2020, while the Centre in Water Research and Development moved from the Faculty of Engineering and the Built Environment to the Faculty of Science.

The Faculty is home to the Centre of Excellence in Mathematical and Statistical Sciences, the Centre of Excellence in Palaeosciences, and the Centre of Excellence for Integrated Mineral and Energy Resource Analysis. A significant number of researchers in the Faculty of Science contribute to the Department of Science and Innovation's Centre of Excellence in Strong Materials and the newly formed African Research Universities Alliance's Centre of Excellence in Materials Energy and Nanotechnology.

The QS World University Rankings for 2020 indicated that Wits Geosciences features within the top 150 Earth Science departments globally.

In 2020, numerous Faculty researchers published in high impact journals. Researchers produced a record number of 493,17 publication units, up from the previous record of 463,30 publication units in 2017. These research outputs – some highlighted in this report – were published in just over 1 000 publications, together with several book chapters and books. A number of publications appeared in high profile journals such as *Science, Nature Communications, Proceedings of the National Academy of Sciences, Scientific Reports, Nature Photonics, Chemical Science, Global Change Biology, Annual Review of Entomology, Critical Reviews in Plant Sciences, Gondwana Research* and the *Journal of High Energy Physics* to name a few.

200 000 years ago, humans preferred to kip cozy

PROFESSOR
LYNN WADLEY

PROFESSOR
CHRISTINE SIEVERS

The extraordinary preservation of plant materials at Border Cave in northern KwaZulu-Natal continues to provide fascinating insights into the behaviour of our species. In 2020, Professor Lyn Wadley and Dr Chrissie Sievers published in Science on evidence of cooked starchy rhizomes 170 000 years ago from the cave and later reported the discovery of grass bedding used to create comfortable areas for sleeping and working at least 200 000 years ago.

Professor Andrew Forbes in the School of Physics published in *Nature Photonics.* He and his team demonstrated the world's first meta-surface laser that produces 'super-chiral light' – that is, light with ultra-high angular momentum. The implication is a world-first laser for producing exotic states of twisted structured light, on demand.

Forbes is also the new Editor-in-Chief of the *Journal of Optics*. He is the first South African to take the reins at this 100-year-old publication published by the UK's Institute of Physics. Forbes was also the youngest winner ever of the South African Institute of Physics' Gold Medal in 2020.

Under the theme of sustainability, Professors Roger Sheldon, Dean Brady and Moira Bode in the School of Chemistry published a review article entitled, *The Hitchhiker's guide to biocatalysis: recent advances in the use of enzymes in organic synthesis* in *Chemical Science,* the flagship journal of the Royal Society of Chemistry. In this pivotal publication the team constructed a practical 'how to' guide for the utilisation of enzymes, their synthetic potential and recent applications.

A study led by Evolutionary Studies Institute (ESI) postdoctoral fellow, Dr Kimberley Chapelle was published in collaboration with Professor Jonah Choiniere in *Scientific Reports*. The study showed that collected dinosaur eggs contain some of the world's oldest known dinosaur embryos by analysis using high powered X-rays. Recreating the extraordinarily detailed 3D models of a dinosaurian embryonic skull, the study shows that these dinosaurs developed in their eggs in a similar way to their reptilian relatives of today.

Also in the ESI, PhD student Kathleen Dollman and Choiniere described changes in the neurosensory systems of ancient crocodilians that lived in the open sea. The article, published in PNAS, used CT scanning and digital reconstructions to show how the balance organs of the inner ear evolve during the land-to-water transition across all crocodilians, both living and extinct.

Professor Marcus Byrne in the School of Animal, Plant and Environmental Sciences (APES) and his international collaborators published a review of dung beetle orientation in the *Annual Review of Entomology*. It covers centuries of observation on the dung beetle's compass, from the Egyptians to modern robotics.

Also in APES, Professor Ed Witkowski published an article entitled *Fire as a Selective Agent for both Serotiny and Nonserotiny Over Space and Time* in Critical Reviews in *Plant Sciences*, essentially showing that getting one's genes into the next generation is the way to evolutionary success.

Professor Rais Latypov (left) and Dr Sofya Chistyakova

Professor Rais Latypov in the Wits School of Geosciences published a paper in *Nature Communications* showing that basaltic magma chambers may develop as large bodies of crystal-free melts in the Earth's crust. This study challenges a recently-emerged paradigm that magma chambers are huge masses of crystal-rich mush – in other words, crystals with just a very small amount of melt.

Professor Dominic Stratford and colleagues in the School of Geography, Archaeology and Environmental Sciences published new evidence in the *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* that our early ancestors in southern Africa from the World Heritage Site, Cradle of Humankind, had evolved adaptations to bipedalism, but that locomotive diversity prevailed until as recently as 1.5 million years ago.

MANY FACULTY OF SCIENCE STAFF WERE RECOGNISED FOR THEIR RESEARCH IN 2020:

Kimberley Chapelle

Cebisa Mdekazi

Images from Mail & Guardian

Two students, Kimberley Chapelle and Cebisa Mdekazi were included in the *Mail & Guardian's* list of 200 influential young South Africans for the Science and Technology category. Chapelle is a postdoctoral fellow and Centre of Excellence in Palaeosciences New Generation Palaeoscientist grantee at the Evolutionary Studies Institute. Mdekazi is the Assistant Director: integrated environment and conservation management at the Cradle of Humankind World Heritage Site.

Caz McNamara

Caz McNamara, Manager of the DSI-NRF Centre of Excellence in Mathematical and Statistical Sciences (CoE-MaSS) was selected to serve as the Global Chapter Convenor of the Australasian Research Management Society.

Professor Judith Kinnaird

Professor Judith Kinnaird won the 2022 National Science and Technology Forum (NSTF)-South32 Research Awards, in the Management category. She is the Director of the Economic Geology Research Unit and Co-Director of the Department of Science and Innovation's Centre of Excellence (CoE) for the Study of Mineral and Energy Deposits in the School of Geosciences.

Professor Luke Chimuka

In the School of Chemistry, Professor Luke Chimuka (left) was selected by the judging panel to appear on *The Analytical Scientist Power List,* while Professor Charles de Koning received the South African Chemistry Institute's Gold Medal and was inducted as a Fellow of SACI.

Professor Jennifer Fitchett

Professor Jennifer Fitchett in the School of Geography, Archaeology and Environmental Studies was voted in as the President Elect of the Society of South African Geographers.

Professor Bob Scholes

The late Professor Bob Scholes was awarded the South African Association of Botanists Gold Medal in 2020 for his contribution to botany as a systems ecologist.

A CLIMATE-SENSITIVE COVID-19 MODEL

developed by the Global Change Institute

Early in the Covid-19 outbreak in South Africa, in March 2020, great concern existed around the potential of the looming South African winter increasing infection rates and contributing to a first wave of infections. In the northern hemisphere, conversely, the hope existed that summer would help to damp out infection rates. The Wits Global Change Institute (GCI) responded to address this uncertainty by developing one of the world's first climate-sensitive Covid-19 models. The research was led by Professor Francois Engelbrecht from the GCI, who embedded the Covid-19 model within the GCI climate model, thereby giving it the ability to be applied in any part of the country or world. Key to the development of the modelling system was linking Covid-19 infection rates to climatic variables such as temperature and humidity. To this extent, the late Professor Bob Scholes was instrumental in developing a hypothetical 'climate correction factor' (CCF), displayed in Figure 1.

FRANCOIS ENGELBRECHT

DISTINGUISHED PROFESSOR OF CLIMATOLOGY

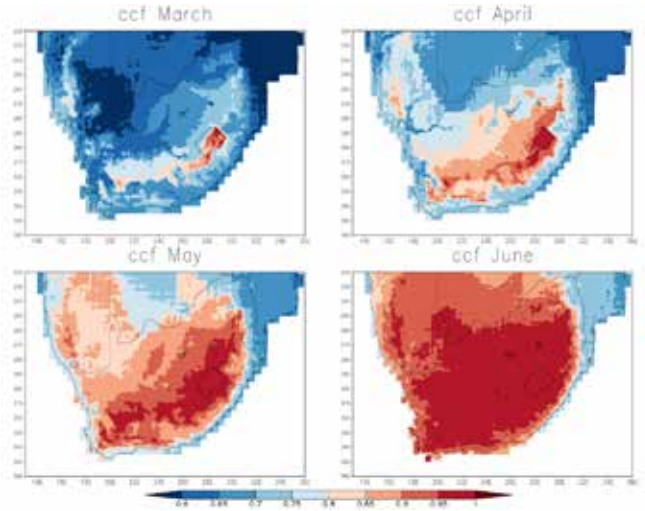


Figure 1: GCI climate-correction factor applied over southern Africa, describing the fractional damping of Covid-19 infection rates by temperature and humidity effects. The cold and dry winters of the South African interior are hypothesised to be close to optimal for Covid-19 transmission, whilst the more humid and warmer autumn and summer months damp infection rates.

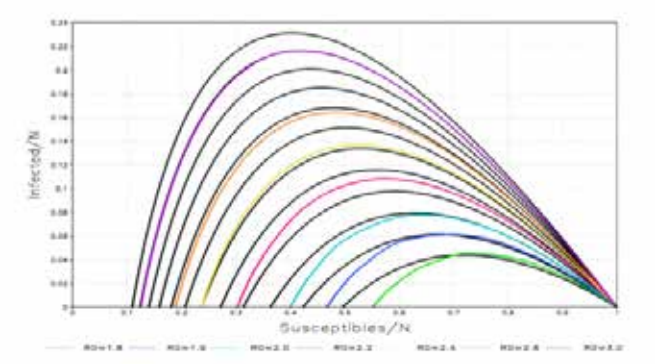


Figure 2: Susceptible-infection orbits depicting Covid-19 propagation in a fully susceptible population of N = 25 million people, for various reproduction numbers (R0) [1.7,3;0.1] in the absence of non-pharmaceutical control. The coloured orbits show the modest impacts of seasonality for the case of winter onset of the disease. See One Health. doi.org/10.1016/j.onehlt.2020.100202.

The GCI climate-sensitive Covid-19 model filled a gap in the Covid-19 modelling capabilities in South Africa at the time. The model revealed that while the disease was in the pandemic phase, the large pools of susceptible people, new variants, the duration of immunity and non-pharmaceutical control were the dominant factors in disease propagation (Figure 2). However, as we moved into the epidemic phase, in the presence of vaccination, seasonality might become an important aspect in managing Covid-19 at seasonal and inter-annual timescales.

The modelling system also has an inverse modelling capability, in that it can be used to construct from reported excess deaths (as reported by the South African Medical Research Council) infection rates in the country, and thus the disease propagation dynamics. When the B.1.351 [beta] variant appeared in South Africa, the GCI started to collaborate with Wits Professor of Vaccinology Shabir Madhi to build relevant scenarios of immunity into the model. This led to further work on the peculiarities of Covid-19 propagation dynamics in South Africa, and the model was able to skillfully project the differential evolution of the third wave of infections in Gauteng compared to the southern coastal provinces. The research effort to apply the model to generate scenarios of future Covid-19 disease propagation dynamics in South Africa is ongoing.

DR JUNE FABIAN

RESEARCH DIRECTOR

WITS DONALD GORDON

Medical Centre

As one of the academic teaching hospitals in the Faculty of Health Sciences, the Wits Donald Gordon Medical Centre (WDGMC) hosts undergraduate, postgraduate, and clinician-led research.

In 2020, we supported 17 Masters and 12 Doctoral candidates, and our researchers collectively published 30 peer-reviewed articles. Our support comprises any combination of biostatistical analysis, supervision from clinicians or researchers at the Centre, access to clinical cases or cohorts, and access to data from existing databases. We have created and maintained 17 longitudinal databases in various clinical specialty units using the Wits REDCap platform.

All databases are approved by the Medical Human Research Ethics Committee and are POPIA (Protection of Personal Information Act) compliant.

Aside from valuable research resources, longitudinal data collection facilitates clinical governance that includes practice audits and annual reports from specialist units made available in the public domain.

Dr June Fabian volunteers for the Oxford/AstraZeneca Covid-19 vaccine trial in 2020.

COVIGEN PROJECT AIMS TO UNDERSTAND HOST SUSCEPTIBILITY TO

SARS-CoV-2 infection in SA populations

In response to the Covid-19 pandemic, the WDGMC and the Sydney Brenner Institute for Molecular Bioscience are leading research in the Faculty of Health Sciences to understand the host genetics of susceptibility to SARS-CoV-2 infection in South African populations. Through many collaborating partners, including the National Institute for Communicable Diseases; the Perinatal HIV Research Unit; the Wits Vaccines and Infectious Diseases Analytics Research Unit; Ezintsha; and the South African Medical Research Council/Wits MRC/Wits Agincourt Rural Public Health and Health Transitions Research Unit (Agincourt – Wits Rural Campus); we will provide knowledge to inform the development of patient stratification algorithms according to host genetic markers, taking into account demographic and clinical data, and inform treatment options related to disease outcomes.

ESTABLISHING AN OPEN-SOURCE PLATFORM FOR KIDNEY TRANSPLANT ORGAN ALLOCATION

This will be a first for South and sub-Saharan Africa.

This project comprises a collaboration between the WDGMC Transplant Unit, the National Health Laboratory Service, and REDCap developers at Wits and Vanderbilt University. We intend to create an automated algorithm-based organ allocation system for the Gauteng Transplant Programme and expand it nationally, and transition from serological to genotypical HLA-typing. Human Leukocyte Antigen-typing is used to match patients and donors for blood or marrow transplants. HLA-typing is more accurate and in line with the recommended standard of care. This will be a first for South and sub-Saharan Africa.

Wits Enterprise

DUNCAN RAFTESATH

CEO: WITS ENTERPRISE

A multidisciplinary panel of researchers proposed a framework for slowing South Africa's economic decline while catalysing long term economic growth.

Wits Enterprise delivers a range of strategic services that are focused on marketing and commercialising the University's research output. Comprising of three specialist units that provide dedicated programmes and solutions to broaden and deepen Wits' impact in society, Wits Enterprise provides short courses, research support, and innovation management.

Like most entities, Wits Enterprise was heavily impacted by the effects of Covid-19 and the subsequent lockdown restrictions. Research projects that involved laboratory work, field work, on-site data collection and face-to-face training or workshops had to be put on hold for extended periods, or had to be significantly re-scoped. Once again, the major share of external funding came from various SETAs, with the School of Education dominating in terms of revenue generated from various research and training initiatives in the education, mining, information technology and banking sectors.

COVID-19 RESEARCH PROJECTS

During 2020, Telkom and the Wits School of Governance (WSG) partnered on a project to explore options for the revival of the South African economy. The South Africa Future Economy project convened a multidisciplinary panel of researchers who proposed a framework for slowing South Africa's economic decline while catalysing long term economic growth.

The project commissioned several research papers pertaining to the socio-economic impacts of Covid-19, to which the following Wits researchers contributed:

Professor Mzukisi Qobo (left) and Dr Nomfundo Ngwenya published Digital divide in South Africa: the COVID-19 experience and beyond *with the late Professor Benno Ndulu of Tanzania.*

Professor Erin McCandless published Forging resilient social compacts in times of crisis and transition.

SHORT COURSES

Wits Enterprise transformed its Short Courses unit in 2020, with efforts concentrated towards moving offerings online. This galvanised significant growth in online offerings, with academics keen to offer short courses online through the Wits Digital Campus platform. For many Wits University departments, schools and faculties, it has become a strategic choice to pursue short courses as a third-stream opportunity. The table below indicates the courses and number of attendees per course in 2020:

	NUMBER OF COURSES	NUMBER OF STUDENTS	SCHOOL/ CENTRE	FACULTY
Digital Campus Online (Wits Plus)	81	2 024	Wits Plus	
Digital Campus Online (SBS)	22	694	School of Business Sciences	Commerce, Law and Management
Mining	28	183	School of Mining	Engineering and the Built Environment
Mining (Wits Mining Institute)	3	43	Wits Mining Institute	Engineering and the Built Environment
Real Estate	10	117	School of Construction	Engineering and the Built Environment
Construction	5	30	School of Construction	Engineering and the Built Environment
Social Work	3	62	School of Human and Community Development	Humanities
BBBEE MDP	4	139	School of Business Sciences	Commerce, Law and Management
Process Engineering	7	7	School of Chemical and Metallurgical Engineering	Engineering and the Built Environment
Accountancy	3	5	School of Accountancy	Commerce, Law and Management
Medical	2	8	School of Clinical Medicine	Health Sciences
Oncology/Pharmaceutical	4	39	School of Therapeutic Sciences	Health Sciences
Conferences and Events	3	225	Various	

Research Innovation

PROFESSOR BAVESH KANA

DIRECTOR: CENTRE OF EXCELLENCE
FOR BIOMEDICAL TB RESEARCH

THE RAPID DEVELOPMENT AND ROLL-OUT OF COVID-19 DIAGNOSTIC TESTING CONTROLS

The ingenuity, pro-activeness and dedication of this team enabled the delivery of working diagnostic controls for Covid-19 testing within weeks of the declaration of the pandemic by the WHO.

A local pharmaceutical company contracted the Department of Science and Innovation/National Research Foundation Centre of Excellence for Biomedical TB Research (CBTBR) at Wits to evaluate the efficiency of one of its products against SARS-CoV-2 virus particles and to determine its effect on viral infectivity and replication under various conditions. Professor Bavesh Kana led the innovation team, which comprised Dr Edith Machowski, Dr Christopher Ealand, and Dr Bhavna Gordhan, in collaboration with SmartSpot Quality (Pty) Ltd. The ingenuity, proactiveness and dedication of this team enabled the delivery of working diagnostic controls for Covid-19 testing within weeks of the declaration of the pandemic by the WHO.

The battle against diseases such as Covid-19 and tuberculosis (TB) requires fast and accurate mass testing. To ensure that diagnostic tests are being executed correctly, control material such as live bacteria or viruses that cause a disease must be utilised regularly to verify the accuracy of the testing, i.e., to ensure that the tests deliver the expected result. Without ongoing accuracy verification, the diagnostic equipment in use could be delivering false-negative or false-positive results, which could have far reaching effects for the national response to an epidemic.

However, these organisms are extremely infectious, and therefore cannot be used in a mass testing rollout. In addition, the rapid spread of SARS-COV-2, the virus that causes coronavirus disease (Covid-19), required the rapid development of a diagnostic control.

The Wits team had developed a platform that enabled the rapid development of disease specific controls using biomimicry – where harmless bacteria are modified to include genetic elements from organisms such as *Mycobacterium tuberculosis*, ensuring accurate controls for diagnostic testing that are completely safe to use. The biomimicry-based controls for TB testing were developed using this platform, and available in 2019. In early 2020, even before the declaration of the Covid-19 pandemic, Kana commenced work with his team to develop controls for Covid-19 using this biomimicry platform.

The early work focussed on the GeneXpert diagnostic system, which was already rolled out by the South African National Health Laboratory Service (NHLS) and used to test for TB in more than 200 sites across South Africa. Already in April 2020, mere weeks after the declaration by the WHO of the Covid-19 pandemic, biomimicry-based controls for the GeneXpert system had been prepared and were being validated to ensure that they worked correctly. In less than a month, the controls were being manufactured by SmartSpot Quality (Pty) Ltd and delivered to the NHLS for deployment to all its testing sites across South Africa.

Not only did this team support the national mass testing effort of the NHLS, by the end of 2020 the control was being shipped to several other developing countries to support their mass testing programmes. Rapid, accurate testing is critical in a response to a pandemic, as it allows rapid tracing and isolation of the prior contacts of an infected person, and in so doing limits the spread of the disease.

WITS HEALTH CONSORTIUM

ALF FARRELL

CEO: WITS HEALTH CONSORTIUM

The Wits Health Consortium (Pty) Limited (WHC) is a wholly owned company of the University of the Witwatersrand under its Faculty of Health Sciences.

The WHC is a leader in clinical trials management and assists with clinical research activities, site logistics support, document storage and overall trial management.

The Consortium provides all necessary support for client negotiations onsite to assess the feasibility of trials and to secure contracts. Once approved, The WHC assists with allocating study coordinators, clinical trial doctors and pharmaceutical support for onsite services. In addition to logistics and patient management, the WHC conducts laboratory services, pathology, data capturing and reporting for donors and researchers.

Major Wits institutes and units under the auspices of the Consortium include:

- Clinical HIV Research Unit
- Clinical Laboratory Services
- Empilweni Services and Research Unit (ESRU) (Rahima Moosa Mother and Child Hospital)
- Health Economics and Epidemiology Research Office (HE2RO)
- MatCH Research Unit (Department of Obstetrics and Gynaecology)
- Perinatal HIV Research Institute (PHRU)
- SAMRC Vaccines and Infectious Diseases Analytics Research Unit (Wits VIDA)
- SAMRC/Wits Centre for Health Economics and Decision Science (PRICELESS-SA)
- SAMRC/Wits-Agincourt Rural Public Health and Health Transitions Research Unit (Wits Rural Campus)
- Wits Clinical Research (WCR)
- Wits Reproductive Health and HIV Institute (Wits RHI)

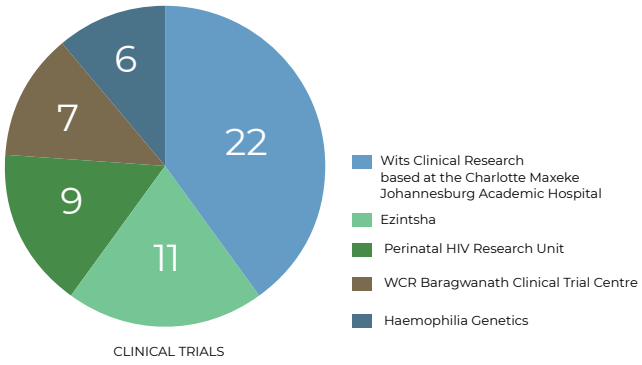
Clinical research at WHC in 2020 included some 88 clinical studies. These were designed to provide important information about disease trends and risk factors, outcomes of treatment or public health interventions, functional abilities, patterns of care, and healthcare costs.

The majority of the studies were research trials related to a number of different diseases and medical conditions such as haemophilia, pneumonia, haemoglobinuria, bacterial skin and skin structure infections, tuberculosis, sickle cell diseases, diabetes mellitus, systematic lupus erythematosus, rheumatoid arthritis, and hidradenitis suppurativa.

19% of the Wits Health Consortium's research activities in 2020 concerned Covid-19.

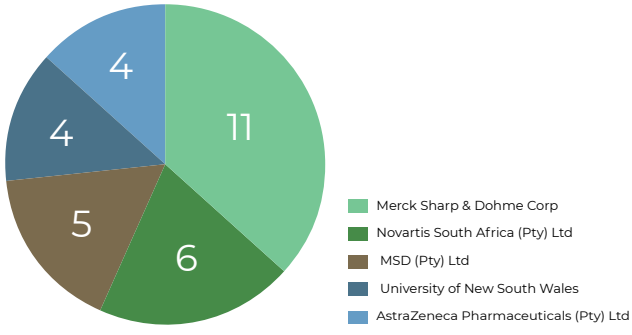
Cancer-related research comprised 26% of all 2020 clinical research studies, and HIV-related research made up 24%.

These five research units did the most clinical trials studies in 2020:



CLINICAL TRIALS

The following top five sponsorships supported more than one clinical research study, with the remainder supporting between one and three clinical studies in 2020:



CLINICAL TRIALS

The total value of all clinical studies in 2020 amounted to **R171 858 309.73**

The total value of Covid-19 contracts from April to December 2020 was **R416 848 256.17**

THE TRIPLE BURDEN OF COVID-19, HIV AND TB

The intersecting Covid-19, HIV, and tuberculosis (TB) epidemics in places with a high burden of HIV and TB infections pose several public health challenges.

TB remains the major cause of mortality in South Africa, the leading immune suppressing infection, and the most common cause of death in patients with HIV infection. Covid-19 will undoubtedly emerge as a major cause of mortality. Studies that investigate how Covid-19 will manifest in people co-infected with HIV and TB will therefore be important.

In 2020, Wits VIDA (formerly the Respiratory and Meningeal Pathogens Research Unit – RMPRU) conducted a study titled *COVID 19: Investigation of hospitalised adults in South Africa*, to assess the burden of SARS-CoV-2-infections in African adults in a setting with high HIV and TB prevalence.

During the first wave of the pandemic, Wits VIDA performed SARS-CoV-2 PCR diagnostic testing on behalf of the National Health Laboratory Service (NHLS) amongst the patients admitted to the Chris Hani Baragwanath Academic Hospital. This allowed for a 24-hour turnaround time for the PCR results to be communicated to the attending physician and enabled them to plan for the clinical management of the Covid-19 infected and uninfected patients.

COVID-19 IN PREGNANT WOMEN

Since this project was also conducted amongst pregnant women and their new-borns, it informed how infants born to SARS-CoV-2 infected mothers should be managed. Results from this study on minimal invasive autopsies revealed that most indicators of respiratory distress syndrome were undifferentiated between Covid-positive and Covid-negative decedents (except for Type-II pneumocytes) and that HIV or TB infection does not appear to have a meaningful correspondence with Covid-19 related deaths.

NEXT GENERATION VACCINES

During this study, Wits VIDA collected various blood samples from Covid-19 infected patients, including during the acute and convalescent phases of the disease and extending to 12 months post-initial infection. These samples will provide crucial information on how these individuals responded to natural infection, including to investigate immune responses to different virus variants. Importantly, the longitudinal samples will provide information on the possible duration of protection.

The Wits Health Consortium has partnered with various collaborators to use the data from natural infection to inform the development of new vaccines, especially targeted to the new variants of interest and variants of concern.

ASSESSMENT OF SARS-COV-2 ANTIBODIES

The assessment of antibody responses needs to be accurate and cost-effective. Therapies (vaccines) can only be deemed effective (or not) with appropriate antibody responses and these assays should soon provide information that enable clinicians to offer better patient care and to ensure that public health programmes can be planned more effectively. In 2020, the Wits Department of Molecular Medicine and Haematology conducted a study titled Comparative evaluation of lateral flow assay (LFA) and ELISA tests that detect human antibodies specific to SARS-CoV-2, to support Covid-19 case management.

CURIOS.TY

Curios.ty is a print and digital magazine that aims to make the research at Wits University accessible to multiple publics. It tells the stories of pioneering research at Wits through the voices of talented researchers, students and academics. First published in April 2017, *Curios.ty* is published three times per year.

Each issue is thematic and explores research across faculties and disciplines at the University that relate to the theme. Since its inception, research themes have included: Cities, iHuman, Capital, Watershed, Mandela100, Hunger Games, Ekhaya [Home], Code, Climate Emergency, Mood, Viral, Solutions and Gender.

www.wits.ac.za/curiosity/

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