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SWISS SOUTH AFRICAN JOINT RESEARCH PROGRAMME

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Swiss Confederation

CONTENTS

LIST OF ABBREVIATIONS AND SYMBOLS(1)

ABS	Access and Benefits Sharing
AHN	adult hippocampal neurogenesis
AIDS	Acquired Immune Deficiency Syndrome
AQ	antimalarials amodiaquine
ARV	antiretroviral
ASSAf	Academy of Science of South Africa
AU	African Union
BIOe	Biotechnology Entrepreneurship
BTech	Bachelors of Technology
C3	three-carbon
CD4	cluster of differentiation
CD 4+	T cell with CD4 receptor
CHE	Council on Higher Education
CoCs	Centres of Competence
CoEs	Centres of Excellence
COHEP	Swiss Conference of Rectors of Universities of Teacher Education
CQ	chloroquine
CRUS	Rectors' Conference of Swiss Universities
CSIR	Council for Scientific and Industrial Research
CTs	CAT scans
CTI	Commission for Technology and Innovation, of Switzerland
CypA	cyclophilin A
deCIPh	decipher
DHET	Department of Higher Education and Training, of South Africa
DST	Department of Science and Technology, of South Africa
DTI	Department of Trade and Industry, of South Africa
Dy	dysprosium
E. coli	*Escherichia coli*
E3	family of ligases
Eawag	Swiss Federal Institute of Aquatic Science and Technology
EC	Enzyme Commission
EDK	Swiss Conference of Cantonal Ministers of Education
EMF	Esperanza Medicines Foundation
EPFL	Swiss Federal Institute of Technology of Lausanne
ERI	Education, Research and Innovation
ETH	Swiss Federal Institute of Technology, Zürich
EU or EU-27	European Union of 27 independent states
FE	faculty exchange
FET	Further Education and Training
FP7	Seventh Framework Programme
FPs	framework programmes
GCI	Global Competitiveness Index
Gd	gadolinium
GDP	gross domestic product
GERD	gross expenditure on research and development
GII	Global Innovation Index
GINI	measure of inequality in a population
HCD	human capacity development
HDL	high density lipoproteins
HEIs	higher education institutions
HEQF	Higher Education Qualifications Framework
HESA	Higher Education South Africa
HIV	Human Immunodeficiency Virus
HIV-1	Human Immunodeficiency Virus type 1
HPLC	high performance liquid chromatography
HSRC	Human Sciences Research Council
ICT	information and communication technology
IDC	Industrial Development Corporation, of South Africa
IEASA	International Education Association of South Africa
IFN	Interferon
IFN-1	type 1 interferon
INSEAD	European Institute of Business Administration
IP	intellectual property
IPR-PFRD	Intellectual Property Rights for Publicly Funded Research and Development Act of 2008, South Africa
ISA3	plant gene isoamylase 3
ISCED	international standard classification of education

LIST OF ABBREVIATIONS AND SYMBOLS(2)

JRPs	joint research projects
KFH	Rectors' Conference of Swiss Universities of Applied Sciences
LDL	low density lipoproteins
MeerKAT	Karoo Array Telescope
MELISSA project	Measuring E-Learning Impact in primary Schools in South African disadvantages areas
MEX	plant gene maltose excess
MRC	Medical Research Council
MRI	magnetic resonance imaging
MS/MS	tandem mass spectrometry
MTB	*Mycobacterium tuberculosis*
NACI	National Advisory Council on Innovation, of South Africa
NCCRs	national centres of competence in research, of Switzerland
NCEs	new chemical entities
NIPMO	National Intellectual Property Management Office, of South Africa
NQF	National Qualifications Framework, of South Africa
NRDS	National Research and Development Strategy, of South Africa
NRF	National Research Foundation, of South Africa
NRPs	national research programmes
NSI	national system of innovation
NST	National Science and Technology Forum, of South Africa
NWU	North-West University
OECD	Organisation for Economic Cooperation and Development
OPET	Federal Office for Professional Education and Technology, of Switzerland
PBMC	peripheral blood mononuclear cells
PET	Professional Education and Training
PGM	platinum group metals
PhD	Philosophae Doctor
PPPs	public-private partnerships
propionyl-CoA	propionyl coenzyme A
PSI	Paul Scherrer Institute
PWD	plant gene phosphoglucan water dikinase
R&D	research and development
S&T	science and technology
S2M	science to market
SA	South Africa
SARChI	South African Research Chairs Initiative
SE	student exchange
SEDA	Small Enterprise Development Agency, of South Africa
SER	State Swiss Secretariat for Education and Research, of Switzerland
SIB	Swiss Institute of Bioinformatics
SKA	Square Kilometre Array
SNSF	Swiss National Science Foundation
SPECT	single photon emission computed tomography
SPII	Support Programme for Industrial Innovation, of South Africa
SSAJRP	Swiss South Africa Joint Research Programme
STAT3	signal transducer and activator of transcription 3
Swiss TPH	Swiss Tropical and Public Health Institute
SUC	Swiss University Conference
T cell	infection-fighting lymphocyte
Tb	terbium
TB	Tuberculosis
THRIP	Technology and Human Resources for Industry Programme, of South Africa
TIA	Technology Innovation Agency, of South Africa
TNF	tumour necrosis factor
TRIM	tripartite motif
TYIP	Ten-Year Innovation Plan, of South Africa
UAS	universities of applied science
UNEP	United Nations Environment Programme
UNIBASEL	University of Basel
Unisa	University of South Africa
UoTs	universities of technology
UPLC	ultra performance liquid chromatography
US dollar	United States dollar
VET	Vocational Education and Training
WEF	World Economic Forum
WHO	World Health Organisation

FOREWORD

It is with great satisfaction and appreciation that the progress of our joint scientific and technological collaboration is presented. The bilateral Agreement on Scientific and Technological Cooperation signed between the Swiss Federal Council and the Government of the Republic of South Africa in December 2007 and the subsequent joint statements provide a historic overview of the significant progress achieved in advancing the objectives of the bilateral cooperation between our two countries. We are pleased with the positive developments and high-quality research outputs of the Swiss South Africa Joint Research Programme (SSAJRP).

This booklet provides a synopsis of the fruitful scientific and technological collaboration between Switzerland and South Africa as experienced during Phase I of the SSAJRP – implemented from 2008 to 2011.

The SSAJRP provides for the following instruments in fostering bilateral collaboration:

- Joint research projects (JRPs);
- Faculty exchange (FE);
- Student exchange (SE);
- Science to market (S2M).

At the first Joint Committee Meeting held in August 2008, 16 JRPs – in the areas of public health and biomedicine, biotechnology and nanotechnology, human and social science – were approved. It is foreseen that energy, with the emphasis on renewable energy sources and clean technology, will be added as a fourth thematic area for future collaboration.

The JRPs made meaningful contributions to the goals of the international research objectives of both Switzerland and South Africa through the strengthening of scientific relationships and international networks. This collaboration and interaction demonstrated the research excellence of both countries, which is evident in the number of publications in internationally recognised scientific journals.

The student and faculty exchanges served as a valuable instrument to establish research networks through the exchange of best practices and technical knowledge. Both countries view scientific excellence and human capital development (HCD) as beneficial and essential outcomes of their joint research collaboration. A total of 48 PhD and post-doctoral students (two thirds South African and one third Swiss) were involved in the collaborative activities at the end of 2010 and at least 80 young researchers have benefited from over 50 SSAJRP exchange projects. Moreover, the annual Swiss government scholarships for doctoral and post-doctoral students serve as an excellent example of HCD in support of scientific and technological enhancement in South Africa.

The Biotech Business Development Programme, launched in September 2010 and focusing mostly on young career scientists, marked the beginning of the S2M collaborating instrument as a direct response of both countries to support and encourage innovation beneficial to both. The programme aims to enhance entrepreneurial skills through a Biotech Entrepreneur Workshop presented in South Africa, followed by a summer camp in Switzerland. An important milestone of the BIOe Programme is also the establishment of partnerships with the Technology Innovation Agency (TIA) as an organisational and funding partner and the University of Pretoria as an implementing and content partner.

Another milestone achieved in the S2M framework was the approval of nine research projects in 2011 under the seed funding call, where the projects were submitted by researchers having an industry partner. The approach of academia and industry collaboration in joint projects aims to stimulate collaboration for innovation. The successful conclusion of these projects will serve as a learning phase for the future implementation of cooperation between industry and academia.

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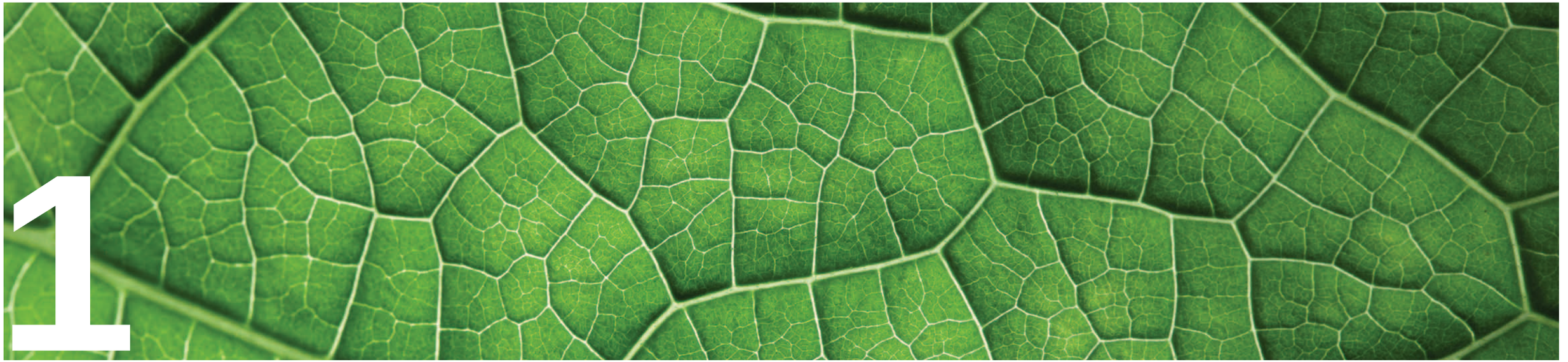
SOUTH AFRICA

Value is added to the bilateral collaboration in the form of joint participation of Swiss and South African researchers in the European Framework Programme (FP). Under the current Seventh Programme, 66 Swiss and South African partners are collaborating on 28 projects (mainly in the fields of the environment, food/agriculture, biotechnology and health). It is intended that further cooperation and projects will be developed and funded through all possible research and development (R&D) programmes for which both parties are eligible.

Besides the activities supported under the SSAJRP, the institutional collaboration between Switzerland and South Africa witnessed steady growth over the last two decades, demonstrating the keenness for scientific and technological exchanges among the researchers of our two countries. The main areas of institutional collaboration during 1990 and 2007 were biomedicine and public health, followed by nuclear physics, astronomy and environmental studies, resulting in 810 peer-reviewed co-publications.
A highlight of the cooperation was the visit of the Minister of Science and Technology, the Honourable Minister Pandor, to Switzerland in June 2011. Minister Pandor was hosted by her counterpart, the Honourable State Secretary Dell 'Ambrogio, demonstrating political and official commitment for the SSAJRP. Minister Pandor met the Head of the Federal Department of Home Affairs, H.E. Didier Burkhalter[1] and they both acknowledged the high quality of projects, researchers and workshops emanating from the SSAJRP. They further encouraged direct institutional links and collaboration between the respective higher education and research institutions, in addition to formal collaborative support and active participation in the European FP through the submission of joint projects. The visit reaffirmed the commitment of both countries to continue the SSAJRP into Phase II for implementation from 2013 – 2016.

Both Ministries are strongly committed to extending and actively encouraging cooperation between Swiss and South African key actors in the fields of science and technology in the years to come. Such cooperation is greatly valued as an important contribution to addressing complex research issues and global challenges.

[1] H.E. Didier Burkhalter moved to the Federal Department of Foreign Affairs as from 1 January 2012.



1

INTRODUCTION TO THE SSAJRP

Identifying the areas of research collaboration between South Africa and Switzerland entailed a number of visits and interactions on bilateral, official and research level. Global challenges linked to national priorities, research competence that could lead to research excellence and the cross-fertilisation of Swiss and South African researchers determined these areas. The end result was the identification of three broad areas of scientific collaboration covering:

- Public health and biomedicine;
- Bio- and nanotechnology;
- Human and social sciences.

Public health and biomedicine. The importance of public health and biomedicine as a discipline to facilitate the well-being of nations, and in turn the global community, cannot be over-emphasised. Public health is a discipline that draws on the strengths of all major disciplines, technologies and scientific frontiers to reach its ultimate goal of ensuring a state of mental, physical and social well-being.

The national public health profile of nations differs considerably across and within national boundaries. Bilateral research programmes in the area of public health and biomedicine call for an understanding of the participating countries' public health systems and disease profiles against the backdrop of the global burden of disease. Both South Africa and Switzerland have public health systems and biomedicine research projects marked for excellence, which are complementary, together leading to enhanced potential for innovation.

These projects are distributed over sub-disciplines such as pharmacology, organic chemistry, experimental microbiology, medical statistics, bioinformatics, cardiology and neurophysiology.

Biotechnology. The research, development and innovation fields of biotechnology have registered remarkable progress and resulted in economic transitions with science and technology (S&T) as the catalyst. In the 21st century we are witnessing the establishment of knowledge-based economies in addition or parallel to current resource-based economies. Biotechnology is a key catalyst for pursuing the trade of knowledge.

The success of Switzerland's biotechnology sector in the knowledge economy, combined with South Africa's emerging biotechnology R&D, stimulated by the rich biodiversity of South Africa, creates excellent opportunities for innovation.

Nanotechnology. Nanoscience has emerged as a technology that can address national and global challenges in areas such as sustainable environmental technologies, new materials and drug optimisation. The combined research strengths and facilities for nanotechnology in Switzerland and South Africa serve as an important catalyst to develop innovative applications, for example in the area of biomedicine and new materials. Both countries have prioritised nanotechnology as a research frontier to contribute to the knowledge economy.

The bio- and nanotechnology-supported projects have applications in the medical sector, i.e. human immunodeficiency virus (HIV) and tuberculosis infections, cancer diagnostics and therapy, a drug delivery system for anti-malarial drugs, as well as plant biotechnology.

Human and social sciences. Both South Africa and Switzerland are known for their social, cultural and linguistic diversity in full acknowledgement of the challenges and opportunities it presents. The robust South African Constitution, linked with knowledge gained from the historical implication of democracy in the Swiss context, provides a fertile ground for joint research in the social sciences. The differences and similarities of the two systems in South Africa and Switzerland offer prolific opportunities for research benefitting both societies, as well as strengthening their social fabrics.

The projects in this area address the performance of public services, the integration and use of information and communication technology (ICT) in education, challenges faced in democratic practice and the effects of personality on occupational stress.

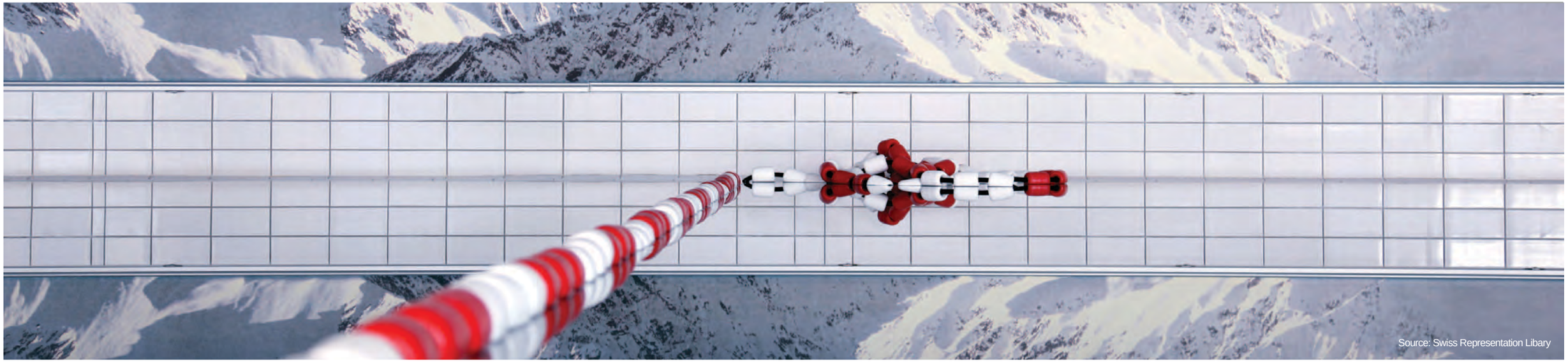
2

SWITZERLAND

Switzerland is home to 8 million people of which 22% are foreign residents. The country covers a surface area of 41,000 km. Switzerland shares borders with Italy, France, Germany, Austria and the Principality of Liechtenstein and lies in the heart of Europe. It has four official languages: German (63%), French (20%), Italian (6%) and Romansh (0,5%). Switzerland is a very diverse country at the crossroads of different cultural and linguistic regions in Europe. English is widely spoken in business, higher education and research settings. Switzerland, with its Alps stretching across the country from the west to the east, serves as a popular tourist destination. The country is known for a high quality of life, with Zurich and Geneva being ranked second and third in the 2010 Mercer's Quality of Living Survey, followed by Bern, the capital, in ninth place.

The Swiss economy is modern, highly competitive, specialised and service-oriented. The highly educated population and the ability of the private sector to recognise developments at an early stage have resulted in a very low unemployment rate, which rarely exceeds 4%. One of the key strengths of the Swiss economy is the many small and medium-sized enterprises that provide 75% of the jobs within Switzerland. In addition to the large number of multinationals operating from Switzerland, the pharmaceutical and high-tech industries play a key role in the Swiss economy. The Swiss economy is highly export-oriented, with one in every two Swiss francs being earned abroad. Switzerland owes the high productivity of its economy to its liberal market system. The country has one of the densest road networks in the world. Research, development and innovation have also made their mark on the Swiss economy, as is evident in the biotechnology and medical sectors.

Contributing to the Swiss economy and highly skilled workforce is the political stability of the country, which is characterised by political balance and decentralised power. The 26 cantons of Switzerland each has its own constitution, parliament, government and court system, with considerable autonomy over matters relating to education, health, public security and the administration of justice. The Federal State, also known as the Confederation, is responsible inter alia for national defence, foreign policy, the national infrastructure, the social insurance system and the currency. Switzerland enjoys close political and economic ties with a great number of countries around the world and is a member of various international organisations. Relations between Switzerland and the European Union (EU) are founded on bilateral sectoral agreements. Switzerland is taking part in the EU education and research programme as a non-member state, supported by bilateral agreements to enhance cooperation with the EU and EU countries.


Source: Swiss Representation Libary

2.1 THE SWISS EDUCATION SYSTEM

The Swiss education system can be divided roughly into four levels: primary, secondary, tertiary and quaternary. (see Figure 1)

- **Compulsory education (primary level and secondary level I):** The system varies from canton to canton, with primary education constituting from four to six years of the nine-year compulsory education period. The admission age throughout Switzerland is six. Pre-school children attend kindergartens for one to two years. After four to six years of primary tuition, pupils complete their compulsory education at secondary level I.
- **Secondary level II** constitutes the first phase of non-compulsory education. There are four types of education open to students:
  - *An apprenticeship* with on-the-job training and theoretical courses at a vocational school. There are more than 300 recognised trades open to school leavers. Another, less usual, method of learning a trade is full-time education at a vocational school. On completing this type of vocational education and training, graduates receive a diploma called the Advanced Federal Certificate.
  - Either during or after their apprenticeship, students can attend further courses to qualify for a *professional Baccalaureate*. On the basis of this certificate they can be admitted to universities of applied sciences (UAS) without the necessity of sitting an entry examination, and by taking a supplementary examination it is possible to study at a university.
  - *Matura schools* (cantonal school, grammar school, lycée) give pupils a broad general education in seven basic subjects, a major subject and a minor one. Matura schools are the usual route taken by those who wish to go to university.
  - *Specialised middle schools* teach both general and specific subjects, such as those required for certain professions in health and social work, education, music and the arts. In addition, students can earn a professional graduating certificate after taking additional practical training or courses.
- **Tertiary level:** At the Tertiary A level there are two types of Higher Education Institutes (HEIs) with differing educational thrusts: firstly the traditional universities, including the cantonal universities and the federal institutes of technology, where instruction is centred on basic research. Secondly there are the UAS, whose teaching is based on applied research. In addition, there are many options in the field of higher vocational education and training (Tertiary B level) with practically oriented certificate and diploma examinations and courses at colleges of higher vocational education and training.

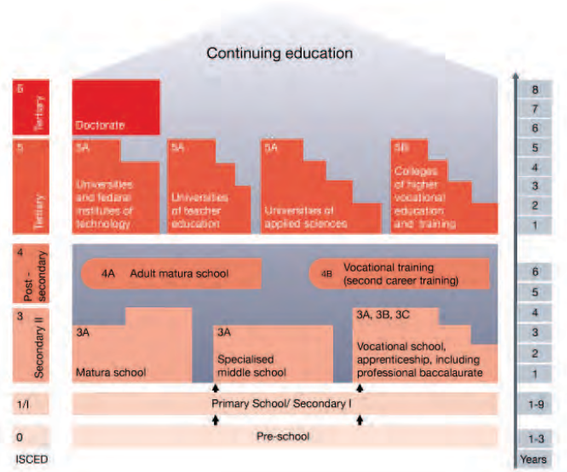
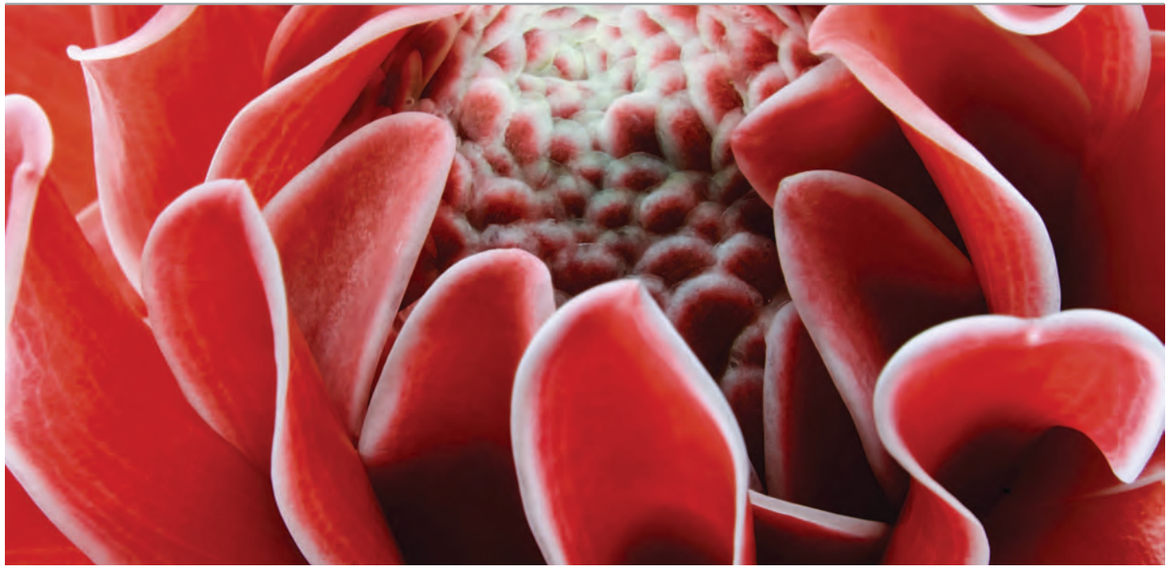


Figure 1: Swiss Education System (SER, 2011).



2.2 TRADITIONAL UNIVERSITIES

The term “traditional university” or simply “university” refers to those HEIs that are highly academic and offer research incentives, which comprise the ten cantonal universities and two federal institutes of technology (ETH in Zurich and EPF in Lausanne). At least 21% of the approximately 130,000 university students are foreign nationals and the higher the level of studies, the greater the proportion of non-Swiss students. The main fields of courses taught at these universities are science, architecture and engineering, and some cantonal universities offer courses in medicine. Engineering is only taught at the two federal universities. The common thread in all Swiss universities is that of a highly active research agenda.

2.3 UNIVERSITIES OF APPLIED SCIENCES

Switzerland has seven regional public UAS offering degree courses developed from tertiary-level B institutions (PET colleges) preparing students for activities that they will perform in the workplace. These universities together offer at least 300 degree programmes with the focus on applied R&D, mainly to serve the needs of the economy. Of the approximate 70,000 students at the UAS, 17% are foreign nationals.

2.4 HIGHER EDUCATION INSTITUTIONS QUALIFICATION SYSTEM

Switzerland and 50 other countries are involved in the Bologna Process, which is intended to create a single higher education area in Europe. As part of this process, the participating countries are introducing the “Anglo-Saxon” model of higher education studies, which consists of a *Bachelor’s degree* (generally three years of full-time study), a *Master’s degree* (a further one and a half to two years of full-time study) and a *doctorate* (which involves writing a thesis to obtain a PhD). At the same time, participating countries are also developing the European Credit Transfer System, which enables students to gain credit for comparable study undertaken in another member state.

2.5 SWISS AGENCIES RESPONSIBLE FOR HIGHER EDUCATION AND RESEARCH POLICY

The **State Secretariat for Education and Research (SER)** is the federal agency responsible for policy relating to education, universities, research, bilateral and multilateral research cooperation and space affairs. Maintaining high-quality university teaching and research is imperative, ensuring that Switzerland is seen as a preferred destination for education, research and facilitating Swiss participation in European and international networks.

The **Federal Office for Professional Education and Technology (OPET)** is the federal agency responsible for upper secondary-level vocational education and training, tertiary-level professional education and training, and UAS and innovation. OPET helps to ensure that Switzerland's VET and PET sectors produce qualified workers and that the country remains an appealing and innovative location for both economic activities and education.

In the context of continuing governmental reform, the SER and the OPET are merging into a new State Secretariat, which will be integrated into the Federal Department of Economic Affairs, the name of which will be changed to Federal Department of Economic Affairs, Education and Research.

The **Swiss University Conference (SUC)** is a joint body that enables the cantons and the Confederation to coordinate higher education policy. The SUC issues binding directives regarding the nominal duration of courses of study, recognition of prior studies and higher education qualifications. The SUC also provides funding for specific projects involving several higher education partners. It also recognises institutions and degree programmes and issues guidelines for the assessment of teaching and research.

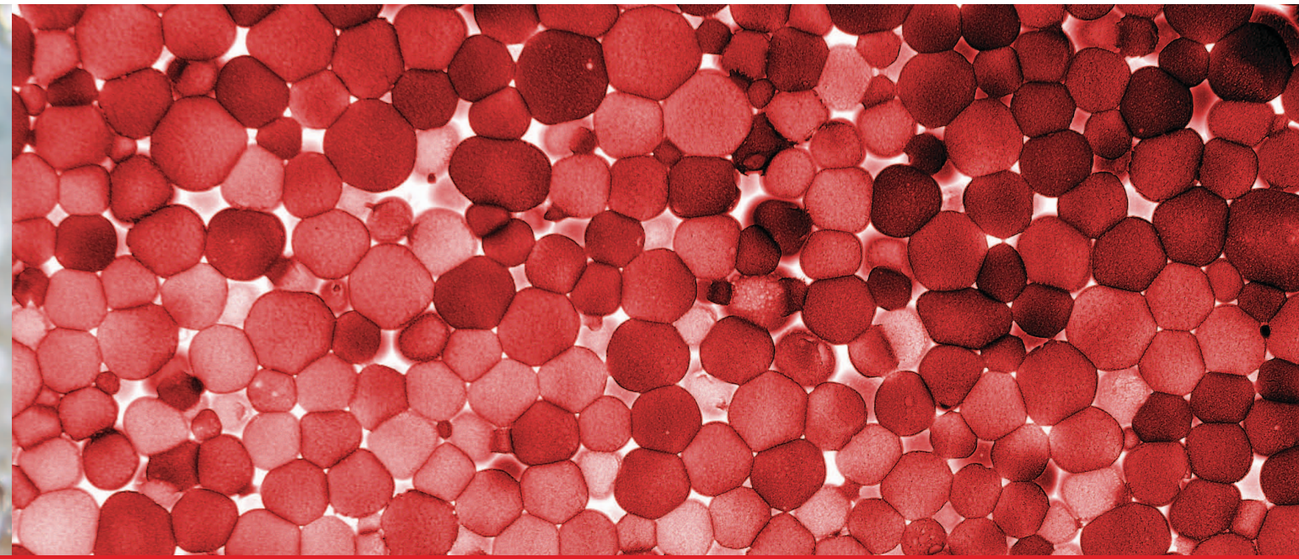
The **Swiss Conference of Cantonal Ministers of Education (EDK)** enables the cantons, which are responsible for education policy matters, to find national solutions to important issues. For example, the EDK could assist in national agreement on key education indicators (structures, objectives), on exchange programmes or on the recognition of qualifications. The EDK also ensures that inter-cantonal agreements on students studying across cantons of residence are concluded.

The **Rectors' Conference of Swiss Universities (CRUS)** represents the shared concerns and interests of all Swiss universities in their dealings with political authorities, companies, social and cultural institutions and the general public. While preserving the autonomy of each individual institution, CRUS promotes inter-university cooperation in teaching, research and the provision of services, thereby ensuring harmonisation across the universities.

The **Rectors' Conference of Swiss Universities of Applied Sciences (KFH)** involves the rectors of the eight UAS that are acknowledged by the Swiss Confederation. The Conference was established in 1999 in order to represent the interests of the UAS when dealing with the Confederation, the cantons and other institutions in charge of education and research policy, as well as the public in general. It works in partnership with the Council of the UAS of the Swiss Conference of Cantonal Ministers of Education and maintains close contact with the Federal Office for Professional Education and Technology, which manages and co-finances the UAS at national level.

The **Swiss Conference of Rectors of Universities of Teacher Education (COHEP)** is a specialised body within the Conference of Cantonal Ministers of Education. COHEP advises them on all issues pertaining to teacher training. In addition, COHEP coordinates and supports the professional development of teachers in areas such as teaching theory, research, continuing education and training, and services.

The **Swiss Academies of Arts and Sciences** is an umbrella organisation for the following institutions: the Swiss Academy of Sciences, the Swiss Academy of Humanities and Social Sciences, the Swiss Academy of Medical Sciences and the Swiss Academy of Engineering Sciences. The purpose of the umbrella organisation is to coordinate the competencies and resources of the various academies.



2.6 SWISS RESEARCH, DEVELOPMENT AND INNOVATION

An important driver for the R&D success of Switzerland is the close link between the universities and the private sector. This cooperation enables the transfer of knowledge from the research laboratory to the market and is therefore an important link in the innovation chain.

The traditional distribution of private and public sector roles has meant that basic research has mainly been the preserve of universities. Applied research, as well as the development of research findings into marketable products and services (R&D), has mainly been driven by the private sector. In Switzerland, 75% of all R&D expenditure is funded by the private sector. The major share of public funding for basic research is channelled to Swiss cantonal universities and the two federal institutes of technology (ETH Zurich and EPF Lausanne), as well as to four specialised research institutes within the ETH domain: the Paul Scherrer Institute (research centre for natural sciences and engineering), the Swiss Federal Laboratories for Materials Science and Technology, the Swiss Federal Institute for Forest, Snow and Landscape Research, and the Swiss Federal Institute of Aquatic Science and Technology (which focuses on concepts and technologies designed to ensure sustainable water resources and the treatment of wastewater).

The **Swiss National Science Foundation (SNSF)** is the most important public grant funding institution for basic research. The SNSF mainly funds basic research of a general nature and is intended to foster the development of junior researchers and professors, ensuring continuation of skilled researchers. About 8% of the SNSF funding is allocated to national research programmes focusing on finding ways to solve problems of national importance.

The **National Centres of Competence in Research (NCCR)** is a Swiss success story, with Centres that institutionally support research initiatives with a nationwide scope. Each NCCR consists of a competence centre and a network of national and international partners from the university or non-university sectors. Established in 2000, the NCCRs have assisted in the development of 27 research focuses to date, straddling many disciplines, as well as a centre that focuses on north-south collaboration. Funding is only provided to the highest quality research projects that place special emphasis on interdisciplinary approaches and/or new and innovative issues within a given discipline. NCCRs also play an active role in promoting the development of women and the next generation of researchers and in facilitating knowledge transfer.

The **Commission for Technology and Innovation (CTI)** is the federal agency responsible for promoting innovation. Its motto is “science to market”. The primary aim of its work is to ensure that innovative knowledge developed in the laboratory is transformed more rapidly into marketable products and services. To this end, CTI supports joint R&D projects where higher education and business partners work together. In order to boost the research activities at UAS, CTI created what are known as “national competence networks”. Through the “CTI Start-up” programme, CTI helps start-up companies get off the ground. In order to encourage more effective entrepreneurial mindsets and company formation, CTI also offers a training course in entrepreneurship.

2.7 INTERNATIONAL RESEARCH COOPERATION

International research cooperation, receiving 20% of all federal funding for the promotion of education, research and innovation, demonstrates the high value Switzerland places on establishing ties with global knowledge networks. The Confederation not only provides a financial injection for international collaboration, but also aims to create the best possible conditions for the internationalisation of university activities. Switzerland's international strategy for education, research and innovation (ERI) aims at, among others, continuing the development of an internationally competitive ERI system. The goal is to establish the country over the long term as a highly competitive, globally preferred location for science and innovation, which is able to attract the best students, researchers and specialist staff from around the world.

European programmes and organisations. Switzerland views collaboration in the EU FPs for research and technological development as an important instrument for international research collaboration. Swiss researchers from universities and private industry have been involved in the FPs since 1987. Since then, the number of participants has constantly increased: the initial number of 500 Swiss researchers who took part in FP3 (1990-1994) swelled to 1,900 Swiss researchers taking part in FP6. These FPs, which are the world's largest international research programmes, are the most important instrument used by the EU to promote science, research and innovation in Europe. In 2011, a new bilateral agreement between Switzerland and the EU on Swiss participation in two EU education programmes, "Lifelong Learning" and "Youth in Action", came into effect.

Switzerland has broadened the scope of its foreign science policy beyond its traditional Eurocentric focus. It is now actively working to develop **bilateral research cooperation ties with countries outside Europe.** In 2007, Switzerland named China, India, Russia, South Africa, Japan, South Korea, Brazil and Chile as priority countries for research cooperation with Swiss universities. Bilateral research cooperation programmes have been launched to achieve the highest possible scientific quality and develop sustainable partnerships. Bilateral research cooperation programmes are coordinated by a designated university in each partner country.

Swiss science attachés and Swissnex offices. Swiss science and technology counsellors abroad are either employees of the SER or career diplomats from the Federal Department of Foreign Affairs. The Confederation sent its first "science attaché" to Washington D.C. in 1958. Switzerland now (2012) has a network of 23 science and technology counsellors working in 19 different countries (see Figure 2). Swissnex offices are an important means of implementing the Confederation's policy of developing bilateral cooperation ties with selected partner countries in the areas of education, research and innovation. The main objective of each Swissnex office is to help Swiss universities and research institutions develop their international activities.

Figure 2: Swiss international science and technology councellors. (SER, 2011)

3

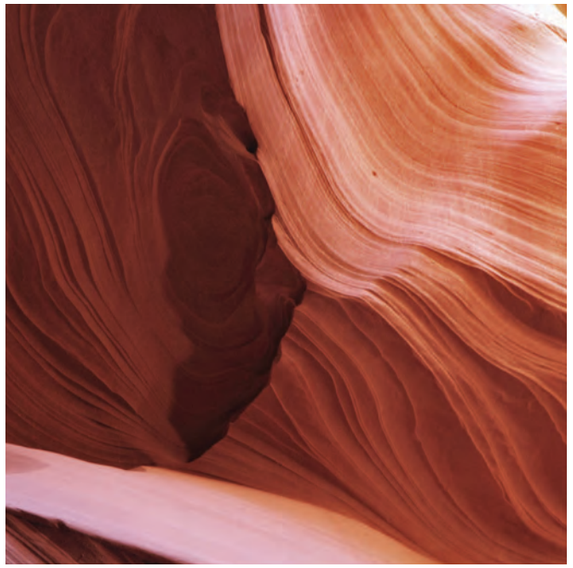
SOUTH AFRICA

South Africa boasts a diverse population of just over 50 million, with a variety of cultures, languages and religions. The African population, constituting 79.5% of the total population, is in the majority, with white and coloured people each presenting 9% of the total population, followed by the Indian/ Asian population at 2.5%.

The new democratic constitution recognises 11 official languages with equal status, with isiZulu as the most common home language spoken by nearly a quarter of the population, followed by isiXhosa, Afrikaans, Sepedi, English, Setswana and Sesotho. The remaining languages (SiSwati, Tshivenda, Xitsonga and isiNdebele) are each spoken by less than 5% of the population. English, as in Switzerland, is mainly used as the language for business, commercial transactions and conversions in international relations and cooperation.

South Africa shares borders with Namibia, Zimbabwe, Mozambique and Botswana, as well as with Swaziland and Lesotho, which are landlocked within Southern Africa. The country is divided into nine provinces, with each province presenting a unique biodiversity. The rich biodiversity of South Africa ranks third in the world and the country is home to 10% of the world's plants and 7% of its reptiles, birds and mammals. Similarly unique is that South Africa is one of only six countries globally with an entire plant kingdom and has eight major terrestrial biomes within its borders. The marine life is as diverse, mostly because of the contrast between the water masses on the east and west coasts. These water masses make the region one of the most oceanographically heterogeneous in the world. At least 12% of the coastal species known worldwide are found only in South African waters.

South Africa is recognised for its robust regulation of it's financial and macroeconomic policy framework, which provides a certain level of protection against the knock-on effects of the global financial crises by which the country was nevertheless affected to a certain extent. Inequality (one of the highest GINI coefficients in the world) and unemployment, at 24%, remain challenges and a number of measures are being enacted to stimulate the economy and job creation. Notable was the elaboration of the "New Growth Path" in 2010 to promote economic policy development across various sectors and administrations, and strategising on 5 million new jobs by 2020.



3.1 THE SOUTH AFRICAN EDUCATION SYSTEM

The South African education system comprises the Department of Basic Education, responsible for the schooling system from Grades R to 12, and the Department of Higher Education and Training (DHET), responsible for post-school education, training and adult literacy programmes.

The National Qualifications Framework recognises the following educational bands:

> Foundation Phase: Grades R - 3.

> General Education and Training, which is compulsory:

- Intermediate Phase: Grades 4 – 6.
- Senior Phase: Grades 7 – 9.

> Further Education and Training (FET):

- Students have a choice in the FET band to obtain one of the following:
  - A senior certificate after passing Grade 12.
  - A vocational qualification at one of 50 FET colleges.
  - An academic qualification after obtaining the senior certificate at one of the HEIs.
  - An academic qualification from one of the universities of technology after the completion of a training course at one of the FET colleges.

The FET band allows for a professional, general or vocational career pathway enabling the Higher Education Qualifications Framework (HEQF), see Figure 3, to generate standards that could articulate the purpose and characteristics of the higher education programmes (CHE, 2011). The DHET has embarked on a process to strengthen vocational training through the FET system, mainly to address the challenge of appropriate skills development for the business and industrial sectors (Kachieng'a, 2009).

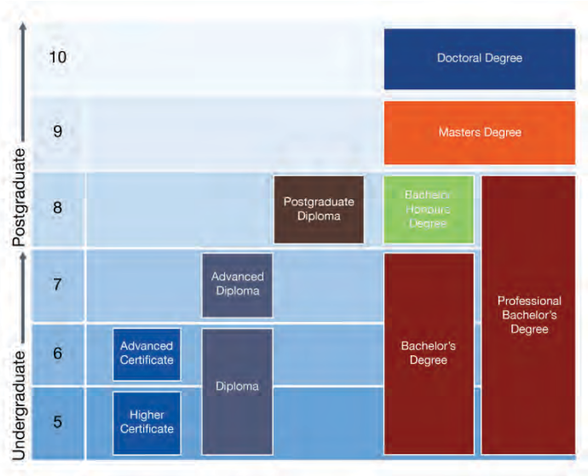


Figure 3: Higher Education Qualification Framework as provided for through the FET. (CHE, 2011)

The university education sector comprises 23 universities (see Figure 4), of which 13 are traditional universities offering theory-oriented programmes and four are comprehensive universities offering a combination of theory and career-oriented programmes. The remaining six institutions are universities of technology providing career-oriented programmes. The South African system also makes provision for specialised training in the form of public nursing and agricultural colleges managed by the respective government departments of health and agriculture.

Figure 4: Location of South African Universities. (HESA, 2012)

3.2 TRADITIONAL UNIVERSITIES

Currently, the South African university education sector has 13 universities referred to as so-called “traditional universities”. These traditional universities are academic- and research-oriented. The university education sector further consists of four comprehensive universities focusing on both academic and technology qualifications. Two National Institutes for Higher Education were established in Mpumalanga and the Northern Cape. The total number of students enrolled at the universities is approximately 650,000, with a student population per university ranging from as few as just over 7,000, at Rhodes University, to as high as 56,000 at the University of Pretoria, but with an average of between 15,000 and 20,000 (IEASA, 2011) The University of South Africa (Unisa) has a student count of nearly 300,000 and is the largest university on the continent, serving an international student population from approximately 130 countries through distance education. South Africa witnessed the production of graduates increasing from 74,000 in 1994 to more than 127,000 in 2007. The focus is being placed on producing graduates that could stimulate the economy, especially in the fields of science, engineering and technology, which now enrol more than a quarter of all students. South Africa produces on average 1,200 PhD graduates per year, of which up to 29% are non-South Africans, mostly from the rest of the African continent.

3.3 UNIVERSITIES OF TECHNOLOGY

South Africa has six universities of technology (UoTs) with a student enrolment figure of just over 140,000 students (IEASA, 2011). The UoTs were established in 2004, and today these universities are an established part of the South African higher education platform. The UoTs provide career-oriented qualifications supported by applied research and links with industry. The main thrusts of the UoTs are to ensure excellence in teaching and learning, applied research, the development of leadership in technology, technology transfer and innovation, partnerships with industry and internationalisation for benchmarking good practice (Kagisano, 2010).

3.4 HIGHER EDUCATION INSTITUTIONS QUALIFICATIONS SYSTEM

The South African model of higher education studies consists of a Bachelor’s degree (three years of full-time study), followed by an Honours (one year); a Master’s (one year full-time) and a doctorate being awarded after a minimum of two years of study and an original research thesis. UoTs offer a range of qualifications from one-year certificates and diplomas, advanced diplomas, Bachelor of Technology (BTech) degrees and postgraduate qualifications up to doctoral level. A BTech degree takes four years although exit qualifications are provided at certificate and diploma level. Comprehensive universities offer both the qualifications system presented at the traditional universities and the universities of technology (IEASA, 2011).

3.5 SOUTH AFRICAN AGENCIES RESPONSIBLE FOR HIGHER EDUCATION AND RESEARCH POLICY

The **Department of Science and Technology (DST)** is the national institution responsible for policy development relating to R&D and innovation, including bilateral and multilateral research cooperation. Operationally the DST strives to introduce measures that put science and technology to work to make an impact on growth and development in a sustainable manner in areas that matter to all the people of South Africa (DST, 2011).

The **DHET** is the custodian of the HEIs and provides policy direction and support for new and applied research. The DHET aims to provide the quality skills required to drive economic growth and social development, as well as to serve a growing number of learners, both youths and adults, through quality learning at institutions of higher education. The DHET, mandated to coordinate outcome 5 of the national government's 12 performance outcomes, articulated the increase of research, development and innovation and the deepening of industry and university partnerships, as well as increased investment into R&D and innovation, as pertinent actions to achieve these national objectives (DHE, 2011).

The **Department of Trade and Industry (DTI)** plays a pivotal role in providing instruments to take science to market. The DTI has put into place a number of funding and supporting instruments to assist innovation at the end of research to market, or to provide a technology and innovation incubator facilities. For example, the Small Enterprise Development Agency (SEDA) provides incubation support to take technology to markets, the Technology and Human Resources for Industry Programme (THRIP) supports increased collaboration between academia and industry, the Support Programme for Industrial Innovation (SPII) and the Industrial Development Corporation (IDC) provide incentives and funding to stimulate research, innovation and commercialisation (DTI, 2012).

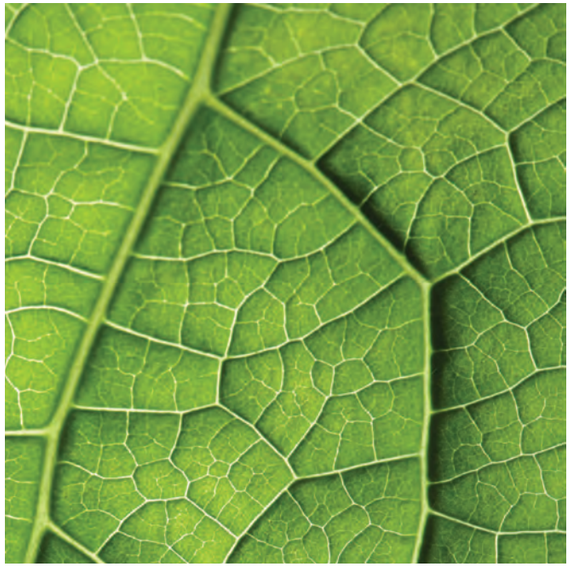
Higher Education South Africa (HESA) is the voice of South Africa's university leadership, representing the 23 vice-chancellors of the institutes of higher education. The mandate of HESA is to develop informed public policy on higher education and to encourage cooperation among universities, industry and government. In addition, HESA provides support services in the areas of strategic research and stakeholder engagement and facilitates collaborative efforts and networks and value-adding services such as scholarships and international programmes (HESA, 2011).

The **Council on Higher Education (CHE)** is, according to the Higher Education Act of 1997, and the Higher Education Amendment Act of 2008, responsible for the quality assurance for higher education and for the implementation of the HEQF. The HEQF, in turn, assigns to the CHE the responsibility for the development of higher education qualifications standards. The CHE also advises the Minister of Higher Education on a number of issues, including university research.

The **National Advisory Council on Innovation (NACI)** plays a unique role as an advisory body to the South African government, but more specifically to the Ministry of Science and Technology. The main function of NACI is the conduct of policy studies, provision of advice to the Minister, increased stakeholder consultation and the dissemination of reports and recommendations.

The **Academy of Science of South Africa (ASSAf)** was inaugurated in May 1996 by the former President of South Africa and patron of the Academy, Nelson Mandela. The mandate of the Academy encompasses all fields of scientific enquiry established under the Academy of Science of South Africa Act of 2001. ASSAf, as the official national Academy of Science of South Africa, represents the country in the international community of science academies. A key performance area of ASSAf is the development of evidence-based study project activities, mainly as a tool to review and inform national policies with the focus on science and technology (ASSAf, 2011).

3.6 SOUTH AFRICAN RESEARCH, DEVELOPMENT AND INNOVATION



The **National System of Innovation (NSI)**, prior to 1994, was mainly centred on technological self-sufficiency to curb international isolation in the energy, food and defence sectors. A major policy shift in science and technology took place with the establishment of the democratic dispensation in the mid-1990s with the promulgation of the White Paper on Science and Technology. This paper called for racial redress and inclusion; new funding mechanisms; monitoring and evaluation models for research; policy formulation, and human resource development.

To date the NSI has achieved an increase in gross expenditure on research and development (GERD) relative to the gross domestic product (GDP), the introduction of human transformation reflective of national demographics, policy frameworks that have prioritised national socio-economic objectives, improved monitoring and evaluation of the national scientific stock and innovation as a research outcome (Marais, 2010).

A key milestone of the NSI was the establishment of a separate Department of Science and Technology in 2002, followed by the National Research and Development Strategy (NRDS) in 2003.

The NRDS prioritised S&T for poverty alleviation, advanced manufacturing, technologies for resource-based industries, ICT and nanotechnology. The Ten-Year Innovation Plan (TYIP) of 2008 emphasises the knowledge economy, global concerns/challenges, the reiteration of human-centred research, development and innovation. The focus areas for the TYIP, referred to as the Grand Challenges, encompass the bio-economy, space sciences, energy security, global change, and human and social dynamics for development.

The NRDS and the TYIP together constituted 44.3% of the total DST budget during the period from 2008 to 2011, signalling the importance of these two policy instruments. HCD as a common element in both policy documents receives a substantial DST budget allocation of over 30% of the total DST budget. The implementation of pilot projects to demonstrate poverty alleviation and the development of human resources for inclusion in scientific and engineering careers remain objectives of the DST (Mjwara, 2011). The OECD (2007) reported that the South African science and innovation profile showed distinct strength, with a 4% increase in high-technology trade from 1997 to 2007.

Statutory science councils. South Africa has eight statutory science councils, through which the government commissions research on social, scientific and technological development in almost all areas, excluding basic sciences. The centres are thematically based in the areas of agriculture, geosciences, the humanities and social sciences, public health and biomedicine, and mineral research. Exceptions are the Council for Scientific and Industrial Research that conducts research in almost all disciplines; the National Research Foundation (NRF) that functions as the implementing agency for the DST, promoting a high quality of HCD, and managing national research facilities; and the South African Bureau of Standards, responsible for standards (Kruss, 2008).

National research facilities. National research facilities under the mandate of the NRF can be broadly categorised into space, environmental and medical nuclear science. These facilities provide infrastructure for national and international communities to use the natural resources of the country for the beneficiation of research, development and innovation. The country has excelled in exploiting its geographic location for the exploration of space science and astronomy. The developments in these areas led to the launch of the SumbandilaSAT and the ongoing bid for the hosting of the Square Kilometre Array (SKA), respectively.

Centres of Excellence (CoEs). The NRDS identified the need for CoEs to promote knowledge, human and resource capital, collaboration and networking and to develop interdisciplinary research and a creative, internationally competitive research training environment. Eight centres have been established, covering communicable diseases, energy, new materials, biotechnology and biodiversity.

Infrastructure. Investment in research infrastructure remains a priority for the DST, as reiterated by Minister Pandor in her 2011 budget speech (Pandor, 2011). Flagship infrastructure programmes include the Centre for High Performance Computing, the South African National Research Networks, the infrastructure to bid for the SKA and the Southern African Large Telescope, and the nanotechnology equipment programme. A recent initiative is the EU-SA project to develop a South African research infrastructure roadmap aligned with the DST priorities for R&D and innovation. The roadmap will aim to address national priorities with a view to provide international research facilities.

Human capital development. In support of the EU-SA Joint Country Strategy Paper, there has been recognition that South Africa, as a middle income country, is not dependent on official development assistance, but is challenged with a desperate need for capacity building and specialised international expertise in certain areas, which include S&T.

The DST has developed instruments to address the skills shortage, which include the implementation of a PhD support programme and the South African Research Chairs Initiative (SARChI). The DST aims to establish 154 research chairs by 2014 at a total investment of R428 million per year (Prinsloo, 2011). The initiative aims to expand the scientific research base, increase the number of world-class researchers, attract and retain excellence and create research pathways. A plausible instrument for HCD is the Research and Innovation Support instrument managed by the NRF.

The **Technology Innovation Agency**, established in 2008, brought about a number of policies and instruments to stimulate innovation further, e.g. the Intellectual Property Rights from Publicly Financed Research and Development Act of 2008, the establishment of the National Intellectual Property Management Office, initiation of Centres of Competence (CoCs), and support for sector competitiveness through R&D and provincial/regional innovation systems (Mjwara, 2011).

Additional funding instruments to stimulate S2M is the THRIP, which supports increased collaboration between academia and industry, the SPII and funding from the SEDA and the IDC, which provides incentives and funding to stimulate research, innovation and commercialisation.

The first innovation survey in South Africa demonstrates that 54.8% of industrial enterprises were innovative, compared with 49.3% of service enterprises. These figures compare favourably with those from EU countries, as reported in the CIS for EU-27 countries (Blankley, 2009). The country has become skilled in setting up public-private partnerships (PPPs) in order to leverage the advantages of both sectors through the principles of shared value.

However, private-sector spending on R&D is standing at 58.6% and the medium term aim of the DST is to establish and enhance partnership with the private sector to increase GERD (Mjwara, 2011). The belief is that increasing private-sector spending will assist in the transition from a resource-based to a knowledge-intensive economy. A catalyst for increasing private-sector spending was the introduction of a tax credit system for R&D expenditure, but the impact of this concession is still to be assessed (Walwyn, 2008).

Centres of Competence (CoCs). CoCs were introduced by the DST in 2010 in support of the TYIP. The CoCs aim to establish collaborative partnership for technology development involving government, industry, higher education institutions and research institutions (Ratsatsi, 2010). CoCs being established for the localisation of technology are those for fluoro-chemicals and the platinum group of metals (PGM). The PGM CoC hydrogen initiative will aim to capture 25% of the global catalyst demand by 2020 and develop the intelligent nanoparticle (precious metal based) system (Mjwara, 2011).

3.7 INTERNATIONAL RESEARCH COLLABORATION

Evident of the high value and commitment attributed to international collaboration is the conclusion of a number of S&T agreements globally, among others with countries on the African continent. The DST (2011) noted that “Developing economies provide a wealth of opportunities for global R&D”. South Africa is no exception, with internationally comparable research capacity in the health sector, natural environment and ICT.

Participation in the European FP furthers international collaboration. South Africa participated in more than 100 projects during the FP7 calls. Most success was achieved in the areas of health, the environment, biotechnology, agriculture and food. Most of the Swiss SA FP7 projects are in the area of health and the knowledge-based bio-economy, with notable collaboration under the environmental theme. Some collaboration is also taking place in the area of ICT, space, security, science in society, energy and nanotechnology.

Confidence in the South African NSI is manifested through the allocation of international research collaboration initiatives such as the hosting of the International Astronomical Union’s Office for Astronomy Development and the International Centre for Genetic Engineering and Biotechnology (DST,

2011). South Africa is currently bidding with Australia to host the SKA, further demonstrating its geographical advantage as a research destination. In preparation for the SKA, the MeerKAT array in the South Africa’s Karoo region is being established, this is a world-class radio telescope providing an excellent opportunity for bilateral collaboration in large research facilities.

Regional collaboration with Africa carries the highest priority nationally and for the DST. Numerous measures have been implemented by the DST to enhance the African S&T agenda. Commitment to S&T is evident through the African Union’s Consolidated Plan of Action on Science and Technology as the highest level African multilateral agreement.

4

PROJECTS

NANO-VESICLE AND MICRO-SPONGE PHEROID™ DRUG DELIVERY SYSTEM FOR ANTIMALARIAL DRUGS WITH PROBABLE REVERSAL OF DRUG RESISTANCE FOR CHLOROQUINE

Swiss partner: Prof. Dr Reto Brun
Swiss Tropical and Public Health Institute

South African partner: Prof. Dr Anne Grobler
North-West University

Project overview

A child dies every 30 seconds from malaria in Africa. The worldwide prevalence is estimated to be in the order of 250 million clinical cases annually, of which 1.0 million die. A total of 40% of the global population are inhabitants of the more than 90 countries in which malaria is considered a public health problem. Sub-Saharan Africa harbours over 90% of all noted malaria cases, the primary victims of which are children below the age of 5 years, the elderly and pregnant women. This can mainly be ascribed to the rapidly escalating acquisition of drug resistance by *Plasmodium falciparum* strains, which subsequently renders the administered treatments ineffective. Other contributing factors, in addition to drug resistance acquisition, that promote the global increase in malarial cases are the elevated cost and limited availability of conventional anti-malarial drugs.

This project hinges on the nature of the Pheroid™ technology and the versatile project task force with their particular facilities. Patents for the Pheroid™ have been granted in a number of European and Asian countries, in the USA, Canada and South Africa. Pheroid™ is a stable lipid-based submicron emulsion delivery system. It is unique in that its morphology, structure, size and function can be manipulated as required. The non-toxic nature of this delivery system is attributed to its constituent natural and/or essential fatty acid compounds that have been formulated with various drugs for novel and innovative dosage forms.

The main aim of the project is to develop Pheroid™-entrapped antimalarial drugs and investigate the potential increases in efficacy and uptake or absorption of these antimalarial drugs in Pheroid™-drug micro-sponge and nano-vesicle carrier combinations. The North-West University (NWU) successfully characterised the chemical and physical nature of the formulations and entrapment of antimalarials in Pheroid™ micro-sponges and nano-vesicles. Both the NWU and the Swiss Tropical and Public Health Institute (Swiss TPH) performed *in vitro* and *in vivo* studies of the efficacy of the entrapped anti-malarials on resistant malaria parasites. The entrapment of the antimalarials amodiaquine (AQ) and artemisone in Pheroid™ vesicles resulted in enhanced uptake in mice. No toxicity or discomfort was exhibited by any of the animals in these studies.

Mouse and primate models are used in the pharmacokinetics studies of Pheroid™-entrapped and free chloroquine (CQ), AQ and artemisone anti-malarials. Dosing regimens of varying amounts and durations are used in the oral anti-malarial administration. AQ uptake or absorption is improved after Pheroid™ vesicle entrapment when compared to pro-Pheroid™ entrapment. In the artemisone investigations, intravenous administration was used to indicate the maximum possible uptake or so-called absolute uptake and all formulations were graded against that. The Pheroid™-entrapped complexes exhibit a greater uptake and longer therapeutic window. Entrapment of artemisone into Pheroid™ vesicles resulted in doubling of the half-life (Steyn *et al.*, 2011).

To date five Pheroid™ antimalarial vesicle and micro-sponge complexes have been manufactured with upscaling to pilot batch size. Development and validation of Pheroid™ size and morphology measurement methods were undertaken and entrapped drug verification is now feasible. Accelerated stability studies were performed for two of the antimalarial drugs entrapped in Pheroid™. The uptake and pharmacokinetics of the Pheroid™-based malarial formulations are currently being determined in non-human primates. Successful formulations may enter clinical trials with human subjects in a subsequent phase. The formulations and the study are executed according to good laboratory practice and good clinical practice guidelines.

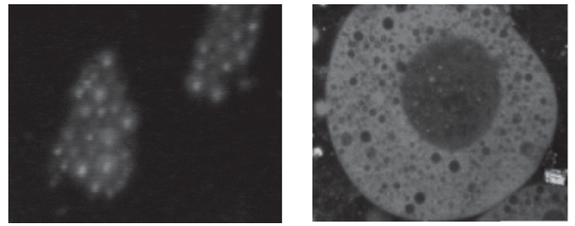
National outcome

The project enabled the scientific exchange of scientists and technical personnel of the Swiss TPH and their counterparts at the NWU in Potchefstroom and other institutions in South Africa. The Swiss TPH and its international networks can be used by our counterparts to gain access to organisations and institutions such as the World Health Organisation (WHO), the Medicines for Malaria Venture, the Drugs for Neglected Diseases initiative and others. The project enabled the creation of new jobs and contributed to capacity building. It provided training for one postgraduate student and for technical personnel. The cost-effective African-focussed new formulations studied during the course of the project may help to improve the health and well-being of malaria-affected countries.

Global outcome

Since 1980 no new active pharmaceutical ingredient (API) has been launched against malaria. In addition to the factors mentioned above, the spread of CQ and sulphadoxine-pyrimethamine parasite resistance prompted the WHO to recommend artemisinin-based combination therapies as a first line of therapy for uncomplicated *Plasmodium falciparum* malarial infection.

The completion of this project may increase the efficacy of global malarial treatment and prophylaxis, resulting in lower mortality rates. The re-use of cheaper raw materials such as CQ, which is off patent, as API in the low start-up and manufacturing cost required in the Pheroid™ manufacturing process will significantly reduce the dreaded costs for pharmaceutical companies. Latent disease and multi-drug-resistant malaria parasites should greatly decrease and the opposite is true for the therapeutic window of the drugs, which will result in the decrease of dosage administration frequency. Pro-Pheroid™ formulations will increase the stability of previously unstable APIs. Novel adult and paediatric dosages will be formulated and the Pheroid™-based concept may be applied to the treatment of other parasitic diseases. New IP and product development may also emerge.



Visual representation of the nano-vesicles and micro-sponges as captured by confocal laser scanning microscopy. In the micrograph on the left, the nano-vesicles are clustered in reaction to a lowering of the pH in the formulation by entrapment of an acidic drug.

Development of anti-malarial formulations with high efficacy and increased therapeutic window against drug-resistant malaria parasites

Publications to date

Steyn J.D., Wiesner L., Du Plessis L.H., Grobler A.F., Smith P.J., Chan W., Haynes R.K. and Kotzé A.F. (2011) Absorption of the novel artemisinin derivatives artemisone and artemiside: Potential application of Pheroid™ technology. *International Journal of Pharmaceutics*, vol. 414, p 260-266.

Student and faculty exchange

From project grant: Three students and 13 faculty visits have been exchanged.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	3	5	2
Other	3	3	0
Qualifications	5	8	2

From left to right, front: Prof. Reto Brun (Swiss TPH), Prof. Anne Grobler (NWU) and Dr Lissinda du Plessis (NWU); **Middle:** Prof. Braam Swanepoel (University of Pretoria), Dr Bethuel Nthangeni (TIA), Prof. Wilna Liebenberg (NWU) and Dr Chris Parkinson (CSIR); **Back:** Dr Sergio Wittlin (Swiss TPH), Prof. Awie Kotze (NWU).

REGULATING MECHANISMS OF STARCH AND GLYCOGEN METABOLISM IN PLANTS AND BACTERIA

Swiss partner: Prof. Dr Samuel C. Zeeman
ETH Zürich

South African partner: Prof. Jens Kossmann
University of Stellenbosch

Project overview

Most living organisms store carbohydrates to provide an energy source. In humans the principal storage carbohydrate is glycogen, which is generated after meals and used during exercise or fasting. This carbohydrate storage process is essential for the management of blood glucose levels and thus for a healthy lifestyle. Diseases resulting from faulty glycogen storage or blood sugar regulation, such as diabetes, are serious and debilitating.

In plants, starch is the ubiquitous form of carbohydrate storage. It is equivalent to glycogen in animals, though unlike glycogen it is insoluble. The starch granules found in the seeds, roots and tubers of crop plants form the basis of nutrition for humans. Starch extracted from these and other plant types is utilised as an industrial raw material and as feedstock for biofuel production. Increasing the starch content in plants and modifying starch properties are thus important biotechnological goals.

The discovery of novel genes involved in starch metabolism in plants was instigated by the Kossmann and Zeeman laboratories. The genes code for starch phosphorylating and/or dephosphorylating proteins and enable the breakdown of the starch and subsequent utilisation of the glucose products for the plant's own growth. This work revealed a previously unknown link to human genes coding for glycogen dephosphorylating proteins that perform their task during glycogen metabolism.

To decipher the importance of carbohydrate phosphorylation and dephosphorylation, *Arabidopsis thaliana* and *Escherichia coli* - plant and bacterium model organisms that accumulate starch and glycogen, respectively - are being employed. These model organisms were selected because it is possible to conduct complete studies of gene function. Results can then be related to the metabolic machinery possessed by humans and relevant starch crops, which are much more difficult to study. A functional screen for identifying carbohydrate kinases in *E.coli* has been established successfully, along with a method for virus-induced gene silencing in plants. The latter has enabled functional characterisation of tobacco plants lacking carbohydrate dephosphorylating enzymes and other proteins that participate in the same biochemical pathway (namely ISA3, MEX and PWD). This approach complements the work done with gene knockout mutants of Arabidopsis.

During the next phase of the project the role of putative glycogen phosphorylating genes from *E. coli* will be studied, and genes playing the analogous role in humans will be identified. This is an essential process. Defects in the glycogen phosphorylation system in humans result in the debilitating, terminal syndrome 'Lafora disease'. Identification of the genes involved in glycogen phosphorylation and dephosphorylation in different organisms will shed light on the fundamental importance of this metabolic step, helping to explain Lafora disease and other glycogen storage disorders.

Complementary work will pursue a complete understanding of starch phosphorylation in plants. Work from the Kossmann and Zeeman laboratories has set the foundation for this. Its completion will explain the interdependencies between starch phosphorylation and its subsequent metabolism at the molecular level. Such a level of understanding will allow the rational control of starch levels and properties in plants. This is crucial for the implementation of biotechnological improvements in starch crops.

National outcome

The interaction between world class scientists and students facilitated by this joint research project has a significant impact. It broadens the students' understanding of the scientific process and empowers them in critical thinking. Networking events (conferences and workshops) form an important part of the programme, affording the students opportunities for direct contact with foreign academics and seeing how their work is viewed from other perspectives. This will ultimately enrich the research environment of both countries through the production of world-class PhD and Masters students and the promotion of their development. In the longer term, a company or products that could emerge as a result of the data collected during this project could benefit the respective economies by taking research to the market.

Global outcome

Groundbreaking research into the mechanism by which glycogen and starch phosphorylation occurs in bacteria, plants and mammals will strengthen previous discoveries in this exciting new research field. The greatest impact will be on demonstrating the biological importance of phosphate in glycogen metabolism in humans and in successfully controlling starch levels in crops.

Student and faculty exchange

From project grant: One faculty exchange visit.
From other funds: One exchange visit.

Importance of phosphate in glycogen and starch metabolism for potential industrial, crop and medical applications

A mechanistic understanding of the metabolism of glycogen will unlock the potential for biomedicines to treat energy metabolism diseases, the burden of which is increasing worldwide. It could also specifically aid in the development of a gene-therapy based treatment of Lafora disease.

Publications to date

Santelia D. and Zeeman S. (2011) Progress in Arabidopsis starch research and potential biotechnological applications. *Current Opinion in Biotechnology,* vol. 22, p 271-280.

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Hejazi M., Fettke J., Kötting O., Zeeman S.C. and Steup M. (2010) The laforin-like dual-specificity phosphatase SEX4 from *Arabidopsis thaliana* hydrolyses both C6- and C3-phosphate esters introduced by starch-related dikinases and thereby affects phase transition of –glucans. *Plant Physiology*, vol. 152, p 711-722.

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Qualifications for this project

	MSc	PhD	Post-doctoral
SSAJRP	0	1	2
Other Qualifications	2	1	0
	2	2	0

Prof. Jens Kossmann, the South African partner

David Seung, MSc student on the project

Mehafo Nepembe, MSc graduated April 2010

Dr Oliver Köttig, junior group leader in the Swiss laboratory

Ebrahim Samodien, MSc graduated December 2009. Currently PhD student on the project

Prof. Samuel C Zeeman, the Swiss partner

Gavin George, PhD graduated April 2010

Dr Diana Santelia, post-doctoral research fellow on the project

PHTHALOCYANINE-BASED SMART PROBES FOR THE MOLECULAR IMAGING DISEASE-RELATED PROTEOLYTIC ACTIVITY

Swiss partner: Prof. Dr Norbert Lange
University of Geneva

South African partner: Prof. Dr Tebello Nyokong
Rhodes University

Project overview

The inept nature of the human eye in detection of tissue deviations from the normal state poses a particular problem in disease imaging. Initially the manifestation of cancer led to the adoption of detection techniques that were both intrusive and cumbersome. These techniques involved procedures such as biopsies or explorative surgery followed by histopathological analysis. The advent of imaging techniques such as ultrasound, whole body scans, CAT scans (CTs) and magnetic resonance imaging (MRI) often averted these time-consuming and cumbersome techniques, though they lacked the ability to detect internal tumours with diameters measuring less than two millimetres.

The need for detection techniques that combined rapid results, high sensitivity and accurate disease identification emerged. Molecular imaging, which is the biological process of imaging in living organisms at the molecular and/or cellular level, addressed this articulated need. With respect to cancer, its non-invasive nature, coupled with high resolution and sensitivity makes endoscopic fluorescence imaging ideal. This technique uses a combination of genetic information, proteomics and new synthetic strategies in order to form new imaging probes, allowing the development of novel imaging techniques.

The presence of disease-associated proteases can be detected via activation of specific fluorescence probes by the specific protease which is the basis of this project. Novel phthalocyanine-based smart probes, inspired by the previously optimised smart probes, will be developed by the utilisation of unique complementary expertise of both Swiss and South African researchers.

Synthesis and purification of suitable slightly water-soluble mono-substituted phthalocyanine dyes (fluorescent reporter) for the innovative smart probes were developed. These were then coupled to a polymeric carrier and quenched, with optimal quenching resulting from the strong interaction of phthalocyanine dyes when multimerised on a polymeric carrier. *In vitro* and *in vivo* disease-associated proteolytic activity investigations were carried out in order to activate, characterise and optimise the probes. The response parameters at which the smart probe were aimed for the purpose of optical fluorescence imaging were the ability to absorb and emit light in the near infrared region of the light spectrum, produce strong extinction and high fluorescence quantum yield and high versatility with respect to the target protease, while possessing a very high specificity for the target tissue.

National outcome

The Swiss partner was pleased to receive two PhD students in their laboratories during the project, as well as the South African partner, Prof. Nykong, for a commencement meeting. This allowed the foreign students to gain insight into research at the edge between applied and fundamental sciences. The visitors were introduced to new biological as well as analytical methods in the Swiss laboratory. There was also intensive cultural exchange between the visiting students and the students in the laboratories. Although not all South African students working on the project have travelled to Switzerland, they have gained valuable insight into state of the art characterisation techniques and other techniques such as synthesis, photochemistry and photophysics. It was important to see that the South African students have developed considerable expertise in chemical organic synthesis, which will allow the Swiss partner to consider PhD students and post-doctoral fellows from South Africa in the future. The project partners have also been exposed to the aspects of running a multidisciplinary project, as this project delves into the fields of biology, physics and chemistry.

Global outcome

This project has had a huge global impact due to the influence it has had on the accuracy of disease diagnosis in the early stages. Endoscopic fluorescence imaging used in cancer diagnosis owes its global appeal to its combination of high resolution and sensitivity and minimal invasive nature. The above-mentioned characteristics are paramount in ensuring that cancer patients live in as comfortable a manner as possible. Students also acquired expertise in high-level synthesis and imaging techniques.

Publications to date

Nombona N., Antunes E. and Nyokong T. (2010) The synthesis and fluorescence behaviour of phthalocyanines unsymmetrically substituted with naphthol and carboxy groups. *Dyes and Pigments*, vol. 86, no. 1, p 68-73.

Masilela N., Nombona N., Loewenstein T., Nyokong T. and Schlettwein D. (2010) Symmetrically and unsymmetrically substituted carboxy phthalocyanines as sensitizers for nanoporous ZnO films. *Journal of Porphyrins and Phthalocyanines*, vol. 14, no. 11, p 985 992.

Nombona N., Chidawanyika W. and Nyokong T. (2011) Photophysical behaviour of unsymmetrically substituted metal free, Mg and Zn phthalocyanines in the presence of folic acid. *Polyhedron,* vol. 30, p 654-659.

Gabriel D., Zuluaga M.F., van den Bergh H., Gurny R. and Lange N. (2011) It is all about proteases: From drug delivery to *in vivo* imaging and photomedicine. *Current Medicinal Chemistry,* vol. 18, no. 12, p 1785-1805.

Gabriel D., Zuluaga M. F. and Lange N. (2011) On the cutting edge: Protease sensitive prodrugs for the delivery of photoactive compounds. *Photochemical Photobiological Sciences,* vol. 10, no. 5, p 689-703.

Heuck G. and Lange N. Exogenously induced endogenous Photosensitizers. In Nyokong T. and Ahsen V. ed. Photosensitisers in medicine, environment, and security, vol. II, no. 3 (accepted for publication).

Student and faculty exchange

From project grant: One student visit.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	5	3
Other	1	3	1
Qualifications	0	1	0

Development of novel phthalocyanine-based smart probes activated by disease-associated proteases for potential use in early cancer detection

Nolwazi Nombona with the Minister of Science and Technology – the Honourable Minister Pandor, on September 13th, 2010. Prof. T. Nyokong is standing in the centre.

During Prof. Nyokong's visit, the three main investigators involved in the project, Prof. van den Bergh, Prof. Nyokong and Dr Norbert Lange (see photo from right to left) discussed the initial steps of the project.

South African student (Ms Nolwazi Nombona, on the right) in Switzerland.

ORGANISATIONAL CAPABILITIES AND THE GOVERNANCE OF UTILITIES: IMPLICATIONS FOR EFFECTIVE PUBLIC SERVICE PROVISION, LONG-TERM VIABILITY OF INFRASTRUCTURE NETWORKS AND REGULATORY DESIGN

Swiss partners: Prof. Bernhard Truffer, Dr Hagen Worch, Dr Jochen Markard
Swiss Federal Institute of Aquatic Science and Technology (Eawag)

South African Partners: Prof. Anton Eberhard, Mundia Kabinga
Graduate School of Business, University of Cape Town

Project overview

Utility services such as electricity, water supply and sanitation face many challenges. South Africa's electricity supply is inadequate, as emphasised by the numerous blackouts and electricity distribution failures experienced since 2005. A deteriorating electricity distribution system was one of the causative factors identified. The Department of Environmental Affairs and Tourism identified the deteriorating quality and availability of water as one of the main challenges in South Africa. A survey completed by the Department of Water Affairs and Forestry revealed that 30% of all waste water treatment plants require intervention. Existing literature has addressed some of the challenges facing utility services in South Africa. The role of organisational capabilities for managing utilities to ensure their long-term viability has, however, not been explored. Organisational capabilities are a key factor to provide effective and cost-efficient services and supply.

Challenges, such as market liberalisation, organisational restructuring, massive investment needs and the introduction of new technologies, are experienced by utility services. This project aims to develop a deeper understanding of the role of competences and skills in providing adequate utility services and to improve the performance of state-owned enterprises in infrastructure sectors, especially in the water supply, sanitation and electricity sectors. Aspects investigated include:

a) How policy decisions influence competence building in public utilities.
b) How utilities acquire and build adequate competences and skills.
c) How the accumulation of competences affects vertical integration and disintegration in infrastructure sectors.

The research focuses on the implications that competences and skills have for effective public service provision, long-term viability of infrastructure networks and regulatory design. Better understanding of the impact of capabilities on the infrastructure sector may allow for the recommendation of adequate regulatory designs to policymakers. Insights from this project may also help utility managers in infrastructure sectors to develop and implement strategies for building and maintaining sustainable organisational capabilities, and therefore improve the quality of public service delivery.

National outcome

The project intends to provide a set of recommendations to utility managers and policy makers on how to improve the quality of public service delivery. This can facilitate the process of setting up specific interventions for utilities to acquire the skills, technological knowledge and managerial capacities to improve the performance of public services and infrastructure networks. The results of this project will be relevant for the improvement of the performance of public services and for securing infrastructure maintenance.

Global outcome

Sustaining the functionality of infrastructure sectors is essential for poverty reduction, more equality, accelerated economic development and growth and improved social welfare. South Africa will contribute to the sustainability of the region in terms of utility services.

Publications to date

Worch H., Kabinga M., Eberhard E. and Truffer B. (2012) Strategic Renewal and the Change of Capabilities in Utility Firms. European Business Review, accepted for publication.

Worch H., Truffer B., Kabinga M., Markard J. and Eberhard A. (2012) Tackling the capability gap in utility firms: Applying management research to infrastructure sectors". *CID Working Paper Series*, Harvard Kennedy School.

Gebauer H., Worch H. and Truffer B. (2012) Absorptive capacity, learning processes and combinative capabilities as determinants of strategic innovation. *European Management Journal*, vol. 30, no. 1, p 57-73.

Student and faculty exchange

From project grant: eight student and faculty exchange visits.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	1	1
Other	0	0	0
Qualifications	0	0	0

Building and improving water and electricity infrastructure have a high priority in both rural areas (e.g. Khubus and Concordia municipalities, Northern Cape) and urban areas (e.g. Cape Town, Western Cape).

The role that organisational competence and skills play in providing adequate utility services and infrastructure maintenance in state-owned enterprises

Core research team: Mundia Kabinga.

Core research team: Hagen Worch.

PhD candidate, Mundia Kabinga, in front of Eskom Holding Limited's upcoming Medupi Power Station in Lephalale, South Africa.

Prof. A. Eberhard.

MELISSA

MEASURING E-LEARNING IMPACT IN PRIMARY SCHOOLS IN SOUTH AFRICAN DISADVANTAGED AREAS

Swiss partner: Prof. Dr Lorenzo Cantoni
University of Lugano

South African partner: Prof. Wallace Chigona
University of Cape Town

Project overview

Information and communication technology (ICT) has a significant impact on the development of countries. The incorporation and integration of ICTs in education is essential for the enhancement of learning practices and for improving the quality of education. Initially the lack of infrastructure in developing countries prevented the integration of ICTs in the education sector. A number of initiatives in South Africa have however, made the technologies available to schools and also attempted to equip the educators with the ability to use ICTs in the curriculum. Unfortunately ICTs are still underutilised, even where the infrastructure is available. The factors resulting in the lack of efficient integration of ICT in the current curriculum should thus be identified and addressed.

The goal of the MELISSA project was to study the impact of ICT training on primary school teachers in the Western Cape province, and to provide them with further training. The project trained 120 primary school teachers to understand ICTs and how to incorporate them in their curriculum. An experimental as well as a control group was incorporated in the project.

The objective of the project is to assist teachers with their understanding of the use of computers, their ability to use computers in their work and also their control over the impact of computers. Questionnaires and interviews have been used to assess the groups. Teachers were assessed before and after the programme. The results are now being used to design effective, efficient and sustainable ICT training interventions and policy guidelines and also to evaluate activities. A framework for evaluating existing programs could also be provided. This will allow for the optimal allocation of available resources.

National outcome

The MELISSA project has helped schoolteachers to understand and integrate ICT better within their practice, making wise and sustainable use of it. While becoming experts in using ICT, they have reduced the digital divide and have become prepared to introduce and guide their students into the knowledge society. The project design has allowed for a wider impact on practice, and ensures that not only the first cohort of students, but all future classes of trained teachers will benefit from it. In addition, those teachers will act as models, driving innovation in their schools and communities. They will also exert influence in terms of ICT to ensure continuous building of skills and lifelong learning. The project will have an impact on the research communities concerned and help in designing more effective and sustainable intervention in the field, not only in South Africa but also in Switzerland.

The improvement of the integration and utilisation of ICTs in the South African curriculum will contribute to effective and efficient growth of teaching abilities as well as improving the quality of education. The learners will benefit directly from this in terms of their performance and capacity building for the future. The outcome of the project is aimed at assisting in both the effective design of efficient and suitable training interventions and provision of a framework for evaluating existing programmes.

Global outcome

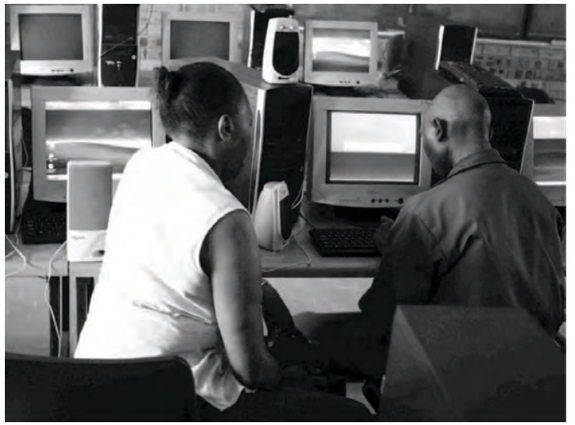
Globally, it has become pertinent to evaluate the perception of technologies in teaching and learning. It is well known that infrastructural challenges hamper ICT adoption. These barriers notwithstanding, the many social meanings and representations that are attached to ICTs may also significantly alter the adoption process. MELISSA's global impact in this regard is to present more comprehensive ways to solve the challenge of technological integration in pedagogy. This will inform the approach to different educational approaches; insights gained from MELISSA may be integrated and facilitated in new, broader international contexts.

Publications to date

Chigona A. and Chigona W. (2010) Capability approach on pedagogical use of ICT in schools, *Journal of Transdisciplinary Research in Southern Africa*, vol. 6, no. 1, p 209-224.

Chigona A., Chigona W., Kayongo P. and Kausa M. (2010) An empirical survey on appropriation of ICT in schools in disadvantaged communities in South Africa. *International Journal of Education and Development using Information and Communication Technology*, vol. 6, no. 2, p 21-32.

Chigona W. and Mooketsi B. (2011) In the eyes of the media: Discourse of an ICT4D project in a developing country, *Electronic Journal of Information Systems in Developing Countries*, vol. 46, no. 6, p 1-16.



Student and faculty exchange

From project grant: Four visits have been exchanged.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	7	2
Other	0	0	0
Qualifications	0	0	0

Training primary school teachers to understand ICTs and how to incorporate ICTs in their teaching

Prof. Wallace Chigona

Prof. Dr Lorenzo Cantoni

MOLECULAR MECHANISMS OF PROPIONATE CATABOLISM IN *MYOBACTERIUM TUBERCULOSIS*

Swiss partner: Prof. Dr John McKinney
École Polytechnique Fédérale de Lausanne (EPFL)

South African partner: Prof. Valerie Mizrahi
University of Cape Town (previously from the University of the Witwatersrand)

Project overview

Tuberculosis (TB) is an infectious bacterial disease caused by *Mycobacterium tuberculosis* (MTB). It is estimated that two billion people worldwide are infected with MTB. The lethal combination of the human immunodeficiency virus (HIV) and TB, coupled with the evolution and spread of multi- and extensively drug-resistant MTB strains, has magnified the burden of disease, particularly in developing countries. Major advances in mycobacterial research have been achieved in recent years. The research to date has not, however, fully elucidated the metabolism of MTB during infection.

As an obligate pathogen, MTB must survive within disparate host environments during successive cycles of infection, replication, persistence and transmission. In turn, this suggests that the organism must possess the metabolic flexibility to adapt to variable nutrient availability, in particular a deficiency in glucose as a carbon source, and an abundance of fatty acids. The consumption of alternative carbon sources, including odd- and branched-chain fatty acids, branched-chain amino acids and cholesterol, generates the compound propionyl coenzyme A (propionyl-CoA) as a three-carbon (C3) terminal product. Propionate is a high-energy metabolite, but is toxic to MTB if accumulated in high concentrations. This dual nature implicates propionate metabolism in the growth and persistence of MTB during host infection.

The methylmalonyl pathway, one of the potential pathways of propionate metabolism in MTB, uses the enzyme methylmalonyl CoA mutase, which is dependent on a vitamin B_{12} derived cofactor for activity. As such, it constitutes a natural fulcrum for this collaborative project, uniting two primary research interests of the applicant laboratories, namely the regulation and function of carbon metabolic pathways (Swiss) and the contributions of vitamin B_{12} biosynthesis and B_{12}-dependent enzymes (South African) to MTB pathogenesis.

The overall aim of this study is to develop better insight into the metabolism of MTB by undertaking processes including MTB mutant strain construction in order to assess the effect of combined methylcitrate cycle and methylmalonyl pathway loss on virulence. *In vitro* characterisation of growth on alternative carbon sources, investigation of the capacity of MTB to transport and utilise selected vitamin B_{12} and pseudovitamin B_{12} precursors to support the function of B_{12}-dependent pathways, and the identification of proteins involved in the transport of vitamin B_{12}, vitamin precursors and cobalt in MTB are central in addressing the main aim of the project.

National outcome

Exposure to state-of-the-art technologies that have been established in the Swiss laboratory has benefited the South African collaboration team at the technological level. These include single-cell microbiology based on time-lapse video microscopy and microfluidics, as well as metabolomics (large-scale metabolite analysis). The application of these techniques is changing the face of research in the field of mycobacterial metabolism. For this reason, the collaboration with the Swiss laboratory is of major strategic benefit to the South African laboratory.

The human capacity development benefits have been substantial. From a South African perspective, collaborating with a pre-eminent international research group has ensured additional intangible benefits including a positive impact on the research team as well as the perceived credibility of the research. The link with the Swiss collaborator has been of tremendous benefit to the professional development of the South African collaborator who has emerged as a top young TB researcher.

Global outcome

The project is expected to consolidate the position of both laboratories as leaders in mycobacterial metabolism research.

Publications to date

None.

Student and faculty exchange

A senior member of the South African team visited the Swiss laboratory in 2009 and met with the Swiss PI again in February 2011. The Swiss PI visited the South African laboratory, which relocated to the University of Cape Town in January 2011, in the middle of 2011. Although no student exchanges have occurred, the laboratories remain in frequent contact through regular teleconferences at which students from both laboratories present their work.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	1	1
Other	0	0	0
Qualifications	0	1	1

Elucidation of MTB metabolism in order to facilitate necessary information required for the improvement of existing and creation of novel tuberculosis drugs

Prof. Valerie Mizrahi

Prof. John McKinney

DISCOVERY AND DEVELOPMENT OF NOVEL NATURAL PLANT PRODUCTS AS LEADS AGAINST NEGLECTED TROPICAL DISEASES

Swiss partner: Prof. Dr Matthias Hamburger
University of Basel

South African partner: Dr Vinesh Maharaj
Council for Scientific and Industrial Research (CSIR)

Project overview

Data generated by the World Health Organisation (WHO) indicate that approximately 800 million individuals in several countries worldwide have succumbed to neglected infectious diseases, with protozoan diseases such as leishmaniasis, African trypanosomiasis and Chagas disease high on this list. All these diseases result in morbidity and mortality, but none more often than malaria. Unfortunately drug resistance has developed in the protozoan, in addition to problems such as an expression of undesired effects, as well as reduced availability of and access to drugs. Because of the high cost of research and development (R&D) of potential drugs and lack of return on investment owing to the economically disadvantaged position of the patients, this group of diseases has become unpopular to investors in the pharmaceutical industry.

Novel leads and pharmacophores for important drugs, as well as the pharmacotherapy branch of New Chemical Entities (NCEs), have been obtained from natural products, which had an introduction rate of more than 50% from 1982-2002. Drugs such as galanthamin, pimecrolimus and prophyrin derivatives have been used in Alzheimer's disease treatment and as immune suppressants and cancer chemotherapy photosensitisers respectively (Butler, 2004). Natural products such as quinine, which is a 19th century antimalarial drug, have inspired the creation of the quinoline scaffold-based antimalarials. In 1990 antimalarial drug combination therapy of artemisinin and semisynthetic derivatives was instituted.

The project aims to investigate novel natural plant molecules against malaria, leishmaniasis and trypanosomiasis parasites and to develop these as far as the preclinical candidate stage. This will subsequently lead to a reduced number of cases of disease-induced mortality and morbidity, as well as poverty among the affected populations in the disease-endemic countries. Of the 300 plant extracts prepared, *in vitro* biological evaluation against the protozoan parasites resulted in 102 (33%) being identified as "hits". The hits were selected for further research after review of the selectivity of their biological efficacy across the various parasites, analysing parameters such as ethobotany strength, plant part used and probable compound type present, resulting in two lists comprising a total of 40 selected hits. The more favoured 20 candidates underwent immediate fractionation and the remaining 20 were reserved as back-up in the event of unacceptable results from the favoured candidate group.

To date approximately 25 of the hits have been fractionated on 96 deep well microtitre plates, using an accelerated approach at both the CSIR and the University of Basel. This approach lends itself to < 100 mg fractionated onto a 96 well plate and ensures that the costly and inefficient large-scale purification is not completed till a much later stage. The fractions were evaluated for efficacy against the relevant parasite at the STPH institute.

None of the extracts fractionated by the University of Basel into the 96 well microtitre plates showed any reasonable potency against the tested parasites. Therefore, no further work is planned for those extracts.

The screening of the microfractions done by CSIR showed that specific microfractions in the 96 well microtitre plate for two extracts had resulted in increased/consistent parasitic growth inhibition. This was a significant finding, as biological activity is often lost during fractionation. The structure elucidation of the active compounds is currently being completed and is a key component of the project.

National outcome

South Africa's unique and largely untapped biodiversity is accessed for the targeted identification of new chemotypes, for natural product based lead discovery in the area of neglected diseases. Knowledge generated from the project provides new entries for medicinal chemistry and potential activities in the areas of drug development. On a more general level, the project provides data on the contribution and the usefulness of ethnomedicine-based plant selection in drug discovery programmes. A new and improved skills base has also been established, involving South African scientists acquiring knowledge in chromatography and biological assaying. Potential socio-economic growth is likely to be realised upon product development.

Global outcome

The public-private partnership Medicines for Malaria Venture, created in 1999, boasts the largest malaria R&D portfolio in 60 years and possesses a number of clinical trial molecules. The Drugs for Neglected Diseases initiative was formed in 2003 and aimed to create methods to combat trypanosomatid diseases. The Special Programme for Training and Research in Tropical Diseases of the WHO supports the identification and development of drugs to fight tropical diseases by other initiatives. Initiatives have blossomed in pharmaceutical companies in the past 10 years, including drugs against TB and malaria developed by four multi-national pharmaceutical companies. Public, private, non-governmental and philanthropic organisations have also begun to work together in the fight against tropical diseases. These initiatives are ready to take up new lead compounds from projects as described in this research programme and move them forward in the drug development pipeline.

Publications to date

Mokoka T.A., Zimmermann S., Julianti T., Hata Y., Moodley N., Cal M., Adams M., Kaiser M., Brun R., Koorbanally N. and Hamburger M. (2011) Screening South African medicinal plants for bioactive constituents against Trypanosoma brucei rhodesiense, Trypanosoma cruzi, Leishmania donovani and Plasmodium falciparum. *Planta Medica*, vol. 77, p 1663-1667. doi: 10.1055/s-0030-1270932.

Student and faculty exchange

From project grant: One student and two faculty members have exchanged visits.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	4	2
Other	2	1	0
Qualifications	0	1	0

Establishment of a set of preclinical candidates against parasites causing neglected infectious diseases exhibiting high *in vivo* activity and low cytotoxicity for advanced development

Mr Tsholofelo Mokoka working in the Swiss laboratories.

Meeting between South African and Swiss scientists held at CSIR in 2010.

SAFEGUARDING DEMOCRACY - CONTESTS OF MEMORY AND HERITAGE

Swiss partner: Prof. Dr Patrick Harries
University of Basel

South African partners: Prof. Dr Philip Bonner, Prof. Dr Sheila Meintjes
University of the Witwatersrand

Project overview

The objective of the project is to provide an analysis that goes beyond conventional understanding of the consolidation of democracy. Democracy is not merely an outcome of long processes of historical struggles but should be viewed as a process that is constantly challenged by memory and heritage in different locales and at different times. Thus, democracy manifests itself, is understood and is produced in different ways at local, regional and national levels.

Despite the different political and social settings of Switzerland and South Africa, it is possible to make interesting comparisons and the different studies of the development of Swiss and South African democratic praxis and culture offer insights into different arenas of democratic politics and the challenges to democracy that they provoke. The two democratic systems – representative versus direct democracy – mark distinctive ways of putting democratic ideals into practice. Strategies employed within the two political systems by politicians, institutions, elites and civil society groups to engage with and influence political processes, the quality of government-society relations and the ways in which different interest groups respond to political opportunity structures offer a comparative perspective to assess the quality of politics, the integrity of the different actors involved and levels of approval or dissatisfaction with political outcomes.

Empirical research on carefully targeted areas of intersecting case studies on provincial and cantonal border conflicts, engagement with and evaluation of dominant perceptions of historical processes, elite interventions and patronage systems and populist politics not only offer insights into political and social dynamics; the comparative perspective also broadens understanding of the strategies and methods used to influence political processes in order to achieve particular outcomes. Consequently, the results of the different studies allow the drawing of preliminary conclusions on what conditions enable or challenge the consolidation of democracy in the different social, economic and political contexts of both countries.

In both countries it is imperative to address questions about the role of the intellectual. The question should be asked why academic research into social science has such limited influence on the power brokers and how intellectuals might have a greater impact.

An interdisciplinary and comparative approach is used to investigate the main challenges to democratic practice and institutions in South Africa and Switzerland. The different investigations and their results will identify strategies to promote social cohesion, identify threats, grievances and causes of disorder and conclusions will be used to propose strategies and policy recommendations to strengthen democratic consolidation and sustain democracy.

National outcome

In South Africa, a stimulating and motivating academic environment was created for both students and academics; it includes vibrant debates, the sharing of knowledge and the examination and exploration of research strategies and problem-solving. PhD students have the opportunity to present and discuss their academic work, which also improves presentation skills. The additional benefits of networking opportunities afforded by interaction with Swiss academics and students and exposure at workshops and conferences enhance the personal development, self-esteem and confidence of South African researchers. The international cooperation enhances the credibility and reputation of the research project.

The project also contributed to intellectual life in Switzerland in various ways. Following two days of joint project-internal exchange and presentations in Basel in 2010, a public workshop gave a broader circle of Swiss academics and the general Swiss public the opportunity to engage with researchers and debate questions raised by the Safeguarding Democracy project and to help explore the functioning and impact of the two different democratic systems. The event increased the visibility of African studies in Switzerland and fostered engaged dialogue between South African and Swiss researchers. The two PhD students employed by the project presented several papers at seminars and conferences in Switzerland and abroad (South Africa, Sweden, Germany, the USA and Canada). Their association with the SSAJRP has allowed them to work closely with the History Workshop at the University of the Witwatersrand and the Anthropology Department at the University of Cape Town, connections which have greatly helped to advance their research.

Global outcome

The Safeguarding Democracy project further contributes substantially to the democracy debate in Switzerland, South Africa and beyond. In exploring the heuristic potential of a 'regard croisée', i.e. south examining north examining south, the project provides an example of a new form of research cooperation between the global North and South by changing the terms of engagement and reversing the usual North-South-oriented patterns. The comparative approach helps to identify shortcomings and problems better in both countries and offers academics and students from South Africa a platform to present their skills and experiences in fields that are less explored and researched in Europe. The project offers valuable networking opportunities with different universities, research centres and think tanks in Switzerland and South Africa.

Publications to date

Daniels G. A. (2010) Fight for democracy internal to democracy itself: The ANC and the media in South Africa. http://www.inter-disciplinary.net/publishing/id-press/ebooks/problems-of-democracy.

Harries P. (2011) The hobgoblins of the middle passage: The Cape and the Trans-Atlantic slave trade. In: Schmieder, Füllberg-Stolberg, Zeuske (editors). The End of Slavery in Africa and the Americas: A Comparative Approach. Litverlag, Berlin.

Bonner P. (2011) South African society and culture, 1910–1948. In: Ross R., Kelk Mager A. and Nasson B. (editors) The Cambridge History of South Africa. Cambridge: Cambridge University Press.

Bonner P. (2011) Labour, migrancy and urbanisation in South Africa and India,1900–60. In: Williams M. and Hofmeyer I. (editors). South Africa and India: Shaping the Global South. Johannesburg: Wits University Press.

Lekgoathi S. (2011) Bantustan identity, censorship and subversion on North Sotho Radio, 1960-1994. In: Gunner L., Ligaga D. and Moyo D. (editors). Radio in Africa: Publics, Cultures, Communities. Johannesburg: Wits University Press.

Lekgoathi S. (2012) Ethnic separatism or cultural preservation? Ndebele Radio under Apartheid, 1983-1994. (Special Issue of the South African Historical Journal titled 'Let's Talk about the Bantustans' scheduled to be published in the first issue of 2012).

Lekgoathi S. (2012) The African National Congress's Radio Freedom, its audiences and the struggle against Apartheid in South Africa, 1963-1991. Book chapter submitted for publication in the South African Democracy Education Trust, The Road to Democracy, vol. 5: The 1990s. To be published by UNISA Press.

Student and faculty exchange

Two South African SSAJRP scholars and one South African PhD candidate conducted research in Switzerland on an SSAJRP exchange grant. On student level, the same funding instrument enabled three South African students to spend a semester at the University of Basel as part of their MA qualification. Moreover, four Swiss MA students received a travel grant to conduct research in South Africa. The joint internal and public workshop in Basel in June 2010 was partly funded through the exchange programme.

2009 Faculty Exchange: Professor Sheila Meintjes.
2011 Faculty Exchange: Professor Cynthia Kros.
2009-2011 Student Exchange: Sarah Godsell (SA), Christopher Wood (SA), Dineo Skosana (SA), Eddy Mazembo Mavungu (SA, PhD), Florian Schönmann (CH), Inge Neugebauer (CH), Michael Aeby (CH), Stephanie Bishop (CH).

Safeguarding Democracy - An interdisciplinary project on the main challenges to democracy in South Africa and Switzerland

Project Team Safeguarding Democracy (Internal workshop in Basel).

Audience of the public workshop: Negotiated Democracies.

In an exchange facilitated by the SSAJRP collaboration but funded independently, three established South African scholars working on the Safeguarding Democracy project taught courses at the University of Basel (Department of History and Department of Media Sciences).

Qualifications from this project

	MA	PhD	Post-doctoral
SSAJRP	0	5	0
Other Qualifications	7	0	0
	7	5	0

STEM CELL ACTIVITY IN THE ADULT HUMAN HIPPOCAMPUS: ITS CHRONOLOGICAL SEQUENCE IN LIFE SPAN, AND COMPARABILITY TO POTENTIAL ANIMAL MODELS

Swiss partner: Prof. Dr Hans-Peter Lipp
University of Zürich

South African partner: Dr Amadi Ogonda Ihunwo
University of the Witwatersrand

Project overview

Adult neurogenesis defies the previously held notion of the inability of the human body to generate neurons after birth. The subventricular zone of the lateral ventricle and the hippocampus are the main regions in which neurogenesis occurs. The need to replace damaged or destroyed neurons resulting from various conditions propels the need to investigate why these neuron-producing stem cells are generated and if it is at all possible to stimulate neurogenesis.

The proliferation of these cells during the life span of an individual is paramount in this investigation, since studies have indicated that cell formation and proliferation rate decrease with age. Another challenge is the incompatibility of the life spans of human versus mouse or rat, which are the commonly used laboratory animals. Thus the significantly shorter life span of the latter group renders them inappropriate as animal models for the human conditions under investigation. Some rodent species in South Africa have a life span of up to 20 years and may prove to be more accurate animal models for the adult human brain condition. The study can be further optimised by employing a combination of the study of the post-mortem brain stem cell proliferation time course of children and young adults, and the use of the advanced modern stem cell activity visualising and quantification methods available in the Zürich laboratory.

Preliminary investigations of the four-striped mouse, common mole rat and the greater cane rat revealed that the animal species that exhibits adult neurogenesis in regions of both the hippocampus and the cerebral cortex is the common mole rat. Thus this species would be able to represent an animal model for human adult neurogenesis. After the launch meeting between the Swiss and South African collaborators, validations of immunostaining in rodents were conducted in the South African laboratory. The pre-immunostaining of human brains protocol was reviewed in Zürich and approved for use in the Johannesburg laboratory. The next phase is the acquisition of ideal human brain specimens within a reasonable post-mortem time frame for investigation.

National outcome

The formation of nerve cells in the adult hippocampus, a brain region mediating memory and behaviour, is one of the most rapidly growing topics in neuroscience. Since most data have been obtained by studying mice and rats only, studies involving other species are of high importance for recognising the physiological and, simultaneously, the potential clinical role of such newly generated nerve cells. During the project an interesting data set documenting neuroanatomical and behavioural data from a multitude of South African rodents was collected. It will result in five to six publications, six Masters dissertations of students from Zurich, and at least one PhD thesis of a student from South-Africa.

The mutual benefits of the projects were many: there was successful transfer of technology and know-how from Switzerland to South Africa, close and ongoing cooperation between ecologists and neuroscientists from both countries, the opportunity for Swiss Masters students to experience the fascinating sides of South Africa both in the laboratory and the wilderness and for the Swiss partner to profit from the availability of native South African species that would have been inaccessible otherwise. The Brain Research Laboratory at the University of Witwatersrand also benefitted from this collaboration, since PhD students were trained on this project and personnel exchanged research visits.

Global outcome

The urgency of the need for cognition or memory and restorative process promoting drugs has sparked interest in obtaining these by the application of neuropsychology and neuroscience in studies of adult hippocampal neurogenesis (AHN). The distinct locality of the AHN has made it the prime focus in adult stem cell studies. AHN mechanistic studies have been performed in rats and mice, primates and humans, with decreasing frequency in the order mentioned. Because of the high proliferation levels in rodents, the results are at present extrapolated to the human condition. In addition to the low AHN levels in monkeys and humans, the paucity of their use in studies is caused by expenses incurred in colony maintenance of monkeys in view of their long life span, the toxicity of the stem cell proliferation marker substances injected into human subjects and lack of expertise in using post-mortem brain stem cell proliferation and differentiation indication antibodies.

Studies using immunological markers at a Swiss laboratory have demonstrated the absence of AHN in many bat species and remarkable AHN neuroanatomical and regulatory differences even among wild-living rodents. The proliferation rate of AHN decreases monthly by 40% in standard laboratory mice. The danger of extrapolation to humans cannot be ignored. This has, therefore, accentuated the need to find alternative rodent or entirely different species with AHN time course and age levels as close to those of the human condition as possible. Adult human neurogenesis is also amenable to future cell replacement therapy in central nervous system repair.

Publications to date

Ajao M.S., Olaleye O. and Ihunwo A.O. (2010) Melatonin potentiates cells proliferation in the dentate gyrus following ischemic brain injury in adult rats. *Journal of Animal and Veterinary Advances*, vol. 9, p 1633-1638.

Student and faculty exchange

From project grant: Two students (one partially and one fully) and three faculty members exchanged visits.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	3	0
Other Qualifications	2 1	0 3	0 0

Determination of the functional role of newly generated nerve cells in the human brain to enable treatment of adverse human brain conditions

Principal Investigators: Dr Ihunwo and Prof. H.P. Lipp at the project launch meeting in Johannesburg

Mrs H. Ali, senior technician in the Zurich laboratory.

Mr A. Becker from Zurich dissecting a brain in Pretoria.

Dr V. Meskenaite with postgraduate students at Wits.

ROLE OF TRIM5 AND CYPA IN THE HIV-1 TRANSMISSION AND PATHOGENESIS OF A WELL CHARACTERISED SOUTH AFRICAN COHORT

Swiss partner: Prof. Dr Jeremy Luban
University of Geneva

South African partner: Prof. Thumbi Ndung'u
University of KwaZulu-Natal

Project overview

Regardless of their high-risk behaviour, some individuals who are constantly exposed to HIV-1 remain uninfected. However, the adverse effects of the disease in the form of immune system deterioration and characteristic developmental signs and symptoms manifest themselves in some infected individuals. When combined, these clinical scenarios present striking heterogeneity. A study of HIV-1-infection-prone individuals has revealed several genetic factors that protect some individuals from infection and disease progression. During a study of the roles of CypA (cyclophilin A) in HIV-1 regulation, the tripartite interaction motif containing protein 5 (TRIM5) was discovered as an additional factor that could explain this disparate clinical phenotype. Upon searching for such factors among a specific cohort, evidence was generated to indicate that differences in TRIM5 and CypA correlate with different rates of infection, or different rates of disease progression in this cohort. The collaborators are currently investigating the causes of the different clinical outcomes of HIV-1-infected people in this specific cohort with respect to the variants in the TRIM5 and CypA proteins.

Type I interferons (IFNs) induce the expression of the TRIM family of E3 ligases. The contribution of these antiviral factors to HIV pathogenesis is, however, not completely understood. Investigations were carried out to determine if the increased expression of a select type 1 IFN and TRIM isoforms is associated with a significantly lower likelihood of HIV-1 acquisition and viral control during primary HIV-1 infection. Concordance was found between type 1 IFN (INF-1) and the TRIM22 isoform. The latter is thought to act as an antiviral effector *in vivo*. To test the hypothesis of the dysregulation of TRIM E3 ligases (TRIM5α, 11, 19, 22, 36), CypA and IFN-1 factors upon HIV infection, the peripheral blood mononuclear cells (PBMC) of HIV-positive subjects (within one year of infection) were tested against those of HIV-negative subjects.

The hypothesis that there is a reduced likelihood of acquiring HIV-1 if innate and intrinsic immunity factors such as TRIM E3 and IFN-1 are expressed in increased quantities was also tested. Matched samples, i.e. PBMC from non-seroconverter subjects versus subjects who were recruited while HIV-negative and who later contracted the disease, were used. Conversely, it was hypothesised that the likelihood of HIV contraction is increased by a high baseline expression of CypA. Results have shown that the expression of these factors indicates the progression of the disease (viral load and CD4+ T cell counts).

The next phase of the project targets *in vivo* characterisation of TRIM E3 ligase and CypA factor expression in different immune cells, with emphasis on those known to be HIV-1 targets. Mechanistic studies to verify IFN-1 effects on TRIM E3 ligase expression and *in vitro* effects of HIV-1 replication will be carried out.

National outcome

In terms of innovation, the project will contribute to the knowledge base of both countries in addressing a disease of global relevance. This project will enable the solutions to a number of questions to emerge. Some of these questions pertain to the relative susceptibility of a well-characterised cohort of high-risk South African individuals to HIV-1 infection being due to expression levels of factors such as TRIM E3 ligases, cyclophilin A and type I interferons in PBMC, and whether these factors correlate negatively with viral loads and positively with CD4+ T cell counts. Insight into the HIV-1 target cells that express TRIM E3 ligases and cyclophilin A and a positive *in vitro* demonstration of enhanced HIV-1 replication upon knockdown of particular TRIM E3 ligases are also questions that, if answered, will pave the way for novel vaccine and therapeutic intervention creation against the disease.

Global outcome

The impact of HIV at the global level is severe, particularly for countries in the developing world. Elucidation of the mechanisms of natural regulation of the HIV-1 restriction factors and HIV-1 cellular co-factors under investigation will enable the creation of novel vaccines and therapeutic interventions against this disease. When these novel vaccines are rolled out into the global market it is envisaged that a significant global decrease in the infection rate will result. The economic and social burden of this pandemic will thus be lifted in the communities currently affected. The innovation of novel HIV therapy will represent a major advance at the global level.

Publications to date

Singh R., Gaiha G., Werner L., McKim K., Mlisana K., Luban J., Walker B.D., Karim S.S., Brass A.L., Ndung'u T (CAPRISA Acute Infection Study Team) (2010). Association of TRIM22 with the type 1 interferon response and viral control during primary HIV-1 infection. *Journal of Virology*, vol. 85, no. 1, p 208-216.

Sewram S., Singh R., Kormuth E., Werner L., Mlisana K., Karim S.S., Ndung'u T. (CAPRISA Acute Infection Study Team). (2009) Human TRIM5alpha expression levels and reduced susceptibility to HIV-1 infection. *Journal of Infectious Diseases*, vol. 199, no. 11, p 1657-1663.

Student and faculty exchange

There has been no exchange to date.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	2	0
Other Qualifications	1	0	0
	1	0	0

Elucidation of the contributing factors to protection against HIV-1 infection and disease progression as enabled by TRIM5 and cyclophilin A proteins

Prof. Dr Jeremy Luban.

Prof. Thumbi Ndung'u.

RELATIONS OF THE JOB DEMANDS-CONTROL-SUPPORT MODEL OF JOB STRAIN WITH PERSONALITY ATTRIBUTES: A CROSS-NATIONAL STUDY IN SWITZERLAND AND SOUTH AFRICA

Swiss partners: Prof. Dr Jérôme Rossier, Dr Koorosh Masoudi
University of Lausanne

South African partner: Prof. Dr Gideon Pieter de Bruin
University of Johannesburg

Project overview

The demands-control-support model has been successfully shown to determine individuals' likelihood of job strain in relation to incidents and conditions they are exposed to. As postulated by the model, the three causative agents of job strain in the work environment are high job demand, low job control or autonomy and poor social support. This model, however, falls short in indicating the individuals who are more prone to falling victim to job strain. Causal and empirical observation indicates that an identical environmental stressor is translated to different individual reactions, with some individuals exhibiting greater resilience than others.

The essence of this project is to investigate the moderating effects of personality (as operationalised by the Big Five model of personality) and control when applied to the demands-control-support model of job strain. Data collection for this project was done according to high quality standards. Methods to establish the psychometric equivalence of the Swiss-South African data and the results obtained showed that assumption of equivalence beforehand would be premature and establishing equivalence before cross-national comparison is essential. Preliminary investigations into the moderating role of personality in the demand-control-support model in Switzerland and South Africa were conducted. The results indicated that the outcomes of the job characteristics and strain relations were moderated by personality traits, which was a trend that was consistent across both countries as well as with theoretical expectations.

National outcome

The interaction between world class scientists and South African and Swiss students facilitated by this joint research project has a significant impact. It broadens the students' understanding of the scientific process and empowers them in critical thinking. Networking events (conferences, meetings of experts and workshops) form an important part of the programme, affording the students opportunities for direct contact with foreign academics and seeing how their work is viewed from other perspectives.

This will ultimately enrich the research environment of South Africa and Switzerland through the production of world-class PhD and Masters students and promotion of their development. Moreover, a review article on the topic of this joint research project was published in a special issue about personality and culture of the Swiss Journal of Psychology, co-edited by Prof. Dr Jérôme Rossier and Dr Koorosh Massoudi. In the longer term, the results of the data collected during this project could lead to the development of new intervention techniques adapted to both the South African and the Swiss economic and cultural context.

Global outcome

Examining the demand-control model from a cross-cultural perspective will shed light on its universality, as it has only been studied in America and Europe. The project also has the potential to enhance psychologists' understanding of culturally specific aspects and their causative nature in job strain.

Publications to date

Allik J., Massoudi K., Realo A. and Rossier J. (2012) Personality and culture: Cross-cultural psychology at the next crossroads. *Swiss Journal of Psychology*, vol. 71, p 5-12. doi: 10.1024/1421-0185/a000069.

Györkös C., Becker J., Massoudi K., de Bruin G. P. and Rossier J. (2012) The impact of personality and culture on the job-demands-control model of job stress. *Swiss Journal of Psychology*, vol. 71, p 21-28. doi:10.1024/1421-0185/a000065.

Student and faculty exchange

Prof. Dr de Bruin from the University of Johannesburg visited the Swiss team in 2009, 2010 and 2011. His six-month stay in 2011 allowed close collaboration between the South African and Swiss members of this project.

Mr Jurgen Becker (PhD student from the University of Johannesburg) visited the Swiss team in 2010 and 2011.

Prof. Dr Rossier from the University of Lausanne visited the South African team at the beginning 2012.

Dr Massoudi and Ms Christina Györkös (PhD student from the University of Lausanne) visited the South African team at the beginning of 2012.

Qualifications

	MSc	PhD	Post-doctoral
SSAJRP	6	3	1
Other Qualifications	0 5	0 1	0 0

The project examines the cross-cultural validity of the demand-control model with the aim of identifying cultural universalities and cultural specificities with respect to job strain. The project also examines the role that personality plays in how people deal with demands and control in the workplace. The outcomes may assist psychologists in identifying persons most likely to experience job strain.

Group picture of the four collaborators on the SSAJRP project.
From left to right: Dr Jérôme Rossier (professor at the University of Lausanne), Ms Christina Györkös (PhD student at the University of Lausanne), Dr Koorosh Massoudi (junior assistant professor at the University of Lausanne), Dr Gideon Pieter de Bruin (professor at the University of Johannesburg).

Prof. Jerome Rossier and Prof. Deon de Bruin.

Some members of the SSAJRP project (Ms Christina Györkös, Mr Jurgen Becker, Dr Koorosh Massoudi, Prof. Dr Gideon de Bruin, and Prof. Dr Rossier) with all participants of the Expert Meeting on Personality and Culture of the European Association for Personality Psychology that took place at the University of Lausanne, Switzerland.

PRODUCTION AND APPLICATION OF TERBIUM RADIONUCLIDES AS A POTENTIAL CANCER DIAGNOSTIC AND TREATMENT TOOL

Swiss partner: Prof. Dr Roger Schibli
Paul Scherrer Institute (ETH Zürich)

South African partner: Prof. Tjaart Nicolaas van der Walt
The Cape Peninsula University of Technology

Project overview

According to the WHO, 20% of deaths worldwide occur as a result of cancer. Early detection and diagnosis, followed by effective treatment, are paramount to the increased quality of life provided to cancer patients. The use of radiopharmaceuticals in the cancer diagnostic tools of single photon emission computed tomography (SPECT) and positron emission tomography renders them non-invasive, and their ability to satisfy the above-mentioned life-quality enhancers makes them indispensible and increasingly used in oncology. Terbium is an element that contains nuclide-emitting particles that give a potentially new dimension to the avenue of cancer therapy. This element also has potential use in positron emission tomography and SPECT diagnostic methods owing to the radionuclides it possesses, and this emphasises the need to find effective extraction methods of these radionuclides from gadolinium (Gd).

This project is a venture into the uncharted waters of the production and application of two extremely attractive tumour-labelling molecules in the form of the terbium radionuclides Tb-152 and Tb-155. The researchers will use state-of-the-art facilities that present an outstanding environment required to undertake this highly relevant, thought-provoking, scientific endeavour at both the unique cyclotron facilities at iThemba LABS (South Africa) and the Paul Scherrer Institute (Switzerland).

This project will use ion exchange chromatography and other extraction methods to separate and obtain radioterbium nuclides from other lanthanide elements such as Gd and dysprosium (Dy). Radioisotope separation from the lanthanide will require the compilation of a hot-cell and the instalment of the required equipment in a hot-cell at iThemba LABS. Investigation of the labelling of organic compound macromolecules, including monoclonal antibodies and peptides, will be undertaken.

National outcome

This collaborative research project develops the technology to produce radioactive isotopes useful for medical purposes. The results give a dynamic impulse to the development of new and effective radiodiagnostics and therapeutics for the management of cancerous diseases. The studies mutually profit from capabilities of unique sites in both South Africa and Switzerland and the know-how of local experts in the field of radiochemistry and radiopharmacy. Significant advances in the field of radio-therapy will be made with this project. Moreover, it will serve as a vehicle to capacitate Masters and doctoral level students and junior faculty members in the areas of radiochemistry, chemistry and biology. These scientists will help to address the increasing demand for experts in these fields.

Global outcome

The establishment of effective methods for the acquisition of the radioisotopes Tb-152 and Tb-155 for potential cancer diagnosis and Tb-161 for therapy can have a significant impact globally in the treatment of cancer.

Publications to date

Lehenberger S., Barkhausen C., Cohrs S., Fischer E., Grünberg J., Hohn A., Köster U., Schibli R., Türler A. and Zhernosekov K. (2011) The low-energy β-- and electron emitter ^{161}Tb as an alternative to ^{177}Lu for targeted radionuclide therapy. *Journal of Nuclear Medicine and Biology*, vol. 38, no. 6, p 917-924.

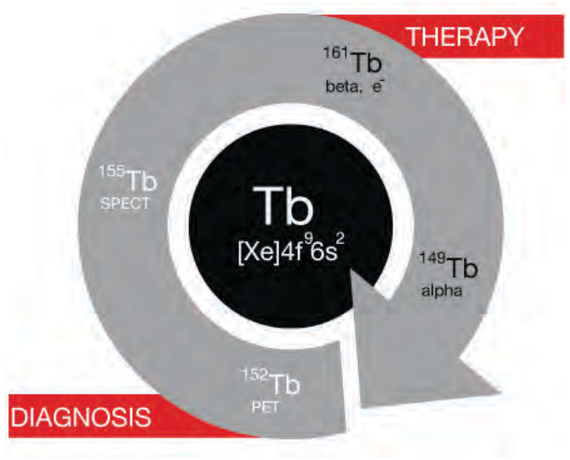
Student and faculty exchange

Prof. R. Schibli (ETH Zurich and PSI) and Dr A. Hohn (PSI) visited CPUT in February 2010.

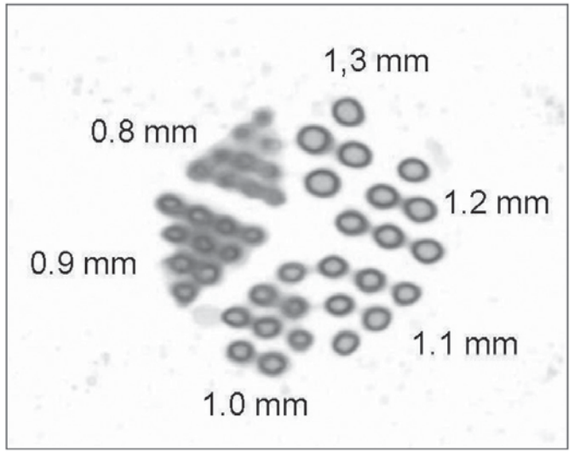
Prof. N. van der Walt, S. Adonis, A. Spies (all CPUT) and Dr C. Naidoo (iThemba LABS) visited PSI in April 2011.

Qualifications from this project

	MTech	DTech	Post-doctoral
SSAJRP	3	2	1
Other	0	0	0
Qualifications	0	0	0



Different nuclides of terbium and their possible application in nuclear medicine.



Derenzo phantom filled with Tb-155 solution. Pinhole diameter range from 0.8 mm to 1.3 mm.

Development of terbium isotopes Tb-152 and Tb-155 for use in potential cancer diagnosis and therapy

Left to right, back: Prof. V. Hugo (assistant dean, CPUT), Dr F. Szelecsenyi (ATOMKI), Dr A. Hohn (PSI), Front: Prof. N. van der Walt (CPUT), Dr B.J. Ximba (head of programmes, CPUT), Dr Z. Kovacsz (ATOMKI).

Left to right: Prof. N. van der Walt (CPUT), Dr C. Naidoo (iThemba LABS), S Adonis (CPUT), Prof. R. Schibli (PSI), A. Spies (CPUT), Dr A. Hohn (PSI).

PROTEIN BIOINFORMATICS RESOURCE DEVELOPMENT FOR IMPORTANT HEALTH-RELATED PATHOGENS

Swiss partner: Prof. Ioannis Xenarios
Swiss Institute of Bioinformatics (SIB)

South African partner: Dr Tulio de Oliveira
University of KwaZulu-Natal

Project overview

Human Immunodeficiency Virus (HIV) and *Mycobacterium tuberculosis* (MTB) are two of the most important health-related pathogens in Africa, causing Acquired Immune Deficiency Syndrome (AIDS) and tuberculosis (TB) respectively. It is, therefore, paramount for an inaugural African protein annotation group to be created to generate scientific research data that shed light on the drug resistance of Southern African HIV-1 and TB strains, specifically in multiple and extremely resistant strains, and the characterisation of the MTB metabolome. Knowledge of this resistance and the ability to create drugs that fight against it can result in significant advancements in the fight against these diseases, especially in developing countries.

This project aims to create the first African protein annotation group to unravel the causes of drug resistance acquisition by some Southern African HIV-1 and TB strains, and also to strengthen viral protein annotation and proteomics resources.

A set of MTB proteins has been selected that is adequate for both training and annotation purposes. A total of 102 MTB proteins from this set have been annotated and 10 others have had their annotations updated. The MTB proteins cited in recent literature as being involved in virulence were also annotated. Up to 60 uncharacterised proteins were assigned Enzyme Commission (EC) numbers.

In the HIV research sector, entries to update the 353 HIV-1 UniProtKB/SwissProt were carried out while the curation of approximately 2,500 genotypes with clinical data from antiretroviral (ARV) treatment cohorts in the South African region was conducted. The HIV proteomics resource and the RNA virus database were updated with information from Swiss-Prot. In addition, two drug-resistance databases, the mirrors of the Stanford HIV drug resistance and RegaDB database, were published.

National outcome

Capacity of South African researchers was built in the field of protein bioinformatics and resource development. This project thus addresses the national goal of human capacity developed in a scarce skills area. Moreover, it has allowed the expansion of resources in South Africa to fight the pandemic of HIV and AIDS via the publication of the "Public database for HIV drug resistance in Southern Africa" in *Nature* (2010).

Global outcome

Strengthening of viral protein annotation and proteomics resource is of importance to the international medical research community. One of its many applications is as a tool that is used globally to feed the drug development pipeline.

Publications

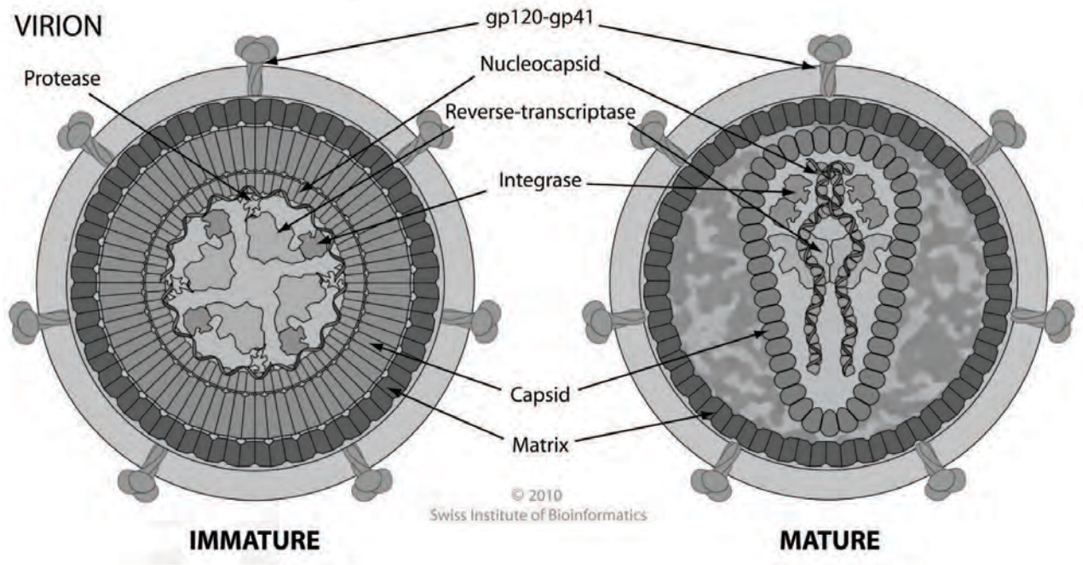
De Oliveira T., Shafer R., Seebgrets C. and 23 Southern African HIV researchers. (2010) Public database for HIV drug resistance in Southern Africa. *Nature*, vol. 464, no. 7289, p 673.

Mazandu G.K., Oppap K. and Mulder N. (2011) Contribution of microarray data to the advancement of knowledge on the mycobacterium tuberculosis interactome: Use of the random partial least squares approach. *Infection, Genetics and Evolution,* vol. 11, p 181-189. PMID: 20850566.

Student and faculty exchange

One visit has taken place.

Characterisation of multiple and extremely drug-resistant HIV and MTB strains in Africa for the potential treatment of HIV/AIDS and tuberculosis




Tulio de Oliveira


Philippe Lemercier


Elisabeth Coudert


Nicola Mulder


Guilaume Keller

HIV DRUG DISCOVERY FROM MEDICINAL PLANTS

Swiss partners: Prof. Dr Alexander Matter
Esperanza Medicines Foundation (EMF), Basel
Prof. Thomas Klimkait
Institute of Medical Microbiology of the University of Basel

South African Partner: Dr Vinesh Maharaj
Council for Scientific and Industrial Research (CSIR)

Project overview

The HIV/AIDS pandemic has had and is still having a severe impact on the African continent, with more than 29 million people in sub-Saharan Africa infected with HIV. In the past year 2.4 million deaths in sub-Saharan Africa resulted from this disease. It is thus essential to discover viral inhibitors, particularly those that are able to hone in on alternative viral targets. This scientific endeavour is complemented by a combination of indigenous knowledge and the extensive biodiversity found in Africa. The development of a pharmaceutical HIV inhibitor involves securing national rights from the local authorities and governmental bodies, while adhering to the Rio protocol of the UNEP "Convention on Biological Diversity" and its rules on "Access and Benefit Sharing" (ABS).

The aim of the project is to fill a compound pipeline with substances isolated from plants and lower organisms. The initial procedure was that of indigenous plant selection based on traditional use related to HIV, followed by plant extract preparation. The extracts and pure compounds (obtained from the CSIR compound library) were divided into three batches and biologically assayed for their anti-HIV activity using Swiss-originating state-of-the-art cellular-based screening technology called the cellular infection anti-HIV system (deCIPh). Of the 88 plant extracts, six displayed potential for further development and were classified as "hits".

Development of these "hits" extracts focused on the isolation and identification of the lead biologically active compounds. HPLC was used to purify the "hits" and subsequent UPLC MS/MS was used to elucidate the structure of the active compounds. The pure compound of one of the extracts was found to be a lignan type compound and further medicinal chemistry and structural modification is targeted at enhancing its potential use as a drug. The remaining plant extracts have resulted in the isolation of xanthones, tannins and caffeic acids as the biologically active compounds. The project is still to incorporate the recollection of the plant material of the "hits", to isolate sufficient active compound quantities, and to carry out further biological evaluations, chemical optimisation and detailed cellular profiling of these.

National outcome

Acquisition of much-needed skills in the discipline of drug discovery from natural products has occurred through this project. This has included the exposure of South African scientists to preparative and bio-assaying techniques, by data exchange as well as personal visits to the Swiss laboratories. In addition, other South African scientists could form part of the "Esperanza-Medicines network" of global leaders in drug discovery from natural products.

First Traditional (South) African medicines are currently being analysed in biotechnology-based assays for HIV activity and cellular toxicity. Newly identified lead extracts and compounds carry the promise of providing agro-processing opportunities for mass production, creating new jobs and commercialising resultant drugs. This will result in the flow of royalties to South Africa.

Global outcome

The rapidly increasing number of HIV infection cases, especially in sub-Saharan Africa, has led to the increased use of traditional medicines in an effort to combat the disease. These traditional medicines have been noted to accomplish feats such as immune system boosting and HIV control in infected individuals. Although it is claimed that the general quality of life of the patients that take these traditional medicines is better than that of those not on the medication, to date there has been no scientific evidence to substantiate this claim. The successful isolation of active ingredients from traditional medicines should provide the necessary evidence to support these claims and will more importantly have a global impact on the availability of novel and less expensive HIV treatments based on natural products. This project has the potential to increase the global acceptance and legitimacy of traditional medicines.

Publications to date

None.

Student and faculty exchange

The project forms the study subject for two African PhD students, who have contributed to collection, fractionation and formulation aspects of active plants; two young scientists on the Basel side interacted closely on the project with a South African student during his four-week term in Basel.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	3	0
Other Qualifications	4	0	0
	0	1	0

Traditional healer delivering plants to CSIR.

South African plants can provide potential bioactive compounds for the development of new leads to combat HIV /AIDS

Prof. Thomas Klimkait (EMF), Prof. Matthias Hamburger (UNIBASEL) and Prof. Reto Brun (Swiss TPH) at the workshop held at the CSIR in 2010.

Chromatography using modern analytical techniques.

CSIR bioprospecting research group.

Plant extraction at CSIR.

ANALYSES OF GEOGRAPHICAL PATTERNS OF MALARIA TRANSMISSION AND MORTALITY IN AFRICA USING BAYESIAN SPATIO-TEMPORAL MODELLING

Swiss partner: Dr Penelope Vounatsou
Swiss Tropical and Public Health Institute

South African partner: Dr Kathleen Kahn
University of the Witwatersrand

Project overview

In South Africa, mortality in most age groups has been increasing. While HIV/TB is the main cause of death in young children and in young adult age groups, chronic non-communicable diseases such as hypertension and diabetes are increasingly affecting middle-aged and older adults. Estimating the geographical patterns of mortality and assessing spatio-temporal trends are important in identifying vulnerable population sub-groups, introducing interventions and evaluating the effectiveness of interventions and progress in achieving the Millennium Development Goals.

Malaria, caused by *Plasmodium falciparum*, the most severe of the parasite species to infect humans, is the most prevalent human parasitic disease. Malaria is responsible for the death of approximately 1 million individuals annually, the majority of the deaths occurring in children under the age of five years. Sub-Saharan Africa carries 90% of the global malarial burden.

The geographical distribution of malaria is not well defined in South Africa. The risk of contracting malaria varies across the risk areas in South Africa. It is thus essential to determine the transmission of malaria to define the areas with the greatest risk and to facilitate appropriate control strategies for these regions. Key factors affecting the transmission of malaria should be identified. A map outlining malaria transmission in South Africa can assist with intervention strategies to optimise human and financial resources.

This project enables South African scientists to acquire the relevant skills and training in disease mapping and risk factor analysis of geographical data in order to contribute to efforts to understand the determinants of mortality and to reduce the risk of malaria. It builds on the long-standing collaboration between the Swiss Tropical and Public Health Institute (Swiss TPH), Wits School of Public Health and the Medical Research Council (MRC) in Durban. The partnership draws on data available within the three institutions and expertise in Bayesian spatio-temporal modelling, malaria epidemiology and mortality, to address key research questions of serious concern across much of Africa.

The first objective is to investigate mortality by identifying risk factors related to cause-specific mortality for defined age groups, producing maps of cause-specific mortality and assessing long-term temporal changes in all-cause and cause-specific mortality. The second objective is to investigate malaria transmission. This will be achieved by estimating and mapping malaria seasonality in Africa, assessing spatio-temporal patterns of malaria transmission and producing regional and continent-wide transmission maps adjusted for age, seasonality and climate factors and to develop models for forecasting malaria case data.

National outcome

Understanding the determinants of mortality is necessary for the development of public health policies and programmes that will address disparities in health and guide South Africa towards its equity goals.

Malaria has a significant impact on the economy of countries affected by this decease. Gross domestic product can be reduced by as much as 1.3% in countries with high transmission levels. This is especially alarming, as the incidence of malaria is highest in developing countries. The cost inflicted on health systems, public and personal finances is immense. Malaria disproportionally affects poor people who cannot afford the treatment and have limited access to appropriate health care. Better control, including availability of treatment, could be directed to the areas with high transmission levels. Trends in the transmission of malaria could also be predicted, which could be used as a preventative measure to lower the infection rate.

This project will assist with capacity building in South Africa. Statistical capacity will be developed by accommodating doctoral students and post-doctoral fellows from both South Africa and Switzerland within this project. The project supports South African doctoral students to be trained in state-of-the art Bayesian spatio-temporal modelling, disease mapping, Markov chain Monte Carlo simulation methods and mathematical modelling of malaria transmission.

Global outcome

This research will contribute novel statistical methodologies in spatio-temporal analysis of large geo-statistical datasets and temporal modelling of count data. Application of this work to mortality and malaria data from Africa, together with state-of-the art existing Bayesian modelling approaches in the analysis of spatio-temporal data, will contribute to (i) understanding of the risk factors, geographical patterns and spatio-temporal changes of mortality, (ii) maps of malaria seasonality and malaria transmission, and (iii) malaria forecasting models. This will provide estimates of the burden of disease and its distribution, which will contribute to public health policy and programmes and evaluation of interventions.

Publications to date

Sartorius B., Kahn K., Vounatsou P., Collinson M.A. and Tollman S.M. (2010) Space and time clustering of mortality in rural South Africa (Agincourt HDSS), 1992-2007. *Global Health Action*, Supplement 3, p 50-58.

Sartorius B.K.D., Kahn K., Vounatsou P., Collinson M. and Tollman S. (2010) Young and vulnerable: Spatial-temporal trends and risk factors for infant mortality in rural South Africa (Agincourt) 1992-2007, *BMC Public Health*, vol. 10, p 645.

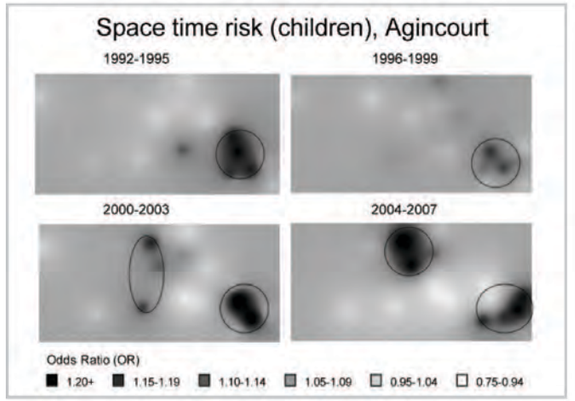
Student and faculty exchange

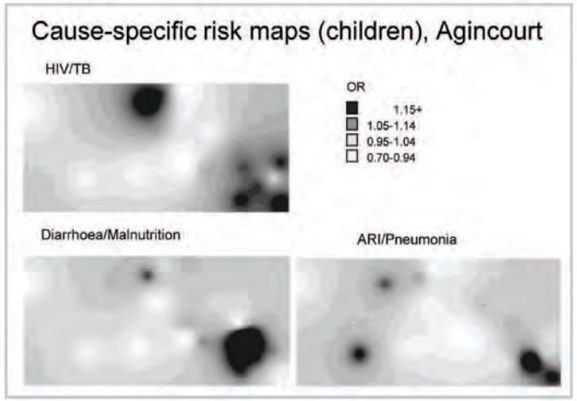
From project grant: Three student exchanges and one faculty exchange.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	3	0
Other	0	0	0
Qualifications	0	3	1

Disease mapping and risk factor analysis of geographical data in order to contribute to efforts to understand determinants of mortality and reduce the risk of malaria





Examples of spatio-temporal maps.

INVESTIGATION OF NATURAL AND SYNTHETIC HIGH DENSITY LIPOPROTEINS AS A THERAPEUTIC VEHICLE FOR CARDIOPROTECTION

Swiss partner: Prof. Dr Richard W. James
University of Geneva

South African partner: Prof. Dr Sandrine Lecour
University of Cape Town

Project overview

Cardiovascular disease and its associated disorders, which include obesity and diabetes, are adding additional pressure on the public health budget. The underutilisation of high density lipoproteins (HDL) as a therapeutic target against cardiovascular disease is of particular concern. It appears that HDL offers a wide range of cardiovascular benefits ranging from modulation of lesion development to cardiomyocytes and eventually that of heart function.

The aim of this project is to investigate the therapeutic potential of natural and artificial HDL and to explore the mechanisms that could be undertaken to utilise synthetic HDL for cardioprotection in a clinical setting. By using an isolated mouse heart model, it was shown that HDL administered in a dose-dependent manner protected the animal from myocardial infarction. Genetically modified animals lacking tumour necrosis factor (TNF) and the cardiomyocyte transcription factor signal transducer and activator of transcription 3 (STAT3) allowed the researchers to confirm the means by which HDL is protective

The replacement of HDL with its major component, sphingosine-1 phosphate, yielded similar results. A significant increase in the cardiopotective nature of HDL was noted when a specially designed sphingosine-1 phosphate-enriched synthetic HDL was used in animal models instead of the native HDL. The signalling pathways involved in HDL-induced cardioprotection are currently being characterised by the use of isolated heart models.

The next phase of the project involves a clinical trial based on the animal model results with an inclination towards the exploration of the HDL composition of the black South African population as compared to the Caucasian population. Since the ratio of HDL to low density lipoproteins (LDL) is high in the black population compared to other South African ethnicities, is thought to be responsible for the rarity of hypercholesterolemia in this population. This may in turn result in the low occurrence of ischemic heart disease. There is, however, the phenomenon of a high prevalence of risk factors for atherosclerotic disease such as diabetes among the black population. It is therefore another aim of this project to investigate whether the rarity of ischemic diseases in the black population is the result of the presence of HDL enriched in the spingosine-1 phosphate component.

National outcome

The leading cause of death in the Western Cape of South Africa is ischemic heart disease, which often leads to fatal myocardial infarction. The data obtained thus far indicate that sphingosine-1 phosphate-enriched HDL is safe for use by cardiovascular disease sufferers, particularly those affected by myocardial infarction and other cardiovascular-related diseases, such as obesity, diabetes, atherosclerosis and hypertension. This project has also assisted in capacity building among previously disadvantaged students and the acquisition of new research skills in South Africa.

The main impact of the collaboration has been to raise awareness and advocate the potential of South African medical research among Swiss scientists. This was evident in the department concerned at the University of Geneva, as visiting South African students had the opportunity to discuss research with members of the department. However, perhaps a more important effect was on young Swiss scientists at the national level via the participation of the South Africa students in the national meetings of the Cardiovascular Research and Clinical Implications Network. The meetings bring together young Swiss scientists working in the cardiovascular domain to present and discuss their studies. Interaction is strongly encouraged and facilitated by informal discussions between the students. These informal contacts, as well as the scientific presentations of the South Africa students, underlined that fruitful scientific exchanges with South Africa are possible beyond those promoted by focused programmes such as the SSAJRP. Indeed, it motivated one PhD student from Lausanne to travel to South Africa, where she is currently doing postdoctoral studies. Dissemination of the potential of South African research was also achieved by successful seminars conducted in the Medical Faculty in Geneva, both during a visit by the group leader of the South African laboratory (Prof. S. Lecour) and the Swiss postdoctoral student (Dr M. Frias) on his return from South Africa.

Global outcome

A recently released WHO report projected 2020 as the initial year in which cardiovascular disease would emerge as the leading global cause of death and disability. Since the risks of cardiovascular diseases are increased by decreased plasma HDL levels, the development of an effective synthetic HDL will be beneficial to patients affected by myocardial infarction, diabetes, obesity and other associated pathological conditions worldwide.

Publications to date

James R.W., Frias M. and Lecour S. (2011) Lipid-induced modulation of protective signalling pathways in cardiovascular disease: The role of high density lipoproteins. *Current Signal Transduction Therapy*, in press.

Lecour S. and James R.W. (2011) When are pro-inflammatory cytokines SAFE in heart failure? *European Heart Journal*, vol. 32, no. 6, p 680-685.

Frias M., Somers S., Lacerda L., James R. and Lecour S. (2010) HDL protects against lethal reperfusion injury via the SAFE pathway. *SA Heart Journal*, vol. 7, no. 3, p 202.

Somers S., Frias M., Opie L. and Lecour S. (2010) The SAFEety and RISKs of Sphingosine-1-phosphate induced cardioprotection. *Journal of Molecular and Cellular Cardiology*, vol. 48, no. 5, S39.

Student and faculty exchange

From project grant: Six student visits and four faculty visits were exchanged.

Qualifications from this project

	MSc	PhD	Post-doctoral
SSAJRP	0	3	3
Other	4	0	1
Qualifications	4	3	4

Synthetic sphingosine-1 phosphate enriched HDL as a potential therapeutic target to prevent or cure cardiovascular disorders

October 2009: Dr Miguel Frias (left) and Prof. James (right) visited the South African partners (Mr Sarin Somers and Prof. Sandrine Lecour). They participated in the inauguration of the South African Society for Cardiovascular Research (SASCAR), which gave them the opportunity to interact with other South African researchers in the field of cardiovascular research.

Mr Sarin Somers (PhD student) from the Hatter Institute in Cape Town (right) went to Geneva in October 2010 to learn specific techniques in the laboratory of Prof. James (centre). He also participated in the annual Swiss Cardiovascular Research and Clinical Implications Meeting, which gave him the opportunity to interact with Swiss researchers in the cardiovascular field.

Dr Miguel Frias presented some findings of this collaborative project at the prestigious Basic Sciences Cardiovascular Meeting, organised by the American Heart Association, in California (July 2010). During this meeting, Miguel received a Young Investigator Award for his presentation.

August 2011. Dr Lydia Lacerda (postdoctoral fellow) and Ms Kim Lamont (PhD student) (both on the right side of the picture) from the Hatter Institute (UCT) spent a few days in the laboratory of Prof. James at the University of Geneva with the objective to learn how to prepare synthetic HDL.

5

CONCLUSION

5.1 CONCLUSION AND OUTCOME

Since the signing of the bilateral Agreement on Scientific and Technological Cooperation between the Swiss Federal Council and the government of the Republic of South Africa in December 2007 and the launch of the SSAJRP, significant progress has been made in advancing the objectives of bilateral cooperation. The partners are highly satisfied with the positive development and the smooth implementation of the bilateral science and technology cooperation strategy between the two countries. The acknowledged high quality of projects, researchers and workshops makes the SSAJRP visible and important in Switzerland and in South Africa.

The partners have agreed to bring the current phase (2008-2011) of the SSAJRP to a successful conclusion and to cooperate in 2012 with at least the same level of commitment and corresponding resources.

In 2011 a call for seed funding projects bringing science and industry partners together was launched. Twelve eligible proposals were received and reviewed in Switzerland and South Africa by international peer review panels, focusing on scientific excellence, industry involvement and innovation potential. Nine projects were selected for funding and the teams have started their collaboration. Furthermore, according to a decision taken by the Swiss and South African joint working group members in 2010, successful JRP research teams applied in 2011 for a prolongation of their research project until the end of 2012. The prolongation of the research projects marks the transition from the first phase of the SSAJRP (2008-2011) to the second phase (2013-2016).

For the next four-year-phase, 2013-2016, both parties agreed that cooperation should continue at the same level, with the potential for increased resources from a wider network of institutional actors in the Swiss and South African S&T landscapes. In addition, the partner countries agreed on exploring new possible common research fields such as energy, in particular renewable sources of energy, energy security and clean technology.

5.2 COMPARATIVE GLANCE AT SOUTH AFRICA AND SWITZERLAND

	Switzerland		South Africa		OECD
General information					
Surface (km²)	41,000		1,219,000		36,225,000
Population (million)	7.87		49.00		1,245.00
GDP (billion US dollars at current price and PPPs) [1]	378		564		43,564
GDP per capita (US dollars at current prices and PPPs) [2]	46,500		10,500		34,000
GDP annual growth rate [2]	2.6%		2.8%		3.0%
Education sector					
Expenditure on education (public + private) as a % of GDP [3]					
All levels of education combined	5.7%		-		5.9%
Primary, secondary and post-secondary non-tertiary education	4.3%		-		3.8%
Tertiary education	1.3% [3]		-		1.5%
Public expenditure on education as a % of GDP [3]					
All levels of education combined	5.3%		6.0%		5.0%
Primary, secondary and post-secondary non-tertiary education	3.8%		4.4%		3.5%
Tertiary education	1.3%		0.7%		1.0%
Public expenditure on education as a % of total public expenditure [3]					
All levels of education combined	16.7%		19.2%		12.9%
Primary, secondary and post-secondary non-tertiary education	11.8%		-		8.7%
Tertiary education	4.0%		-		3.0%
Expenditure per student (public + private) US dollars [3]					
Primary to tertiary education	14,977 [3]		-		8,831
Primary education	9,063 [3]		1,582 [3]		7,153
Secondary education	17,825 [3]		1,852 [3]		8,972
Tertiary education	21,648 [3]		-		13,717
Research and Development (R&D)					
Gross domestic expenditure on R&D [1]					
As a percentage of GDP	3.0%	rank 7	0.93%	rank 34	2.4%
In billion US dollars at current price and PPPs	10.5	rank 18	4.7	rank 29	968.1
Per capita US dollars at current price and PPPs	1,365	rank 3	95	rank 38	790
Gross domestic expenditure on R&D % financed by [1]					
Industry	68.2%		42.6%		60.7%
Government	22.8%		45.1%		30.5%
Abroad	6.0%		11.38%		-

	Switzerland		South Africa		OECD
Gross domestic expenditure on R&D % performed [1]					
Industry	73.5%		58.6%		67.3%
Higher Education	24.2%		19.9%		18.1%
Government	0.7%		20.3%		11.9%
Researchers (in full-time equivalent) [1]					
Total researchers	25,000	rank 31	19,000	rank 37	4,201,000
Per 1,000 total employment	5.6	rank 29	1.4	rank 38	7.6
Publications[4]					
Worldwide publication share	1.2%	rank 18	0.3%	rank 36	81%
Publications per year for 1000 inhabitants	3.2	rank 1	0.1	rank 40	1.5
Publications per year for 1000 researchers	987	rank 2	405	rank 23	433
Impact (relative citation index) [4]	116	rank 2	74	rank 30	Worldwide = 100
Triadic patents [2]					
Number	879	rank 9	27	rank 27	45,571
% worldwide	1.9%		0.1%		97%
per million inhabitants	113.5	rank 1	0.5	rank 31	37

Innovation Rankings	Switzerland	South Africa	Number of countries ranked
The Global Competitiveness Report 2011-2012 (WEF)			
Rank in Global Competitiveness Index (GCI)	rank 1	rank 50	142
The Global Innovation Index 2011(INSEAD)			
Rank in Global Innovation Index (GII)	rank 1	rank 59	125
IMD World Competiveness Yearbook 2011			
Rank in Overall ranking 2011	rank 5	rank 51	59

University Rankings	Switzerland	South Africa
Number of universities in Shanghai Ranking		
Switzerland 7	23 ETH Zurich	201-300 Univ. Cape Town
South Africa 3	56 Univ. Zurich	301-400 Univ. Witwatersrand
	73 Univ. Geneva	401-500 Univ. KwaZulu-Natal
	89 Univ. Basel	
	102-150 EPF Lausanne	
	151-200 Univ. Bern	
	201-300 Univ. Lausanne	
Number of universities in QS Ranking		
Switzerland 7	18 ETH Zurich	156 Univ. of Cape Town
South Africa 1	35 EPF Lausanne	
	69 Univ. Geneva	
	106 Univ. Zurich	
	136 Univ. Lausanne	
	143 Univ. Bern	
	151 Univ. Basel	
Number of universities in Times Ranking		
Switzerland 7	15 ETH Zurich	103 Univ. Cape Town
South Africa 3	46 EPF Lausanne	251-275 Stellenbosch Univ.
	61 Univ. Zurich	251-275 Univ. Witwatersrand
	111 Univ. Basel	
	112 Univ. Bern	
	116 Univ. Lausanne	
	130 Univ. Geneva	

1 = OECD (2012a); 2 = OECD (2012b), 3 = Only public education institutions; 4 = OECD (2011); 5 = SER (2011b).

SWISS LINKS

Academies of Arts and Sciences
www.akademien-schweiz.ch

Conference of Cantonal Ministers of Education (EDK)
www.edk.ch

Conference of Rectors of Universities of Teacher Education (COHEP)
www.cohep.ch

Federal Institute of Aquatic Science and Technology (EAWAG)
www.eawag.ch/index_EN

Federal Institute for Forest, Snow and Landscape Research (WSL)
www.wsl.ch/index_EN

Federal Laboratory for Materials Testing and Research (EMPA)
www.empa.ch/plugin/template/empa

Federal Office for Professional Education and Technology (OPET)
www.bbt.admin.ch

National centres of competence in research (NCCR)
www.snf.ch/nfp/nccr/E/Pages/home.aspx

Rectors' Conference of Swiss Universities (CRUS)
www.crus.ch

Rectors' Conference of Swiss Universities of Applied Sciences (KFH)
www.kfh.ch

Swiss Federal Institute for Vocational Education and Training (SFIVET)
www.ehb-schweiz.ch/en/Pages/default.aspx

State Secretariat for Education and Research (SER)
www.sbf.admin.ch

Swiss University Conference (SUC)
www.cus.ch

The Paul Scherrer Institute (PSI)
www.psi.ch/science/scientists-and-users

RESEARCH INSTITUTIONS OUTSIDE OF THE HIGHER EDUCATION SECTOR

Centre for Electronics and Microtechnology (CSEM)
www.csem.ch/site/

Foundation for Social Sciences Research (FORS)
www.unil.ch/fors

Graduate Institute of European Organisation for Nuclear Research (CERN)
http://public.web.cern.ch/public/

IDSIA for Artificial Intelligence
www.idsia.ch/

IDIAP Research Institute
www.idiap.ch/

Institutes for Agroscope
www.agroscope.admin.ch/org/index.html?lang=en

Institute for Allergy and Asthma Research (SIAF)
www2.unil.ch/fors/?lang=de

Institute for Bio-informatics (SIB)
www.isb-sib.ch/

Institute of Comparative Law
www.isdc.ch/default_en.asp

International and Development Studies
http://graduateinstitute.ch/

National Metrology Institute (METAS)
www.metas.ch/

National Supercomputing Centre
www.cscs.ch/

Swiss Tropical and Public Health Institute (STPH)
www.swisstph.ch/

SOUTH AFRICAN LINKS

Centres of Excellence
www.dst.gov.za/centres-of-excellence

Department of Science and Technology
www.dst.gov.za/

National Advisory Council on Innovation (NACI)
www.nacinnovation.biz/

South African National Space Agency
www.sansa.org.za/

SCIENCE COUNCILS

Agricultural Research Council (ARC)
www.arc.agric.za/

Council for Scientific and Industrial Research (CSIR)
www.csir.co.za/

Council for Geosciences (CGS)
www.geoscience.org.za/

Human Sciences Research Council (HSRC)
www.hsrc.ac.za/

Medical Research Council (MRC)
www.mrc.ac.za/Mintek for mineral-research
www.mintek.co.za/

National Research Foundation (NRF)
www.nrf.ac.za/

South Africa Bureau of Standards (SABS)
www.sabs.co.za/

NA TIONAL RESEARCH FA CILITIES

iThemba Laboratory for Accelerator-Based Sciences (iThemba Labs)
www.tlabs.ac.za/

Hartebeesthoek Radio Astronomy Observatory
www.hartrao.ac.za/

Hermanus Magnetic Observatory
www.hmo.ac.za/

National Zoological Gardens
www.nzg.ac.za/

South African Astronomical Observatory
www.saao.ac.za/

South African Environmental Observation Network
www.saeon.ac.za/

South African Institute for Aquatic Biodiversity
www.saiab.ac.za/

PRIORITY AREAS FOR RESEARCH

Centre for the AIDS Programme of Research
www.caprisa.org/joomla/

MERAKA – ICT Research
www.csir.co.za/meraka/

National Health Laboratory Services
www.nhls.ac.za/

South African Biodiversity Information Facility (SABIF)
www.sabif.ac.za/

South African National Antarctic Programme
www.sanap.org.za/

South African National Research Network
www.sanren.ac.za/

South Africa Research Chair Initiative
www.nrf.ac.za/projects.php?pid=61

Southern African Large Telescope
www.salt.ac.za/

Water Research Commission
www.wrc.org.za/

INTERNATIONAL COLLA BORATION FOCUS

Africa Institute of South Africa
www.ai.org.za/

International Centre for Genetic Engineering and Biotechnology (ICGEB)
www.icgeb.org/home.html

South African National Energy Development Institute
www.saneri.org.za/

FUNDING

Small Enterprise Development Agency (SEDA)
www.seda.org.za/Pages/Seda-Welcome.aspx

Support Programme for Industrial Innovation (SPII)
www.spii.co.za/

Technology and Human Resources for Industry Programme (THRIP)
http://thrip.nrf.ac.za/

Technology Innovation Agency (TIA)
www.tia.org.za/

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