

# PROGRAM VIR DIE TWEEDE PLEGTIGHEID

## *DIE FAKULTEITE NATUURWETENSKAPPE, AGRIWETENSKAPPE, INGENIEURSWESE, GENEESKUNDE EN GESONDHEIDSWETENSKAPPE*

*'n Vriendelike beroep word op alle aanwesiges gedoen om selfone af te skakel en nie die saal tydens die plegtigheid te verlaat nie en sodoende te verseker dat die verrigtinge sonder ontwinging verloop.*

1. Akademiese prosesie kom die saal binne. U word versoek om te staan terwyl hulle die saal binnekom en te bly staan vir die sing van die Nasionale Lied.
2. Sing van die Nasionale Lied (kyk binneagterblad). Neem asseblief daarna u sitplekke in.  
Begeleiding: Universiteit Stellenbosch Koperblaaskwintet. Orrelis: Francisco Salies.  
Voorsanger: Barend van der Westhuizen.
3. Konstituering deur die Kanselier.
4. Gebed deur dr Coenie Burger.
5. Verwelkoming deur die Kanselier.
6. Voorstelling van doktorandi deur die dekane van die betrokke fakulteite en toekenning van grade deur die Kanselier.
7. Sluiting deur die Kanselier.
8. Akademiese prosesie verlaat die verhoog.

*Die aanwesiges word versoek om te bly staan totdat die akademiese prosesie uitgestap het.*

# PROGRAMME FOR THE SECOND CEREMONY

## *THE FACULTIES OF SCIENCE, AGRISCIENCES, ENGINEERING, MEDICINE AND HEALTH SCIENCES*

*To help ensure that the proceedings run their course without disruption, will all those present kindly keep their cell phones switched off, and refrain from leaving the hall, while the ceremony is in progress.*

1. Entrance of academic procession into the hall. You are requested to stand while it enters, and then to remain standing for the singing of the National Anthem.
2. Singing of the National Anthem (see inside back cover). Thereafter, please be seated.  
Accompaniment: University of Stellenbosch Brass Quintet. Organist: Francisco Salies.  
Precentor: Barend van der Westhuizen.
3. Congregation formally constituted by the Chancellor.
4. Prayer by Dr Coenie Burger.
5. Welcome by the Chancellor.
6. Presentation of doctoral candidates by the deans of the respective faculties and conferment of degrees by the Chancellor.
7. Closing by the Chancellor.
8. The academic procession leaves the stage.

*Those present are requested to remain standing until the entire academic procession has left the hall.*

# ISICWANGCISO-NKQUBO SOMSITHO WESIBINI

## *IIFAKHALTHI EYOBUNZULULWAZI KWEZOBUGQI, EYEEAGRISAYENSI, EYOBUNJINELI, EYEZAMACHIZA NOBUNZULULWAZI KWEZEMPILO*

*Ukuqinisekisa ukuba umsitho uqala ngaphandle kwesiphazamiso, bonke abakhoyo bayacelwa ukuba bacime iiselfowuni zabo, kwaye bangaphumi eholweni ngeli xesha umsitho uqhubekayo*

1. Kungena umkhosi wemithika eholweni. Niyacelwa ukuba nime ngeenyawo xa ungena, nihlale nime njalo ukuze kuculwe uMhobe weSizwe.
2. Kukulwa uMhobe weSizwe (Jonga kumphakathi weqweqwe lokugqibela). Emva koko, ningahlala phantsi. Umculo: yi-Stellenbosch University Brass Quintet. Umdlali wohadi: nguFrancisco Salies. Umhlabeli: nguBarend van der Westhuizen.
3. UMsitho uvulwa ngokusesikweni nguTshansila.
4. Umthandazo wenziwa Gqr Coenie Burger
5. Ulwamkelo lwenziwa nguTshansila.
6. Ukunikezelwa kwabafundi bezidanga zobugqirha ziintloko zefakhalthi (iidin) ezichaphazelekayo nokuthweswa kwezidanga nguTshansila.
7. Ukuvalwa koMsitho nguTshansila.
8. Umkhosi wemithika uyalishiya iqonga.

*Bonke abakhoyo bayacelwa ukuba beme ngeenyawo de umkhosi wemithika ube uphume wonke eholweni.*

## KANDIDATE WAT KWALIFIKASIES ONTVANG

Hier volg 'n lys van graduandi met hul studierigtings, proefskriftitels en opsommings van die navorsing. Die grade van graduandi wat nie by die gradeplegtigheid teenwoordig kan wees nie, word in hulle afwesigheid toegeken.

## CANDIDATES RECEIVING QUALIFICATIONS

Here is a list of graduands with their fields of study, dissertation titles and summaries of research. The degrees of graduands who are unable to attend the graduation ceremony are awarded in absentia.

## ABAFUNDI ABAFUMANA IZINGQINI ZEZEMFUNDO

Nalu uluhlu lwabathweswayo kwiinkalo zesifundo, izihloko zeedizethyishini kunye nezishwankathelo zophando. Izidanda zabathweswayo abangakwazanga ukubakho ubuqu kumsitho wothweso-zidanga bathweswa bengekho benjalo.

### Fakulteit Natuurwetenskappe

#### Faculty of Science

#### IFakhalthi yezobuNzululwazi kwezobuGqi

##### PhD

ANDRIANTIANA, Eric Ould Dadah (Mathematics)

*Energy and related graph invariants*

Graphs provide useful models of molecules, and a number of graph invariants, such as graph energy, have been put forward to help us relate the structure of molecules to their physical properties. This research led to improvements in our understanding of these invariants. Extreme structures (maximising or minimising different graph invariants) in classes of acyclic and unicyclic graphs were examined specifically. The solution of several decades-old open problems in chemical graph theory resulted from the theorems developed in this study.

Supervisor: Prof S Wagner

BOARDMAN, Leigh (Entomology)

*Low temperature tolerance in insects: interactions with ambient gases*

Understanding the mechanisms of low temperature tolerance, and determining the conditions from which cellular damage may be repaired or is irreversible, are critical to insect pest control. Several important findings were presented, including the determination of important baseline knowledge related to low temperature and gas stress, the identification of potential mechanisms underlying low temperature and gas tolerance, potential commonalities in cellular stress responses between gas and temperature stress, and whether fluctuating stressors resulted in protection or accumulated damage in a model pest insect. Fundamental insights into understanding low temperature tolerance for pest management were generated.

Supervisor: Prof JS Terblanche

External Co-supervisor: Dr JG Sørensen

BURGER, Hester Maria (Biochemistry)

*Altered lipid metabolism as a possible mechanism in fumonisin-induced hepatocarcinogenesis in rats and investigations into risk assessment in humans*

Vulnerable rural populations with daily maize dietary staple and poor agricultural practices are susceptible to chronic exposure to highly contaminated foods. The carcinogenic mycotoxin, fumonisin B<sub>1</sub>, is a liver cancer promoter involved in the disruption of lipid metabolism and the modification of membrane integrity, thereby modulating cell growth indices. To assess the complexities of mycotoxin exposure in South Africa, a multidisciplinary approach is warranted in the mycotoxin risk analysis framework. This was achieved by integrating mechanisms of carcinogenesis and human epidemiological studies for assessing exposure with the development of a uniquely sensitive risk model for the South African population.

Supervisor: Prof WCA Gelderblom

Co-supervisor: Prof P Swart

DAVIS, John Christopher (Chemistry)

(This is the first joint PhD awarded by Stellenbosch University and St Andrews University in Scotland.)

*Understanding the origin of <sup>35/37</sup>Cl and <sup>16/18</sup>O isotope effects on <sup>195</sup>Pt and <sup>103</sup>Rh NMR nuclear shielding in selected Pt(IV) and Rh(III) complexes. A DFT study*

State-of-the-art computational methods rooted in density-functional theory (DFT) have been applied to calculate and understand the isotope effects on <sup>195</sup>Pt and <sup>103</sup>Rh NMR chemical shifts. In the broader context of computational NMR spectroscopy, which is a mature field of study, this work marks a further advancement in these methods. The tools can be used to study minute effects of less than one part per million in terms of chemical shifts. This is a new and important finding to understand the isotope effects that allow for the unique identification by <sup>195</sup>Pt and <sup>103</sup>Rh NMR of the many possible complexes that may occur in process solutions involved in the refining industry of these precious metals.

Supervisor: Prof KR Koch

External Co-supervisor: Prof M Beuhl

DRÖGEMÖLLER, Britt Ingrid (Genetics)

*Investigation of genetic variation contributing to antipsychotic treatment response in a South African first episode schizophrenia cohort*

Schizophrenia is a severe and debilitating disorder, the symptoms of which are treated with antipsychotics. Unfortunately, only approximately 50% of schizophrenia patients respond to antipsychotic treatment. Therefore this project aimed to identify genetic mutations that cause non-optimal treatment response. An exome sequencing strategy was used to search for genetic variants present in a cohort of first-episode schizophrenia patients. Analyses of these and clinical data identified eleven genetic variants associated with treatment outcomes. Not only will these findings improve our understanding of the functioning of antipsychotics, but they ultimately also can be used to predict treatment response outcomes.

Supervisor: Prof L Warnich

Co-supervisors: Prof RA Emsley and Prof DJH Niehaus

EDWARDS, Shelley (Zoology)

*Patterns and processes of adaptation in lacertid lizards to environments in southern Africa*

The environmental adaptations of lacertid lizards were investigated. Different lines of evidence, including data on genetics, morphology and performance, were combined. The main findings were that morphologically similar species do not necessarily have a shared ancestry. Instead, their morphological commonalities are due to convergence because they are adapted to similar environments. Conversely, species living in different habitats, for example sand versus rock substrates, showed very different morphological features that are adaptive for that particular habitat. This work led to a better understanding of how species respond to their environment.

External Supervisor: Dr KA Tolley

Co-supervisor: Prof PLN Mouton

EICHER, Johann Josef (Biochemistry)

*Understanding glycolysis in Escherichia coli: a systems approach using nuclear magnetic resonance spectroscopy*

The behaviour and regulation of central carbon metabolism in the bacterium *Escherichia coli* under fermentative conditions were explored. This required an integrative systems approach combining quantitative experimentation with mathematical modelling. A new method was developed to determine enzyme kinetic parameters from reaction time courses obtained with real-time nuclear magnetic resonance spectroscopy. These parameters adequately describe the typical properties of enzyme-catalysed reactions *in vivo*. The parameters were collated in a mathematical model of fermentative glycolysis, which provided a platform to explore the regulation of carbon flux and redox balancing in *E. coli* under conditions of oxygen limitation and variability.

Supervisor: Prof JM Rohwer

Co-supervisor: Prof JL Snoep

GESWINDT, Theodor (Chemistry)

*Chemical speciation of Rh(III) complexes in acidic halide-rich solutions by means of high-resolution <sup>103</sup>Rh NMR spectroscopy: the importance of speciation in the selective separation and recovery of rhodium*

The recovery of dissolved rhodium (Rh) from refinery process solutions and spent catalysts is an important process given the high cost of rhodium. The complex chemistry of Rh in hydrochloric acid makes this a challenge. Numerous polyamine precipitants were tested in an effort to recover rhodium selectively and quantitatively from authentic process solutions by means of precipitation. An important finding is that the chemical speciation of the  $[\text{RhCl}_{6-n}(\text{H}_2\text{O})_n]^{(3-n)+}$  complexes in solution is critical in determining the complete recovery of Rh. Moreover, this study showed that <sup>103</sup>Rh NMR spectroscopy can determine the chemical speciation of these complexes accurately, leading to the first direct chemical speciation distribution diagram for rhodium complexes in concentrated hydrochloric acid solutions.

Supervisor: Prof KR Koch

GILDENHUYS, Johandie (Chemistry)

*Interactions of quinoline antimalarial drugs with ferrihaem: structural and kinetic insights into the inhibition of malaria pigment formation*

The antimalarial activity of quinoline compounds, exemplified by chloroquine and quinine, has been known for decades. These drugs inhibit the formation of crystalline malaria pigment, leaving the malaria parasite vulnerable to ferrihaem. The first known single crystal structures of three ferrihaem-quinoline complexes, as well as of synthetic malaria pigment, are reported. Furthermore, evidence is presented that quinoline antimalarial drugs act by slowing the rate of lipid-mediated synthetic malaria pigment formation, via a mechanism of adsorption. Together the results provide definitive insight into key drug-target interactions, which may be exploited in the future rational design of novel antimalarial drug candidates.

Supervisor: Dr KA de Villiers-Chen

Co-supervisor: Dr T le Roex

GROBLER, Ilne (Chemistry)

*Solid-state dynamics of porous materials*

An exploratory study involving the preparation of new porous materials was carried out. A number of porous metal-organic frameworks (MOFs) and a metallocycle were prepared with a view to studying the solid-state dynamics involved in gas sorption and guest-exchange processes. Single-crystal X-ray diffraction experiments were carried out under variable temperature and pressure conditions, supplemented by thermal analysis and sorption experiments. A two-dimensional layered MOF with discrete cavities that can selectively capture carbon dioxide molecules was prepared, as well as a three-dimensional MOF with permanent channels that can exchange its guest molecules. The abovementioned MOF also displays tuneable anisotropic thermal expansion.

Supervisor: Prof LJ Barbour

Co-supervisor: Prof C Esterhuysen

HAUPT, Kerstin Anna (Physics)

*Phase transitions in transition-metal dichalcogenides studied by femtosecond electron diffraction*

The electrical conductivity of particular crystals (their ability to support current) can be changed by illumination with light between highly insulating and highly conductive, making these new materials candidates for ultrafast optical switches. The change in conductivity is accompanied by small variations of the crystal structure. The dissertation experimentally investigates the order dynamics during the light-induced transition between different crystal phases on an atomic spatial scale and in real time. A special electron microscope with a temporal resolution of better than a millionth of a millionth of a second was developed for this project.

Supervisor: Prof HPH Schwoerer

Co-supervisor: Prof EG Rohwer

HECTOR, Stanton Bevan Ernest (Plant Biotechnology)

*Molecular studies of galactan biosynthesis in red algae*

Red algae are exploited for their accumulation of agar, an important ingredient in foodstuffs and an indispensable chemical in microbiological and molecular biology laboratories. They are used as a solidifying agent in bacterial growth media or as a molecular sieve for the separation of nucleic acids and other large molecules. The aim of this study was to isolate genes encoding enzymes for agar synthesis to devise means of producing agar in bioreactors to prevent the eradication of red algal species.

Supervisor: Prof J Kossmann

KALILI, Kathithileni Martha (Chemistry)

*Comprehensive two-dimensional liquid chromatographic analysis of phenolics*

Comprehensive two-dimensional liquid chromatography (LC×LC) was explored as a powerful analytical approach for the detailed characterisation of phenolic compounds in complex natural products. Experimental results revealed important insights into the complexity of natural phenolics, suggesting that combining multiple, complementary analytical techniques is necessary for the in-depth investigation of complex phenolic fractions. The combination of LC×LC separation with fluorescence, mass spectrometry and radical scavenging detection methods simplifies compound identification and increases specificity, allowing maximal exploitation of the complementary benefits of each of the methods.

Supervisor: Prof AJ de Villiers

KOTZE, Izak Aldert (Chemistry)

*Cation- $\pi$  induced association and nano-structured aggregate formation of water-soluble  $[Pt^{II}(\text{diimine})(L^N-S,O)]^+$  complexes examined with high-resolution  $^1H$  and DOSY NMR: toward understanding their potential anti-malarial activity*

This research extends what is known of water-soluble platinum complexes that show significant biological activity, which are important in the development of anti-malaria drugs against chloroquine-resistant strains of the malaria parasite *Plasmodium falciparum*. A series of novel platinum complexes was prepared, some of which are significantly more active than chloroquine. The pronounced tendency of these molecules to aggregate in water, ranging from simple 1:1 aggregates to

large nano-structured clusters, loosely termed "metallogels" in the literature, was studied in detail. The existence of such nano-structures was verified by transmission electron microscopy and atomic force microscopy (AFM). New nuclear magnetic resonance (NMR) spectroscopy techniques were developed to study these phenomena.

Supervisor: Prof KR Koch

LAMPRECHT, Renate Luise (Genetics)

*Molecular characterisation of South African isolates of grapevine fanleaf virus and a new, associated satellite RNA*

Grapevine fanleaf virus (GFLV) is one of the most widespread and devastating viruses infecting grapevine. The first full-length genome sequences of two South African GFLV isolates were determined and found to be phylogenetically distinct from other described isolates. One of these isolates was found to be involved in a putative recombination event, involving GFLV and another nepovirus, *Arabis* mosaic virus. The satellite RNAs associated with two local GFLV isolates were described. A fully functional, full-length infectious clone of one of these satellite RNAs was constructed and modified into an expression and silencing vector for grapevine.

Supervisor: Prof JT Burger

Co-supervisor: Dr D Stephan

MAGCWEBEBA, Tandeka Unathi (Biochemistry)

*Chemopreventive properties of South African herbal teas, rooibos (*Aspalathus linearis*) and honeybush (*Cyclopia* spp.): mechanisms against skin carcinogenesis*

Methanol extract of rooibos (*Aspalathus linearis*) and aqueous extract of honeybush (*Cyclopia* spp.) inhibit the growth of skin cancer cells effecting apoptosis by inducing mitochondrial dysfunction via oxidative polyphenol/iron interactions. The antioxidant properties pointed to the role of monomeric flavonoids and polymeric proanthocyanidins, which can be used to predict the chemopreventive properties *in vitro*. These extracts also enhanced the removal of damaged cells via apoptosis utilising an *in vitro* UVB/HaCaT cell model, thereby preventing cancer initiation and inflammation, a key mechanism during cancer promotion in the skin.

External Supervisor: Prof WCA Gelderblom

Co-supervisor: Prof P Swart

McCLELLAND, Gregory Thomas William (Zoology)

*The ecology of the black-faced sheathbill (*Chionis minor*) on Marion Island*

The impacts of climate change and biological invasions on a key terrestrial species in the sub-Antarctic, the black-faced sheathbill, were examined. The study demonstrated for the first time that indirect interactions between the invasive house mouse and sheathbills through food resources are being exacerbated by climate change. Declining penguin populations as a consequence of climate change are also likely to have an effect. The sum of these ecological changes is a declining black-faced sheathbill population. This work shows that conservation steps implemented now will help secure the future of this unusual bird species.

External Supervisor: Prof SL Chown

Co-supervisor: Prof TJ Robinson

MIRA, Joele Paulus (Physics)

*The role played by quasi-elastic and inelastic break-up of the  $^{12}\text{C}$  and  $^{16}\text{O}$  projectiles in the production of intermediate mass fragments at 14-35 MeV/u*

The role played by quasi-elastic and inelastic break-up of the  $^{12}\text{C}$  and  $^{16}\text{O}$  projectiles in the production of intermediate mass fragments was studied using  $^{12}\text{C}$  and  $^{16}\text{O}$  ion beams at an incident energy of 14 to 35 MeV/u. Experimental data were used to evaluate the validity of two Monte Carlo simulation codes, FLUKA and GEANT4, in an energy regime in which transitions are observed between reaction mechanisms. Experimental data yielded new cross sections for the production of intermediate mass fragments relevant for  $^{12}\text{C}$  hadron therapy. The influence of hydrogen contamination contributed significantly to the production of secondary alpha particles, explaining the anomalous alpha energy distributions observed in past investigations.

Supervisor: Dr SV Förtsch  
Co-supervisor: Prof P Papka

MOTHAPO, Natasha Palesa (Zoology)

*Effects of biotic resistance and resource availability on the invasion success of the Argentine ant, *Linepithema humile* (Mayr), in the Cape Floristic Region, South Africa*

Empirical field and laboratory studies investigated resource usage by and competition between the invasive Argentine ant (*Linepithema humile*) and indigenous fynbos ants. Carbohydrate resources available within the fynbos, coupled with the lack of competition from native ant species, are facilitating the spread of *L. humile* in pristine fynbos environments. The negative impacts that this ant species has on both aboveground foraging ants and floral visitors highlight the threat of *L. humile* to this biodiversity hotspot.

Supervisor: Prof TC Wossler

MUSAKWA, Walter (Geography & Environmental Studies)

*Evaluating earth observation for supporting sustainable urban land use planning in Africa*

Data to monitor land-use transformations due to rapid urbanisation is often out of date, unreliable, expensive to collect or simply unavailable in many developing countries. This inhibits local authorities' capacity to carry out sustainable urban land-use planning. The efficacy of earth observation (EO) and satellite imagery for developing indicators of sustainable urban land use was investigated. The indicators were applied in Stellenbosch to perform spatiotemporal analyses in a geographic information system (GIS). The study demonstrated how EO data, urban sustainability indicators and GIS can enhance local authorities' capacity for monitoring urban sustainability.

Supervisor: Prof A van Niekerk

NDLOVU, Joice (Botany)

*The invasion ecology of *Acacia pycnantha*: a genetic approach*

Australian acacias have emerged as a model group for the study of woody plant invasions. Applied molecular tools were used to under-

stand the invasion ecology of *Acacia pycnantha* and its rhizobial symbionts. Seven microsatellite markers, two nuclear genes and one chloroplast gene showed that invasive *A. pycnantha* in South Africa originated from admixed populations in the native range, and that *A. pycnantha* in its native range is geographically structured into two lineages (dryland and wetland forms). Rhizobial symbionts of *A. pycnantha* were identified and showed that *A. pycnantha* utilises a wider suite of symbionts in its invasive range than in its native range.

Supervisor: Prof DM Richardson  
Co-supervisors: Dr JJ le Roux and Dr JRU Wilson

POTGIETER, Linke (Operations Research)

*A mathematical model for the control of *Eldana saccharina* Walker using the sterile insect technique*

The problem of finding an optimal economically viable release strategy for the sterile insect technique in terms of release ratio, frequency and method of release was considered. A mathematical model was developed for the population growth and dispersal of the pest *Eldana saccharina* Walker in a temporally variable and spatially heterogeneous sugarcane environment under the influence of partially sterile released insects. The model is the first to describe this technique for *E. saccharina*. Few of the models in the literature describe the technique for Lepidopteran species with more than one life stage, and none where F1-sterility is relevant and when fully sterile females and partially sterile males are released.

Supervisor: Prof JH van Vuuren  
External Co-supervisor: Prof DE Conlong

REYSKENS, Kathleen Maria Simone Elise (Physiological Sciences)

*The maladaptive effects of HIV protease inhibitors (*Lopinavir/Ritonavir*) on the rat heart*

Although antiretroviral treatment decreases HIV-AIDS morbidity/mortality, long-term side effects include cardio-metabolic complications. A unique rat model of chronic antiretroviral treatment – focusing on HIV protease inhibitors (*Lopinavir/Ritonavir*) – was established. Protease inhibitor-treated rats exhibited weight gain, increased serum LDL-cholesterol, higher tissue triglycerides (heart, liver), and upregulated hepatic gene expression of key regulators of fatty acid oxidation and cholesterol synthesis. Treated hearts also displayed impaired contractile function and dysregulation of the ubiquitin-proteasome system. These changes resemble the metabolic syndrome and reflect a pre-atherogenic profile. This study provides mechanistic insights into cardio-metabolic side effects of antiretroviral treatment and allows for the development of co-treatments for HIV-positive patients.

Supervisor: Prof MF Essop

SSEBULIBA, Doreen (Mathematics)

*Mathematical modelling of the effectiveness of two training interventions on infectious diseases in Uganda*

Mathematical models were used to investigate the effectiveness of two training interventions of mid-level practitioners at IDCAP in Uganda. The investigations were carried out at 36 sites and were evaluated using performance indicators. Linking performance indicators to patient outcomes and transmission dynamics demonstrated a fall in the prevalence of and mortality from malaria-pneumonia dynamics, but no change in their incidence. The HIV-TB model revealed that testing is

capable of offsetting a slight reduction in Artemisinin treatment (ART) enrolment. Generally, problems such as case detection and drug stock-outs need to be addressed to enable a substantial training impact, especially when performance indicator proportions are low.

*Supervisor:* Dr R Ouifki

*Co-supervisor:* Prof JW Hargrove

VON DER HEYDEN, Bjorn Phillip (Geology)

*Distribution and characterization of marine iron-rich particles*

A novel synchrotron-based spectroscopic method was devised to determine the speciation of iron in marine nanoparticles. The iron chemistry of natural particulates is very complex and a significant contribution was made to understanding the marine iron cycle, the interaction of iron with carbon and the controlling impact of iron on ocean primary productivity. The results bring about a paradigm shift, leading to the inclusion of the role of iron particles and not just dissolved iron in efforts to understand the lack of productivity in the otherwise nutrient-rich Southern Ocean.

*Supervisor:* Prof AN Roychoudhury

*External Co-supervisor:* Prof SCB Myneni

## DSc

BARBOUR, Leonard James (Chemistry)

*Mass transport phenomena in the crystalline solid state*

Research spanning a period of approximately twenty years has focused on unravelling unusual phenomena in the crystalline solid state. The work began with the serendipitous discovery of transient porosity – that is, the diffusion of small molecules through a seemingly nonporous solid matrix. The research then expanded to include a rational design strategy for the preparation of further porous molecular solids. This led to additional discoveries, including anomalous thermal expansion, self-inclusion, polar ordering of guest molecules and prioritised selectivity for the separation technologies. During the course of the work presented, several new research tools were developed that are now implemented internationally.

*Supervisor:* Prof C Esterhuysen

## Fakulteit Agriwetenskappe

### Faculty of Agrisciences

### IFakhalthi yeeAgrisayensi

## PhD

FAWOLE, Olaniyi Amos (Horticultural Science)

*Maturity indexing, pharmacological properties and postharvest performance of pomegranate fruit grown in South Africa*

Preharvest and postharvest studies on maturity and postharvest quality of pomegranates grown in South Africa showed that fruit could be stored at 5°C and ≥90% relative humidity for 8-12 weeks to maintain quality and reduce incidence of disorders. Discriminant analysis of instrumental and sensory measurements revealed that the harvest period for best poststorage quality occurred when fruit were har-

vested at sugar:acid ratio ≥55 for Ruby. For Bhagwa, the harvest indicators were sugar content ≥16°Brix and juice content >65 mL/100 g arils. Pharmacology of edible and non-edible fruit fractions showed that pomegranate is a rich source of compounds with potential health benefits.

*Supervisor:* Prof UL Opara

JACOBSON, Daniel Allan (Wine Biotechnology)

*Networks and multivariate statistics as applied to biological datasets and wine-related omics*

Wine production is a complex biotechnological process aiming at productively coordinating the interactions and outputs of several biological systems, including grapevines and many microorganisms such as wine yeast and wine bacteria. This dissertation explores the development of Computational Biology tools, using network theory and multivariate statistics that are essential to gain a better understanding of such complex biological systems. To achieve this aim, computational methods have been developed and applied in the areas of transcriptomics, phylogenomics, chemiomics and microbiomics. Furthermore, several of the approaches have started to explore the intersection between networks and multivariate data analysis.

*Supervisor:* Prof MA Vivier

LAWRENCE, James Mark (Entomology)

*Restoration ecology of the Seychelles giant millipede*

The Seychelles giant millipede is remarkable in that it efficiently converts fallen leaves into soil-organic matter on the nutrient-poor, granitic Seychelles islands. Yet it is also threatened with extinction. Conservation measures were urgently required. To achieve this, a detailed study was undertaken to assess its requirements. Besides needing alien invasive trees to be removed, it also requires restored forest with special features. Among these features are cool, moist rock crevices into which it can retreat during hot days, from where it can then forage on the forest floor at night.

*Supervisor:* Prof MJ Samways

*Co-supervisor:* Dr JA Kelly

MAVENGAHAMA, Sydney (Soil Science)

*The contribution of indigenous vegetables to food security and nutrition within selected sites in South Africa*

Indigenous vegetables (IV) are an important source of food in the maize-based subsistence farming sector of rural South Africa contributing to food security. A survey revealed IV to be important in the diets of most rural people. IV were consumed as relish although none were cultivated. Acquisition happens through gathering from homesteads and the wild. The study indicated problems in domesticating the vegetables and indicated IV as an important source of nutrition regarding vitamin and micronutrient intake related to soil quality. The study showed that the micronutrient contribution to diets could be enhanced through adequate fertiliser/manure application.

*Supervisor:* Dr WP de Clercq

*Co-supervisor:* Prof M McLachlan

REINECKE, Michiel Karl (Conservation Ecology)

*Links between lateral riparian vegetation zones and flow*

The way in which riparian plants are distributed on river banks, and how river flow influences this, was shown to be predictable for different South African rivers, despite variability in the flow regime, topographical setting and climate. The incidence of floods and the period of inundation when flooded were important variables determining how plants are distributed and the timing of seed dispersal. Knowing how plants are distributed on river banks and how river flow influences their distribution and life history is used to inform restoration strategies and to assess impacts of water resource developments (including abstraction) on rivers.

Supervisor: Prof KJ Esler

Co-supervisor: Prof CA Brown

### PhD (Agric)

MAGWAZA, Lembe Samukelo (Horticultural Science)

*Non-destructive prediction and monitoring of postharvest quality of citrus fruit*

The study demonstrated the potential of applying visible to near infrared spectroscopy as a non-destructive tool for sorting citrus fruit based on external and internal quality. It was found that emission head spectroscopy in diffuse reflectance mode predicted fruit mass, colour index, total soluble solids, and vitamin C with high accuracy. Rind colour index, dry matter, total carbohydrates and water loss were predicted accurately. Fruit inside the canopy, especially artificially bagged fruit, had lower dry matter, higher mass loss and were more susceptible to rind breakdown. Optical coherence tomography showed potential for rapid, real-time detection of rind affected by the disorder.

Supervisor: Prof UL Opara

Co-supervisor: Dr PJR Cronje

### PhD (For)

CHANYENGA, Tembo (Forest Science)

*Effect of population size on viable seed output, seed rain and natural regeneration pattern of a tropical conifer Widdringtonia whytei-remde in Malawi*

Fires around fragmented forest patches, invasive insects and timber harvesting threaten the survival of the endemic, fire-adapted and light-demanding Mulanje cedar (*Widdringtonia whytei*) on Mulanje Mountain in Malawi. This field study showed the low viable seed output, limited seed dispersal, low seedling regeneration (despite good seed germination) and high seedling mortality due to regular cool fires outside forest patches and the shade and thick litter layer inside forest patches. Occasional natural intense spot fires and larger forest gaps could promote effective seed dispersal, seedling establishment and population growth of Mulanje cedar.

Supervisor: Prof CJ Geldenhuys

Co-supervisor: Dr M Sacande

## Fakulteit Ingenieurswese

### Faculty of Engineering

## IFakhalthi yobuNjineli

### PhD

BOOYSEN, Marthinus Johannes (Electronic Engineering)

*The effect of awareness at the medium access control layer of vehicular ad hoc networks*

Into ebalulekileyo kuqhagamshelwano olulungileyo bubuchule bokumamela kwanokuba nenkathalelo kwabo basingqongileyo. Kwixesha elizayo, iinqwelo-mafutha ziya kuba noqhagamshelwano oluzimeleyo kwesinye nesinye ukuthintela iingozi kwakunye nokuphucula ukhuseleko ezindleleni. Ngenxa yentshukumo ephezulu yeenqwelo-mafutha, kunye nokungabikho kolungelelwano lweenqwelo-mafutha ezinokubangela uphazamiseko, ukugqithiswa kolwazi ngokuyimpumelelo phakathi kweenqwelo-mafutha kungumceli-mngeni. Lo msebenzi wazisa ingqiqo yokwenza abammelwane bazi nge-multi-hop kwinkalo yoqhagamshelwana lweenqwelo-mafutha, into leyo eyenza lwenzeke ngokuzenzekelayo ulungelelwano lwamaxesha phakathi kweenqwelo-mafutha ezigqithisayo. Iziphumo zibonisa ukuba ukuphucula ukwazisa kuliphucula ngokubalulekileyo iqondo lem-pumelelo, ngemveliso, nangokuba sexesheni lokugqithisa phakathi kweenqwelo-mafutha.

Umqeqeshi: Njing G-J van Rooyen

Umqeqeshi oncedisayo: Njing S Zeadally

DREIJER, Janto Frederick (Applied Mathematics)

*Cardiac MRI segmentation with conditional random fields*

Diagnosis of many cardiac problems depends on measurements that are derived from magnetic resonance imaging (MRI). Deriving these measurements currently requires that cardiologists analyse sequences of MRI images. Analysis typically involves separating the left ventricle of the heart from the rest of the image. This is a time-consuming process, often complicated by structures within the heart obscuring the edge of the ventricle. This research describes an automated process that integrates shape, motion and appearance of the heart into a probabilistic model. This model is then used to efficiently separate the left ventricle, with minimal input from a human operator.

Supervisor: Prof BM Herbst

Co-supervisor: Prof JA du Preez

ILGNER, Robert Georg (Electronic Engineering)

*A comparative analysis of the performance and deployment overhead of parallelised finite difference time domain (FDTD) algorithms on a selection of high performance multiprocessor computing systems*

The design of contemporary engineered products relies heavily on computer simulation, leveraging advances in computing technology (epitomised by Moore's Law) to build ever larger and more accurate engineering models on the computer. The candidate investigated the deployment of a numerical technique widely used in electromagnetic engineering, namely the finite difference time domain method, across a variety of high performance computing platforms, which ranged from



commodity graphical processing units to an IBM BlueGene super-computer. He developed an integrated approach to guide future work, informed by a multi-criteria evaluation framework.

*Supervisor:* Prof DB Davidson

JOUBERT, James Rattray (Mechanical Engineering)

*Design and development of a novel wave energy converter*

This study entails the research and development of a novel wave energy converter incorporated into a breakwater of a port development. A suitable location on the South African coast was identified and a detailed analysis of the prevailing wave conditions and available resource at this site was conducted. The structure was designed to survive extreme storm events and the wave energy conversion efficiency of the device was evaluated by means of experimental tests and a numerical model. Finally, an estimate of the electricity generation potential of the device at the selected location was made.

*Supervisor:* Prof JL van Niekerk

*Co-supervisor:* Mr G de F Retief

OWEN, Michael Trevor Foxwell (Mechanical Engineering)

*Air-cooled condenser steam flow distribution and related dephlegmator design considerations*

Despite considerable water consumption advantages, air-cooled condensers (ACCs) are not often used at thermal power plants due to high costs and performance issues. The air-side operation of these systems has been the topic of rigorous attention in the literature to the neglect of the important issues on the steam side. This work presents a detailed analysis of the steam-side operation of an ACC with particular emphasis on the vapor flow distribution and related system design considerations. The methods, models and results presented in this study contribute towards the continual improvement of ACC reliability and provide a sound basis for further research on steam-side performance concerns.

*Supervisor:* Prof DG Kröger

STRAUSS, Johannes Matthias (Elektriese Ingenieurswese)

*Direct piston displacement control of free-piston Stirling engines*

Hierdie studie stel 'n direkte suiverplasingsbeheer-benadering tot die beheer van vrysuier- Stirling enjins voor, deur die intydse beheer van die oomblikkragte vanaf die lineêre elektriese masjiene wat aan die suiers verbind is. Om die evaluering van lineêre masjiene moontlik te maak, is spesifikasies en ontwerpstrategieë waaraan lineêre masjiene moet voldoen bepaal aan die hand van 'n omvattende gevallestudie. Dit word gevolg deur die daarstelling van 'n optimeringsraamwerk ten einde lineêre masjiene te optimeer. Die studie toon aan dat hierdie benadering moontlik is deur 'n longitudinale lineêre masjien met dubbel-lugspleet en lugkern te evalueer aan die hand van die spesifikasies.

*Promotor:* Prof MJ Kamper

VAN DEN HEEVER, Thomas Stanley (Electronic Engineering)

*Development and optimisation of a zinc oxide nanowire nanogenerator*

When a piezoelectric material is deformed, it will generate electricity. This effect was exploited to design a novel nanogenerator on a flexible substrate, where zinc oxide nanowires were used as the piezoelectric elements. The nanowires had a diameter of a 100 nanometers, about a thousand times thinner than a human hair. The fabrication process was optimised and the output voltage of the device was increased from less than 1 volt to more than 5 volts when continuously bent. The output voltages obtained are now large enough to charge small devices, such as heart pacemakers, utilising the natural movement of people.

*Supervisor:* Prof WJ Perold

VAN DYK, Liezl (Industrial Engineering)

*Development of a telemedicine service maturity model*

Telemedicine is the delivery of health care services over a distance and can potentially contribute to the quality, accessibility, utilisation, efficiency and effectiveness of health care services. Despite this potential, the success rate of telemedicine services disappoints. This study, which spans several academic and professional disciplines, responds to this problem through the development, application and validation of a maturity model for telemedicine services. This model describes patterns in the development of organisational capabilities of telemedicine services to facilitate the assessment and provide guidelines for the optimisation of telemedicine services in a consistent, systematic and systemic way.

*Supervisor:* Prof CSL Schutte

VOLKMANN, Mark Hans (Electronic Engineering)

*A superconducting software defined radio front-end with application to the Square Kilometre Array*

The Square Kilometre Array (SKA) will be the world's largest, most sensitive radio telescope, but relies on technology that does not yet exist. Superconductor electronics are a capable platform for disruptive technology. The candidate developed test circuits and experimentally demonstrated that a 20 GHz analogue-to-digital converter – sufficient to digitise the entire band of interest envisioned for the SKA instantaneously – could be placed directly into the cryogenic feed. Furthermore, he has developed first demonstrators of a novel ultralow-power logic family that could dramatically improve the power requirements of the SKA back end, promising orders of magnitude better power efficiency than current supercomputers.

*Supervisor:* Prof CJ Fourie

*Co-supervisors:* Prof DB Davidson and Prof WJ Perold

YOUNG, André (Electronic Engineering)

*Improving the direction-dependent gain calibration of reflector antenna radio telescopes*

Future radio telescopes will require extensive and continual calibration to achieve their full observing potential. For the Square Kilometre Array, 'third generation' calibration techniques will be required: these methods permit calibration of direction-dependent effects. An important example of these is the primary beam pattern, which is usually obtained by measurement in real time. The amount of measured data is limited by various factors, and determining how best to use such limited data is the main topic of the candidate's dissertation. The methods have been demonstrated through application to the MeerKAT antennae, the first of which is being installed at present.

Supervisor: Prof DB Davidson

Co-supervisor: Prof I Ivashina and Prof R Maaskant

## **Fakulteit Geneeskunde en Gesondheidswetenskappe**

### **Faculty of Medicine and Health Sciences**

### **IFakhalthi yezamaChiza nobuNzululwazi kwezeMpilo**

#### **PhD**

BARNARD, Marinus (Molecular Biology)

*Diagnostic utility of the HAIN line probe assay for the detection of drug resistance in Mycobacterium tuberculosis*

This dissertation investigated the diagnostic utility of the line probe assay (LPA) for the rapid diagnosis of *Mycobacterium tuberculosis* and its associated drug susceptibilities towards both the first- and second-line antitubercular drugs, directly from both smear-positive and smear-negative specimens. Excellent performance parameters were achieved and showed a significant reduction in turnaround time. This led to the establishment of the first molecular TB diagnostic laboratory in South Africa with subsequent endorsement of the first rapid molecular TB diagnostic assay by the World Health Organization, in order to expedite the initiation of treatment on a global scale.

Supervisor: Prof RM Warren

FASINU, Pius Sedowhe (Pharmacology)

*In vitro assessment of some traditional medications used in South Africa for pharmacokinetic drug interaction potential*

Many patients combine prescription drugs with traditional medicines. The study described the *in vitro* inhibitory effects of the extracts of 15 popular South African herbal remedies such as Sutherlandia and African potato on drug-metabolising enzymes/transporters using human liver microsomes, cryopreserved hepatocytes and recombinant cell lines expressing transporter proteins. All selected herbs inhibited one or more of the cytochrome P450 isozymes, P-glycoprotein, breast cancer resistant protein and organic anion-transporting polypeptide. The findings are clinically important since they suggest that South African herbal remedies can interfere with the elimination of prescription drugs, if sufficient concentrations are achieved *in vivo*.

Supervisor: Prof B Rosenkranz

External Co-supervisor: Prof PJD Bouic

HATTINGH, Susanna Maria (Medical Physiology)

*Ischaemic preconditioning: an investigation of the patterns of kinase activation and protein expression profiles during reperfusion in the rat heart*

Controversy exists regarding kinase activation and the mechanisms involved in ischaemic preconditioning (IPC) induced-protection of the heart. Using the isolated perfused working rat heart model, western blots and 2D-proteomics, results demonstrated that activation of kinases after IPC rather correlated with sympathetic stimulation and haemodynamic parameters prior to onset of experiments, than with functional parameters. It was established that hearts were unable to recover after an IPC protocol if they were exposed to physiological stress before sacrifice. The resultant heart failure was due to insufficient glucose metabolism and altered fatty acid transport, thereby leading to energy depletion.

Supervisor: Prof SS du Plessis

Co-supervisors: Prof AM Engelbrecht and Dr R Salie

ITHETE, Ndapewa Laudika (Medical Virology)

*Investigation of small mammal-borne viruses with zoonotic potential in South Africa*

Most emerging infectious diseases (EIDs) are viral and of zoonotic origin. Ms Ithete studied rodents, shrews and bats – at the origin of most human EIDs – for the presence of various viruses. She identified and characterised several novel astro-, arena- and coronavirus sequences, one of them closely related to the recently emerged MERS coronavirus, pointing to bats as a possible source of this ongoing outbreak. A serosurvey found hantavirus antibodies in 1% of the Western Cape population. The results highlight the importance of small mammals in the emergence of novel infections and reinforce the importance of virological surveillance of wildlife.

Supervisor: Prof W Preiser

LOUW, Adriaan (Physiotherapy)

*Preoperative neuroscience education for patients undergoing surgery for lumbar radiculopathy*

Following lumbar surgery for radiculopathy, many patients still experience pain and loss of function, driving their health care behaviour. The study set out to develop, validate and test a simple preoperative neuroscience education (NE) programme for patients undergoing lumbar surgery. After this intervention a significant positive effect was demonstrated, leading to a better understanding of pain, 40% decrease in health care seeking behaviour and earlier return to work. The NE programme empowered patients towards meaningful behavioural changes in the postoperative period.

Supervisor: Dr I Diener

Co-supervisor: Prof QA Louw

LÜTGE, Elizabeth Eleanor (Epidemiology)

*Economic support to improve TB treatment outcomes in South Africa: a pragmatic cluster randomised controlled trial*

Few rigorous studies have evaluated the effectiveness of economic interventions to improve health. Dr Elizabeth Lütge prepared a Cochrane systematic review to examine what is known about the effects of economic support in patients with tuberculosis (TB). She also conducted a pragmatic, cluster randomised controlled trial in 20 clinics in KwaZulu-Natal (including 4 091 patients), to evaluate the feasibility and effectiveness of delivering a monthly voucher valued at ZAR120 to patients on treatment for active TB. A process evaluation provided contextual information to explain the findings of the trial. This dissertation makes an important contribution to knowledge in a difficult field of research.

Supervisor: Prof J Volmink

MASIBO, Peninah Kinya (Nutritional Sciences)

*Effects of initial nutritional status on the responses to a school feeding programme among school children aged 6 – 13 years in the Millennium Villages Project, Siaya, Kenya*

This research was carried out within the framework of the Millennium Villages Project in Kenya to determine the effect of a school feeding programme on the growth, body composition, prevalence of anaemia, iron stores and vitamin A status of school children. A controlled intervention study was carried out over a 30 month period, using a community-driven and local foods-based model to ensure sustainability. Compared to the controls, the school feeding programme was associated with improved height velocity (especially when inadequate nutritional status was present at baseline) with lower anaemia prevalence at 6 months only. Body composition and vitamin A status was unaffected.

Supervisor: Prof D Labadarios

Co-supervisor: Prof MG Herselman

External Co-supervisors: Prof RJ Deckelbaum and Dr G Ettyang

OOSTHUYSEN, Wilhelm Frederick (Geneeskundige Mikrobiologie)

*Population structure, host cell interactions and pathogenesis of Staphylococcus aureus strains isolated at Tygerberg Hospital, South Africa*

*S. aureus* is 'n bakterie wat algemene en ernstige infeksies veroorsaak. Die kandidaat het deur molekulêre metodes en fenotipiese toetsing die herkoms en virulensie van Suid-Afrikaanse isolate bestudeer om die populasiestruktuur en patogenisiteit van plaaslike organismes te beskryf. Sy bevindinge het die eienskappe van die pasiëntpopulasie en die kliniese kenmerke van infeksie in verband gebring met die molekulêre stam-tipering van die veroorsakende organisme sowel as genetiese virulensiefaktore en die *in vitro*-vermoë van elke stam om gasheerselle binne te dring en te dood. Bekende endemiese stamme sowel as unieke plaaslike stamme is aangetoon.

Promotor: Prof E Wasserman

VILJOEN, Albertus Johannes (Molecular Biology)

*The glutamate dehydrogenase of the slow-growing mycobacteria: its function in nitrogen metabolism and importance to in vitro and intracellular survival*

Development of new antituberculosis chemotherapies requires the identification of unique physiological features of the slow-growing pathogenic mycobacteria which cause tuberculosis. In this PhD study enzymes in the metabolism of the amino acid glutamate were investigated for their roles in the survival of slow-growing mycobacteria under specific culturing conditions as well as during infection of host immune cells. The enzyme glutamate dehydrogenase, which is responsible for the degradation of glutamate, was identified to be required for the optimal growth of slow-growing mycobacteria in macrophage cells and may be a novel antituberculosis drug target.

Supervisor: Prof IJF Wiid

External Co-supervisor: Dr CJ Kirsten

WANJIKU, Samuel Mburu (Haematological Pathology)

*Impact of inflammatory-induced oxidative stress on the integrity of immuno-haematopoietic cells and potential ameliorating interventions: an in vitro HIV model*

Chronic inflammation is an important cause of oxidative stress in HIV infection and may contribute to loss of immune cells and disease progression. Early damage to the gut mucosa results in 'leakage' of bacterial products, such as lipopolysaccharide (LPS) into circulation. This study demonstrated lower antioxidant status and higher levels of oxidative stress by-products in untreated, clinically well HIV infection. In addition, the effects of LPS stimulation of CD4+ T-cells in whole blood were determined by measuring levels of CD4+ T-cell activation and death by flow cytometry. Furthermore, the potential ameliorating effects of the combination of N-acetyl cysteine and vitamin C were demonstrated.

External Supervisor: Prof JL Marnewick

Co-supervisors: Prof A Abayomi and Dr H Ipp

WILKINSON, Euan (Medical Virology)

*Origin and phylodynamics of HIV-1 subtype C in South Africa*

This study looked at the origin of the subtype C HIV-1 epidemic in South Africa and the greater Southern African region. From longitudinal sequence data sets the origin of the South African epidemic was estimated around the mid 1960s, while the origin of the Southern African epidemic was estimated to have originated in the mid 1950s. Using Bayesian coalescence methods, short periods of exponential growth in the epidemic were observed in the 1980s and 1990s. Furthermore, an explosion in viral variance was observed during the 1980s, indicating multiple introductions of various strains of subtype C into South Africa.

*Supervisor:* Prof S Engelbrecht

ZÖLLNER, Ekkehard Werner Arthur (Paediatrics)

*Hypothalamic-pituitary-adrenal axis suppression in asthmatic children on corticosteroids*

This study addresses the important and controversial topic of hypothalamo-pituitary-adrenal suppression (HPAS) in asthmatic children on inhalation and nasal steroids. Numerous dogmas are questioned and useful clinical guidelines are proposed to manage such patients. HPAS is not rare and, in fact, occurred in 65% of cases. The clinical diagnosis of HPAS is totally unreliable and the baseline endocrine tests, which are routinely proposed to diagnose HPAS (e.g. serum or urine cortisol, ACTH), were found to be too insensitive. Only definitive tests, like the overnight metyrapone test, were useful to diagnose children with steroid-induced HPAS.

*Supervisor:* Prof FS Hough

*Co-supervisor:* Prof EM Irusen