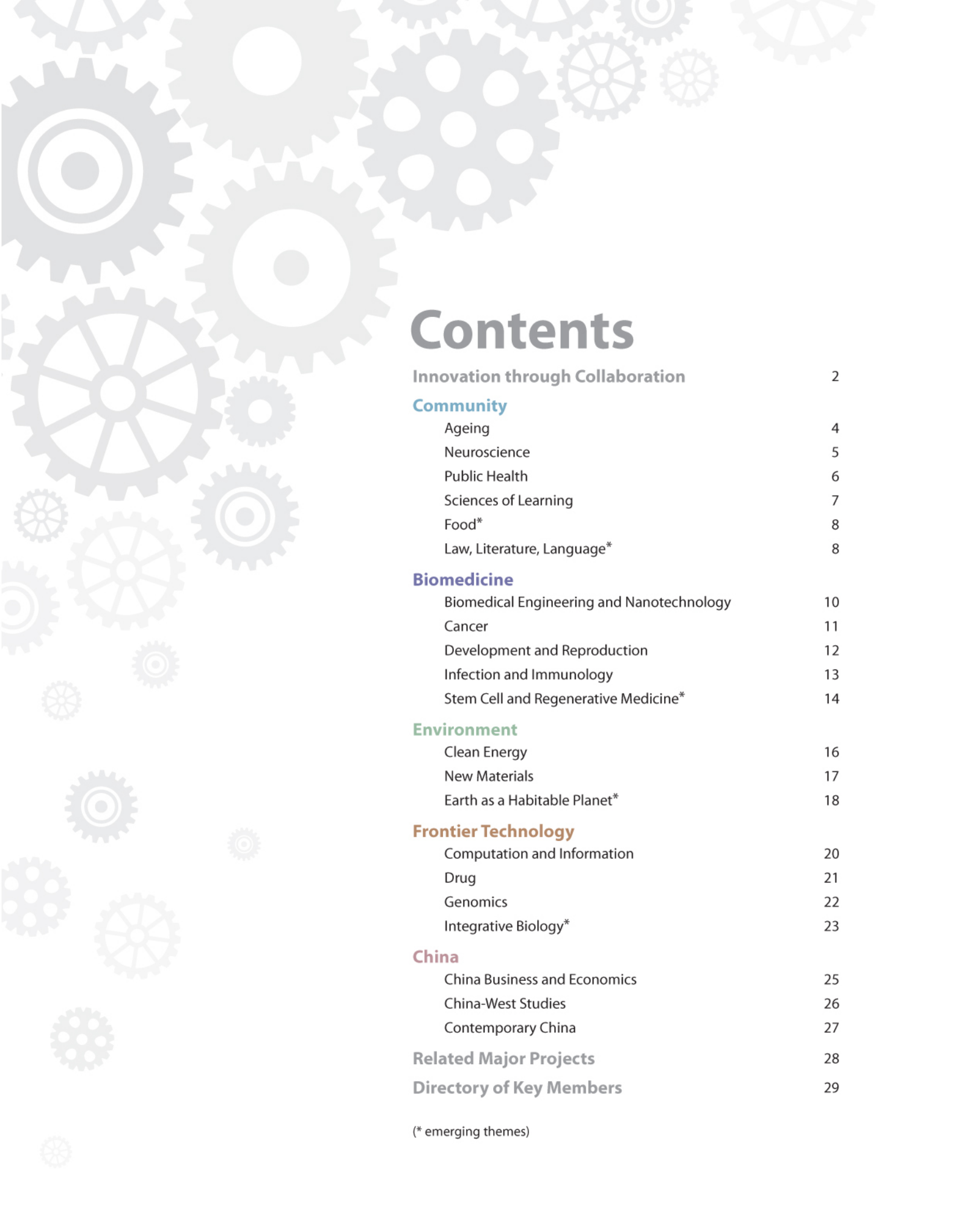




Excelling Together

Strategic Research at
The University of Hong Kong





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(* emerging themes)

To maximise the **impact of our research** which spans all major disciplines

we are focusing development on 5 strategic research areas

comprising **16 strategic research themes** and

5 emerging themes of proven and potential strength

in issues critical to advancing Hong Kong, Mainland China and the rest of the world.

Innovation through Collaboration

Excelling together through interdisciplinary research has long been a goal of The University of Hong Kong (HKU) as it seeks to develop strategically relevant research themes.

Since 2004, the University has been identifying themes of current or potential strength for strategic development to maximise the impact of its research. These themes build on expertise and interests that cross disciplines—utilising the synergies that such collaborations can bring—and address issues of importance to the community here in Hong Kong and Greater China as well as around the world. The task of identifying the themes is undertaken by the University Research Committee, a multi-disciplinary team of experienced researchers, chaired by the Pro-Vice-Chancellor (Research).

The current 16 strategic research themes and 5 emerging themes—which form 5 strategic research areas of *Community*, *Biomedicine*, *Environment*, *Frontier Technology* and *China*—build on two previous rounds of the initiative in 2004–07 and 2008–11. Over the three cycles we are enriching and refining areas of expertise and nurturing emerging topics of potential strength and importance.

As well as stimulating productive working relationships within these themes, there is also interrelation with major work at the University funded from external sources. The table on page 28 provides an indication of the links between the strategic research themes and current large-scale projects under the HKSAR government-funded Areas of Excellence and Theme-based Research Scheme, and the National Key Basic Research Development Program (973 Program) of the Ministry of Science and Technology of the People's Republic of China; and also HKU's Partner State Key Laboratories, which work closely with research institutions in Mainland China.

Research at the University spans its 10 Faculties and numerous departments, research centres and institutes. This wide range of experience is reflected in the membership of the themes outlined in this publication, which it is hoped may encourage interest in HKU's research and potential collaboration. More information on research at HKU can be found at www.hku.hk/research.



Community

Community looks at education, health, law, policy and social issues affecting those in Hong Kong and around the world.

- Ageing
- Neuroscience
- Public Health
- Sciences of Learning
- Food*
- Law, Literature, Language*

(* emerging themes)

Ageing

The problem of ageing populations is affecting the entire developed world. In Hong Kong, for instance, one-quarter of the population will be over 60 years old by the year 2020, placing a great strain on healthcare and support services. HKU scientists are providing help by finding ways to identify, treat and manage age-related diseases.

The SRT on Ageing brings together world-renowned experts in the Faculties of Medicine, Social Sciences and Education, who have been making inroads in scientific investigations of age-related diseases. They have already made important breakthroughs relating to cardiovascular diseases, diabetes, and Alzheimer's disease, and there is promise of more to come. Their work covers three main programme areas:

Cardiometabolic research on ageing concerns research into cardiovascular diseases and diabetes. Our researchers have identified novel biomarkers of cardiometabolic diseases and inspired hundreds of follow-up studies in the field. They have also been conducting long-term studies of these diseases in populations in southern China and Hong Kong. In the coming years, they will investigate hormones with diagnostic and therapeutic potential and continue to develop their long-term studies and use the databases to inform further research.

Psychosocial research on ageing considers issues in the care of dementia patients and those requiring long-term support. Three projects are planned. One will test the effectiveness of applying a U.S.-based support programme to dementia caregivers in Hong Kong. Another will collect data from long-term care facilities to see how care can be improved and resources best utilised. The third project will test the use of a smartphone application to raise awareness about chronic age-related illnesses in the general population.

“As people age they become more vulnerable to age-related diseases and conditions. We aim to translate our basic and clinical research to real-life clinical applications that can help patients, family caregivers and the community.

Professor K.S.L. Lam, Convenor



HKU Alzheimer's Disease Research Network. This network was formed in 2008 and has resulted in the identification of biomarkers for the progression of Alzheimer's disease, such as a link between the disease and testosterone levels in men. Attention is now turning to combinations of blood, spinal fluid and neuroimaging biomarkers to identify which are the most effective in detecting Alzheimer's disease, and to evaluating the psycho-social impacts on caregivers of Alzheimer's patients.

Related major work at the University includes a project on 'Personalized Medicine for Cardiovascular Diseases: From Genomic Testing and Biomarkers to Human Pluripotent Stem Cell Platform' (Theme-based Research Scheme project) and a Partner State Key Laboratory of Pharmaceutical Biotechnology, focusing on diabetes and obesity.



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Neuroscience

Neuroscience research has been gathering strong momentum and high-level funding around the world. HKU scholars have been active in various aspects of this field for some years. Now they are joining forces to seek new opportunities for collaboration and strengthen the focus on neuroscience within the University and the region.



Neuroscience offers great potential for understanding the brain and nervous system, and many other aspects of human brain processes and the respective behavioural outcomes. HKU researchers in the Faculties of Arts, Education, Engineering, Medicine and Social Sciences, who have notched up impressive research results in this field, are combining their strengths into the new Neuroscience SRT with the aim of promoting collaboration and advancing new research directions.

The Neuroscience SRT is starting from a strong base at HKU that includes a comprehensive spectrum of neuroscience research across the human lifespan; excellent neuroimaging, engineering and genomic research platforms; and a Partner State Key Laboratory of Brain and Cognitive Sciences. Members of the team have already achieved international recognition in such areas of neuroscience research as retinal detachments, learning and memory, social cognitive and affective processes, brain development and neuroregeneration, and dementia.

In joining forces, the Neuroscience SRT will focus on seven areas of interdisciplinary research:

- Basic neuroscience
- Vision
- Engineering and neuroimaging
- Cognitive neuroscience
- Social affective neuroscience
- Clinical neuroscience
- Communication and education

The team will invite new scholars to the SRT and form a stronger research network across disciplines and institutions worldwide. The potential for working with partners beyond Hong Kong is very high, making neuroscience a field of strategic importance for HKU.

As well as the Partner State Key Laboratory, related major work at the University includes a project on 'Brain Mechanisms Underlying Chinese Language Processing and the Neurogenetic Basis for Its Disorder' (973 Program).

“As one of the world's leading universities, HKU possesses a great diversity of minds who can potentially advance the field of neuroscience. The vast amount of research attention that neuroscience has received globally is a clear indicator that this is the opportune time for our University to take the lead in shaping the development of the field in this region and beyond.

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Public Health

Public health is more than a medical issue. It also involves particular politics and economics, the natural environment, food quality and safety, the built environment, and everything else that can affect human health. Scientists at HKU are attempting to steer research towards that broader direction.

The SRT on Public Health started out in 2005 focusing on an important issue in the community: adolescent health. In particular, it studied obesity and activity levels and their impacts on health. A significant number of findings resulted from that work, and so did the realisation that this was more than a medical issue. In the third phase of this SRT, the project convenors are aiming to widen the breadth of their remit.

They are taking the widest possible definition of public health, to include the totality of factors that affect human health. The Faculties of Medicine and Dentistry are continuing their membership of the SRT and they will seek participation from scholars in other disciplines in the University to create synergies with the health sciences. It is hoped the linkages will stretch from biological studies, such as public health virology, to issues relevant to the built environment, food supply and safety, air quality, transport, housing and even economic policy. The SRT will also encourage the use of different methodologies, such as epidemiology studies, health economics and computer modelling.

An example of the issues the researchers hope to look at is the contribution of lifestyle, diet and other non-medical factors to problems of disordered metabolism and age-related degeneration. More research in this area could help to spur government and individuals to see the connections and take action.

Within three years the SRT aims to develop at least two cross-theme linkages and have active research collaboration developing in other areas. By consolidating different approaches, it is hoped that a body of research can be produced that can influence and inform policies affecting the community's well-being.

Related major work at the University includes an Area of Excellence on 'Control of Pandemic and Inter-Pandemic Influenza' and a Partner State Key Laboratory for Emerging Infectious Diseases.



“ This SRT is taking a broader perspective of disrupted human ecologies and environments as the key threats to public health.

Professor R. Fielding, Convenor

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Sciences of Learning

Research on how people learn and how that learning can be enhanced and improved has recently received increasing attention from policy makers and educators. HKU scholars are drawing on a host of disciplines to consider the problem from neural, cognitive, pedagogical, technological, theoretical and policy perspectives.

The Sciences of Learning SRT casts a very wide net, bringing together expertise from the Faculties of Education, Arts, Science, Social Sciences, Medicine, Engineering and Dentistry to consider fundamental questions and approaches to learning.

Members of the SRT team have established strong track records investigating the neuroscience of learning, language and motor learning, literacy, technology in learning and assessment, and education policy. Moving forward, they will focus on three sub-themes to integrate their findings and develop new insights.

The first sub-theme concerns the neural, cognitive and pedagogical aspects of language learning research and educational interventions. HKU is particularly strong in language learning research – our researchers have done groundbreaking work on the neuroscience of Chinese language learning, bilingual education, Chinese language pedagogy and curriculum designs for first and second language speakers. Language learning in a multilingual context will be a focal research area in the coming years.

The second sub-theme is technology-enhanced learning and assessment, a rapidly evolving field. HKU has developed a strong reputation in technology enhanced learning and pedagogical innovation. It has also expanded research in natural language data mining and is participating in the edX massive open online course consortium with Harvard and other universities. The next stage of research will develop a more nuanced understanding of how people learn in different settings, build better tools and theories of assessment, and develop pedagogical and technological designs to enhance learning in authentic learning environments.

The third sub-theme aims to build tools and theory to connect our current state of knowledge about learning at different levels from individuals to groups, organisations,

Neuron image courtesy of Renjith Krishnan / FreeDigitalPhotos.net



communities and social systems. It will draw on members' extensive expertise in local and international innovation programmes at school and classroom levels, and comparative studies of pedagogy and student achievement. Research outcomes will contribute to successful strategic and policy interventions for large-scale learning improvements.

“ *Learning lies at the core of all aspects of human performance. Therefore, understanding how we learn should have essential implications on human lives. Our mission is to contribute to advances in learning related policy and practise that are grounded in research that connects our understanding of learning in individuals, teams, organisations and communities.*

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<http://sol.edu.hku.hk>

Food

From the possible cancer chemopreventive effects of certain foods to the toxic effects of the likes of melamine, the benefits and safety of food are never far from people's minds. HKU researchers are applying their expertise to deepen our understanding of these issues.

Researchers from the Faculties of Science, Medicine, Social Sciences and Engineering are combining forces in this Emerging SRT on Food. They are applying a wide variety of scientific approaches to enhance food safety and quality, explain the health benefits of certain food components, link scientific and medical research on food, and identify food contaminants and toxins that are potentially harmful to human health.

Their work has been organised into three areas. The first concerns food safety, food-related disease and biomonitoring. Scientists are investigating bacterial food poisoning and the toxicity levels of certain foods, and developing strategies to address these issues. They plan to establish a research group on clinical biomonitoring, which will work with local hospitals to monitor foodborne and environmental chemicals, and food-related diseases. New strategies will also be developed to control the formation of food toxicants in food production.

The second area concerns food security and bioactive food components. Research here is focused on identifying novel molecular pathways in plants and using these to develop strategies for optimising food production, and applying biological evaluation to figure out potential food components with health benefits and develop healthy foods.

The third area of research will investigate food policy and how food is regulated and monitored.

The output of this Emerging SRT is expected to boost basic and applied research on food and benefit public health and the local food and nutritional industry.

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Law, Literature, Language

Law is a linguistic product and the implications and possibilities of that fact have only recently started to be explored by scholars around the world. This Emerging SRT aims to make HKU a leader in the region in this cutting-edge field of research.

Law has traditionally been studied as a set of rules and doctrines, but what of the linguistic and rhetorical devices used to express these? Consider the example of gender identity. In some cases, courts have had to decide whether a male-to-female transsexual would count as a 'woman' in the context of marriage, a question that lies at the intersection of law, language, history, and culture. This Emerging SRT investigates issues such as this to bring new perspectives on the nature, contemporary relevance and interdisciplinary connections of the law.

Participants from the Faculties of Arts and Law are combining their strengths and interests in a unique way,

by bringing their respective modes of interpretation to bear on common legal-cultural texts and events. The outcome is expected to be an interdisciplinary dialogue and a sharing of insight and expertise.

Several projects are planned to help build momentum for this Emerging SRT, including a joint conference with Oxford University and New York University, a forum on the use of language and the law, and the publication of at least one volume of research.

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Biomedicine

Biomedicine probes the mechanisms underpinning many diseases, offering insights into potential treatments and preventive measures.

- Biomedical Engineering and Nanotechnology
- Cancer
- Development and Reproduction
- Infection and Immunology
- Stem Cell and Regenerative Medicine*

(* emerging theme)

Biomedical Engineering and Nanotechnology

Engineering deals with structures, medicine with bodies, but there is a surprising amount of overlap. With new advances in health technologies, the merging of these fields holds much promise for benefiting human health.



The rapidly evolving fields of biomedical engineering and nanotechnology illustrate explicitly the value of cross-disciplinary research. Engineering techniques are enabling medical doctors and researchers to explore health and diseases in new and more precise ways, while medical needs are opening up new directions for engineering know-how. This synergy is recognised in the Biomedical Engineering and Nanotechnology SRT.

“With populations ageing in developed countries, including Hong Kong and Mainland China, there will be increasing demands for better healthcare technologies. Rapidly evolving advances in engineering are opening new windows of opportunity and we hope to translate these emerging methodologies and technologies in ways that benefit life sciences and healthcare.

Professor E.X. Wu,
Corresponding Co-Convenor



This SRT is a merger of two previously separate SRTs that have moved closer together in their work. Researchers in the Faculties of Medicine and Engineering have become internationally competitive in several areas, such as biomedical imaging, biomaterials, tissue engineering, micro-fluidic systems, and nanomechanics. Now, they will harness that expertise to focus on three key areas:

- Biomedical imaging, such as magnetic resonance imaging, biophotonics, ultrasound, EEG, bioinformatics and neural engineering.
- Bio-nanomaterials and bio-nanomechanics, which are being applied in such areas as prosthetic devices, tissue engineering and regenerative medicine.
- Biomedical devices, such as medical robotics, microfluidics, and computer-brain interface.

The SRT team is relatively small so the goal is to "bind" researchers together through retreats, workshops and other activities that deepen collaboration, and to connect with international research communities to identify new multidisciplinary directions for the team.

Both faculties are firmly behind the SRT, giving priority to this cross-and transdisciplinary field. "Healthcare technologies" is one of two key themes of development for the Faculty of Engineering, while "biomedical engineering" is a key emerging field in the Faculty of Medicine.

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Cancer

Everybody wants a cure for cancer but the answer is not likely to come in a single magic bullet. Rather, it requires scholars in multiple disciplines to work together with a singular goal. HKU researchers are focused on identifying and tracking cancer genetics and stem cells, and exploring the role of psychosocial aspects in cancer care and progression.

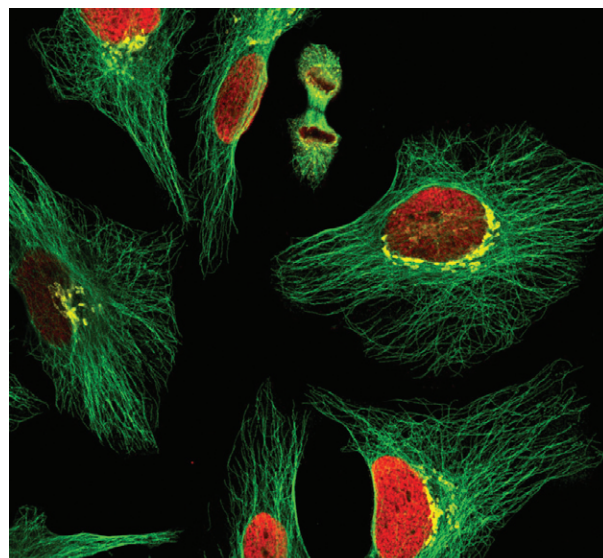
The Cancer SRT has a firm foundation at HKU, where scholars have produced important research on a wide spectrum of cancers, such as liver cancer, stomach cancer, colon cancer, lung cancer, nasopharyngeal cancer, leukaemia, esophageal cancer and breast cancer. In the process they have developed broad areas of expertise. As the SRT moves forward, their focus will be on not only individual types of cancers, but also their underlying causes and treatment.

Three key areas have been identified for investigation, after a rigorous review of the SRT:

- Cancer genetics and biomarkers. Research into the genetic basis of cancer development can improve our understanding of how tumours form and how to detect and treat them.
- Imaging and cancer stem cells. The role of cancer stem cells in the development and progression of tumours is still not fully understood. HKU has an array of imaging technologies and capabilities that can help improve understanding of the biochemistry and behaviour of these cells.
- Psychosocial oncology. This is a new focus for this SRT and will concentrate on studying the effectiveness of psycho-behavioural intervention in cancer prevention and care. It will draw on existing research strengths in integrative care, Traditional Chinese Medicine and social sciences, as well as medicine.

Researchers from the Faculties of Engineering, Medicine, Science and Social Sciences are engaged in this SRT, which will aim to develop new techniques and platforms, launch new projects, organise international workshops and lectures, and establish strategic partnerships with universities in Mainland China.

Related major work at the University includes a Partner State Key Laboratory for Liver Research and the 'Center for Nasopharyngeal Carcinoma Research' (Areas of Excellence project).



“With cancer rates rising worldwide, especially in Mainland China, the quest for cancer biomarkers, therapeutic targets, prevention and care has been in the spotlight of medical science. We foresee opportunities from national and international research funding, intellectual exchange and collaboration that will nurture multi-institute cancer research, and we will seize on them with the aim of achieving world-class excellence in our research.”

Professor X.Y. Guan,
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Full membership : www.med.hku.hk/download/ccr-srt-membership.pdf

Development and Reproduction

HKU researchers are working at the cutting edge to identify the genes and mechanisms that control development and reproductive health, and the underlying causes of congenital and degenerative conditions, to help improve quality of life for humankind.

Disturbances of normal foetal development and growth can lead to a spectrum of disorders, ranging from mild to more serious outcomes such as death at birth and crippling malformation, to progressively disabling disorders that may manifest later. Such issues can significantly impact throughout a person's life, causing economic and other burdens on society. Disorders of reproduction affect fertility, complicate pregnancy and may affect hormonal controls and cancer development.

With over 80 members from the Faculties of Medicine, Science, Engineering, Dentistry, Law, Social Sciences and Arts, the Development and Reproduction SRT focuses on five main areas: developmental and functional genomics, reproduction, stem cells and regenerative medicine, genetics of disorders, and enabling technologies.

The members have established internationally recognised collaborative programmes, contributing to the discovery of the genetic bases of developmental and degenerative disorders such as those affecting the skeletal system and the neural crest (a stem cell disorder affecting foetal development); and in reproductive medicine, providing advances in prenatal diagnoses of genetic disorders and insights into the regulation of fertility. They are also developing biomaterials and improving imaging and other technologies.

Through evolving research collaborations, members are also participating in international research consortia with world-renowned experts and have secured important

research grants for projects on unravelling how genomic variation affects people's risk of developing skeletal and lumbar disc disease, on the mechanisms of ageing and of innate immunity, and on the application of synthetic biology for the treatment of cancer.

Moving forward, a new mentorship programme will develop future leaders, and collaborative research will continue to be strengthened and expanded across disciplines and with our partners in Hong Kong, Mainland China and beyond.

Related major work at the University includes group research projects on 'Developmental Genomics and Skeletal Research' (Areas of Excellence project) and 'Functional Analyses of How Genomic Variation Affects Personal Risk for Degenerative Skeletal Disorders' (Theme-based Research Scheme project).



“ Our mission is to make significant contributions through multidisciplinary synergistic partnerships and cutting-edge science to enable ambitious research questions to be tackled so as to reach our long-term vision of bench to bedside research, translating discovery to the clinic.

Professor K.S.E. Cheah,
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Infection and Immunology

Emerging threats to human health, such as influenza and SARS, have come under the global spotlight in recent years. HKU is at the heart of research to identify, understand and control these infectious agents.



HKU scientists have reported internationally significant findings on infectious diseases over the past decade. They traced the origin of the SARS coronavirus to horseshoe bats, identified 22 other novel coronaviruses, and discovered more than 40 other novel viruses in animals that could have implications for human health. That track record and the expertise that underpins it – with members from Medicine, Dentistry, Engineering and Science – are providing a platform for new breakthroughs in infectious diseases, with a particular focus on the following areas:

Viruses

Our scientists are working on genomic and metagenomic studies to help explain the origin and interspecies transmission (animal-to-animal and animal-to-human) of new and emerging viruses from the animal kingdom.

Fungi

Work is proceeding on the fungus *Penicillium marneffeii*, which can cause respiratory, skin and other complications in patients with compromised immune systems, often with fatal results. Our scientists have published the genome sequence and other findings on *P. marneffeii* and are investigating its virulence properties and the possible role of microRNAs in regulating its gene expression.

Oral microbiome

The mouth contains about 500 species of microbes and

provides a welcome environment for infectious agents, so our scientists plan to profile changes in oral microbiota in response to oral and systemic diseases and conditions, especially those affecting the elderly. They also plan to investigate therapeutic and surgical interventions.

Crunching the data

New technology has made available huge amounts of data about how a microbial community affects disease. Our scientists aim to develop software tools to help in the analysis and understanding of this information.

Microbial chemical genetics

Chemical genetics has been applied at HKU to identify and characterise a small molecule compound that inhibits the cellular trafficking of influenza A virus nucleoprotein. Further studies will target this compound and modulate the virulence of the virus. The chemical genetic approach is also being extended to bacterial virulence, with a focus on *Staphylococcus aureus* (MRSA), which is resistant to most antibiotics.

Related major work at the University includes a Partner State Key Laboratory for Emerging Infectious Diseases.



We have developed a pipeline of genome sequencing, bioinformatics analysis, database construction and post-genomics work and we now want to put that to productive use. The novel projects that we have proposed will change our understanding in their respective fields.

Professor P.C.Y. Woo,
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Stem Cell and Regenerative Medicine

Stem cell research is gathering momentum at HKU, with the goal of becoming a regional and global leader in the field.

Stem cell and regenerative medicine has the potential to treat incurable conditions related to the inability of certain cells in the body to regenerate. These conditions can be caused by diseases such as heart attack or stroke, traumas such as spinal cord injuries, or ageing effects such as glaucoma. At HKU, researchers have been developing strength in this field and are preparing to raise their profile through this Emerging SRT.

The University already has several strategic areas of excellence in stem cell research, such as cell-based heart regeneration, basic and clinical stem cell biology, orthopaedic engineering, blood and cancer stem cells, stem cell immunology and bio-artificial tissue engineering. It is one of four major stem cell centres in China, and arguably the most international, with ongoing collaborative projects or programmes involving such centres as Johns Hopkins University, Stanford, Harvard, Karolinska Institutet in Sweden and the University of Edinburgh.

With this ground laid, researchers now plan to raise the profile and level of activity of stem cell research at HKU. An in-house Good Manufacturing Practice facility has been established with several cell-based clinical trials in the pipeline. A range of in vitro diagnostic tools developed at HKU is also being commercialised for industrial applications. The immediate focus is

on enhancing capability and quality, rather than just quantity, to become a key stem cell research centre in the region and the world. There are also plans to establish a joint PhD programme in stem cell biology with a foreign reputable university, and to collaborate with the Innovation Technology Commission and other units on setting up a regional biotech cluster focused on stem cells that would enhance Hong Kong's knowledge-based economy.

The team is also working to raise public awareness of the possibilities of stem cell research through knowledge exchange activities – such as public lectures, laboratory visits, meet-the-expert luncheons and Nobel Laureate lectures – with a particular focus on getting secondary school and university students interested in the field.

Related major work at the University includes the 'Cell-based Heart Regeneration' Theme-based Research Scheme project.

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Environment

Environment addresses some of the key issues currently faced by humankind such as sustainability, pollution, and alternative power sources.

- Clean Energy
- New Materials
- Earth as a Habitable Planet*

(* emerging theme)

Clean Energy

Economies everywhere are keen to find energy sources that are sustainable, secure and environmentally friendly. HKU has an active team of researchers investigating emerging energy sources as well as technologies for harvesting, transmitting, using and storing renewable energies and minimising their environmental impacts.

Clean energy research by its nature requires a cross-disciplinary effort to identify new energy sources and convert them into a useable form. HKU scholars from a variety of specialities in the Faculties of Engineering and Science are collaborating closely on three areas of growing importance and opportunity: salinity gradient power, energy recovery and storage, and biomass energy.

Salinity gradient power is the energy drawn from the difference in salt concentrations between fresh and sea water when they mix as in estuaries. It is attracting increasing attention around the world as a source of renewable energy. HKU scholars are trying to improve brine management, which is a major issue in harvesting this kind of energy, with the goal of enhancing energy efficiency and minimising the associated environmental impacts.

Energy recovery and storage is a constant concern for renewable energies. The SRT team is focused on three specific issues: recovering waste heat by applying nanomaterials and nanoengineering; investigating ways to improve the lithium-air battery by trying to identify a stable electrolyte and the best combinations of electrode materials and electrolytes; and investigating recycled lead and its use in lead acid batteries, which currently are the only economic means of storing electricity from renewable sources on a large scale.

“Clean energy technology is a major concern of governments, public interest groups, socially responsible corporations and others around the world. Our aim is to make HKU a leading international centre of clean energy research and to promote collaboration with international and Mainland scholars and organisations in this important field.

Professor S.Y.R. Hui, Convenor

Biomass energy is an alternative source of energy commonly produced through yeast fermentation. HKU scholars are aiming to generate yeast strains that have improved growth performance and yield in biofuel production. They are focusing in particular on the transportation fuel, isobutanol.

The SRT platform will enable the team to develop preliminary initiatives in these fields that, if successful, can evolve into major projects in future.

Related major work at the University includes a Theme-based Research Scheme project on 'Sustainable Lighting Technology: From Devices to Systems'.



CONVENOR:

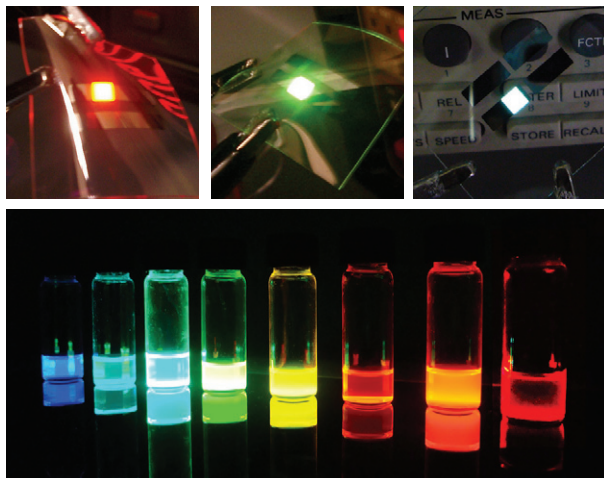
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New Materials

Harnessing energy from light is the focus of research that seeks to develop materials with the potential to advance the flow of information and improve energy efficiency.



The horizon for technology is bright with the promise of moving information and processes at ever faster speeds, over longer distances and with greater energy efficiency. One of the key areas for fulfilling this potential is in the interplay of light and electronics, which is leading to the development of new materials for such things as energy efficient lighting, displays, solar cells, electronic sensors and energy storage devices. HKU has an active and successful team working in this field, with a particular focus on optoelectronics, photonic and sensory functions, printable electronics, photovoltaics, and other electronic applications.

The team is seeking to contribute not only to industrial applications, but also to the fundamental understanding of the underlying principles and basic sciences of the materials being investigated. Work currently is focused on developing high-performance, patentable materials in the following areas:

- Organic light emitting diodes, polymer light emitting devices and organic thin film transistors that can have a huge market potential.
- Printable electronics, which hold promise for lowering manufacturing costs, especially for large-area displays.

- Devices that run on renewable energy, including organic photovoltaic devices, dye-sensitised solar cells and hybrid solar cells.
- Inorganic and carbon-based nanostructured materials that can provide an efficient way to capture and store energy.

The interdisciplinary team comes from the Faculties of Science and Engineering and includes expertise in synthetic chemistry, physics, materials science, and device and processing engineering. Its members hold major awards including the L'Oreal-UNESCO for Women in Science Award, RSC Centenary Medals and State Natural Science Awards.

As it moves forward, the SRT hopes to establish HKU as an internationally eminent research centre in new materials with functional properties.

Related major work at the University includes the 'Institute of Molecular Functional Materials' (Areas of Excellence project); 'Challenges in Organic Photo-Voltaics and Light Emitting Diodes' (Theme-based Research Scheme project); and 'Excited States of Metal Complexes' (project under the 973 programme).

“ Our research is strongly related to environmental concerns as it is about better utilising the energy we have, as well as trying to understand how we can make use of light energy to do different types of conversion.

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Earth as a Habitable Planet

Concern about global warming has led to growing awareness of the fragility of the planet and the need for a multidisciplinary approach to tackle the problem.

Researchers in astronomy, biology, chemistry, earth sciences, engineering and social sciences are all part of this Emerging SRT, which seeks to address some of the most fundamental questions facing humanity and the planet.

What impact is global warming having on animals and humans? Is the warming unusual compared to past warmings? What about human-made products – how are they affecting the environment?

These are questions all being considered in this Emerging SRT, which takes as its basis the fact that the physical, chemical and biological processes in the land, oceans and atmosphere are inter-related and are all being affected by natural and artificial causes.

Examples of the group's research output include measuring the effect of thermal stress on snails – an indicator of the impact of warming – and the urban heat

island effect in Hong Kong; investigating the different ways in which a certain human-made nanomaterial affects marine life; and digging into the past to track variations in ocean temperatures several hundred years ago based on the radiocarbon content of coral skeletons.

Ongoing and future studies aim to draw on the past to predict future changes, evaluate the current state of the planet and, in a broader context, consider what lessons can be learned about Earth by looking at objects in other solar systems.

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Frontier Technology

Frontier Technology explores new possibilities for discoveries and developments in diverse medical and technological fields.

- Computation and Information
- Drug
- Genomics
- Integrative Biology*

(* emerging theme)

Computation and Information

Computer and information technology has fundamentally changed our everyday lives through the computing, collection, processing and transmission of vast amounts of information. And the story is far from over. The power of computation is increasing by leaps and bounds. Researchers at HKU are helping to find new ways of creating, processing, managing and modelling this avalanche of data.

The Computation and Information SRT has evolved in a way that reflects the vast changes happening in these fields. Previously, there were two separate SRTs, on Computational Sciences and on Information Technology. But now they have converged, opening up the potential for new research fields to emerge.

The University's scientists already have numerous achievements in each field. They now plan to extend their work to tackle major common problems, with an initial focus on eight areas:

- The development of fast algorithms for applications in engineering, science and medicine.
- Cloud computing, in particular, enlarging cloud storage.
- Big data processing, in particular for indoor WIFI positioning with big data using the Hadoop cluster, and for the Materials Genome Initiative (see below).
- Computer graphics and 3D stereovision, which are increasingly important in helping people to understand complex datasets.
- The Materials Genome Initiative to develop new paradigms for discovering new materials. This will integrate databases, computer modelling and experiments to help speed up discovery in functional molecular materials, photovoltaic and solar cells, and drug leads.
- Emerging electronics and multi-scale simulation, with the goal of helping to address problems and gaps between quantum mechanics and the development of devices.
- Computational biology, in particular computer modelling and visualisation.
- Mathematical finance, using computational science to solve practical problems in finance and develop models for risk management and statistical arbitrage.

The Computation and Information SRT involves interdisciplinary teams from the Faculty of Engineering and the Faculty of Science.

Related major work at the University includes an Area of Excellence on 'Theory, Modeling and Simulation of Emerging Electronics'.



“By pulling together our strengths in information technology and computational science under the Computation and Information SRT, we aim to solve the major challenges that are common to both fields and thus promote further HKU's position and reputation in the world.”

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Drug

HKU is becoming a centre of innovation in drug discovery, particularly drugs derived from metal compounds and natural products in Traditional Chinese Medicine (TCM).

Building on a strong track record that includes identifying a number of anti-cancer active compounds, the SRT on Drug will expand the interdisciplinary nature of this research in the coming years.

The SRT team to date has secured several big research grants, published more than 150 papers on their drug leads and other findings, and filed 10 patent applications, 5 of which have already been granted.

They have also established infrastructure and facilities for drug discovery at HKU, developed new technologies for drug synthesis, and implemented biological mass spectrometry platforms which are playing a crucial role in understanding drug leads. Examples of the drug leads include anti-cancer gold(III) medicines which have promising anti-tumour activities to overcome drug resistance and saponins from Chinese medicines or natural products with therapeutic applications for the treatment of cancers and/or neurodegenerative diseases.



Taking this work forward, scholars in chemistry, medicine and biology are collaborating to try to convert these leads into potential patentable therapies for human diseases. They have identified several priorities:

- Anti-cancer drugs remain a primary target and they are planning to test their leads on cell- and animal-based models, and identify potential new drug leads.
- Pharmacologists are working on the design or modification of these and other leads, and will suggest how they can be delivered to the target.
- Biological mass spectrometry facilities are being strengthened to support work to profile proteins and metabolites and study the interactions between proteins and drugs.
- Greater emphasis is also being placed on developing natural products from TCM and inorganic medicines – an area where HKU, with its deep understanding of Western and Chinese medical traditions, and its strength in scientific investigations, has potential to be a world leading centre.

Their work will help to advance their objectives of advancing drug research at HKU and contributing to the cure of human diseases through interdisciplinary drug research involving the basic sciences and medicine.

Related major work at the University includes a Partner State Key Laboratory on Synthetic Chemistry.

“ Our interdisciplinary work will open opportunities for discovering new drug leads which may circumvent the problem of current chemo-resistance and enhance the success of drug development to the clinical stage.

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Genomics

Rapid advances in technology are enabling scientists to look at the gene- and protein-level changes associated with disease, which ultimately will accelerate detection, prevention and treatment.

Genomics research has been entrenched at HKU for well over a decade and our scientists have participated in major initiatives to expand knowledge in this field, including the International HapMap Project, genome-wide association studies (GWAS) and whole-exome sequencing studies (WESS).

The scientists have acquired experience and expertise in essential genomic research tools, such as DNA sequence assembly, alignment and variant calling and statistical analysis of GWAS and WESS data, and they have applied these tools with fruitful results.

Among their discoveries are new chromosomal regions (susceptibility loci) linked to a number of complex diseases such as colorectal cancer, liver cancer, Hirschsprung's disease, biliary atresia, osteoporosis, intervertebral disc degeneration and schizophrenia. They have also identified novel mutations for single-gene diseases such as congenital Crohn's disease and familial dilated cardiomyopathy (enlargement of the heart).

In the current SRT round, the team from the Faculties of Medicine, Science and Engineering hope to take the work further. New and expanded fields of work include cancer genomics, in particular locally prevalent cancers such as nasopharyngeal and hepatocellular carcinomas, as well as breast, lung, esophageal and colorectal cancers; and pharmacogenetics and personalised medicine using genomic information to predict differential responses and adverse reactions to drugs, and individual differences in disease risks and outcomes.

“ *There is huge potential for clinical translation, including molecular diagnosis of patients and families with inherited diseases, genetic risk stratification in population screening, and the identification of novel drug targets.*

Professor P.C. Sham, Convenor

”

Work will also continue in another area of considerable strength, viral and microbial genomics and evolution, which was recently extended to include bacteria with the development of a Next-Generation Sequencing platform for complete bacterial genome sequencing. The team is also evaluating the impact of drugs and other extraneous influences on gut and environmental microbiomes.

Professor Pak Sham, the Genomics SRT Convenor, said their work is underpinned by a strong infrastructure – including the University's Centre for Genomic Sciences, which provides cost-effective, high-quality core services in genomic technologies and bioinformatics – and a focus on inclusive, interdisciplinary and collaborative research.

Related major work at the University includes projects on 'Developmental Genomics and Skeletal Research' (Areas of Excellence project) and 'Functional Analyses of How Genomic Variation Affects Personal Risk for Degenerative Skeletal Disorders' (Theme-based Research Scheme project).



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Integrative Biology

The lines between scientific disciplines are increasingly being blurred. With Integrative Biology, HKU is working at the frontier of interdisciplinary research to discover new insights into human health, and diseases and their treatment.

The Integrative Biology Emerging SRT incorporates traditional and new fields in science to address fundamental biological and biomedical questions. Chemistry, physics and biology are married with genomics, proteomics, genetics and synthetic biology – as well as engineering – to investigate two new and evolving fields: structural and chemical biology, and synthetic biology.

Structural and chemical biology draws on the successes of genome sequencing to take our understanding of one-dimensional DNA sequencing to the next step. It aims to unravel molecular functions and the progression of disease, and to use these findings to develop drugs that target diseases at the molecular level.

Imaging is important to this field and HKU researchers are developing powerful methods for synthesising agents that can be used to track the location, concentration and function of proteins in cells and tissues. They are also applying other imaging techniques to research in cancer, immune disorders and microbial infections.

Synthetic biology is about the design and construction of new biological parts and new biologically based systems or devices that do not exist in the natural world. This has the potential to provide solutions in such areas as medicine, energy and the environment.

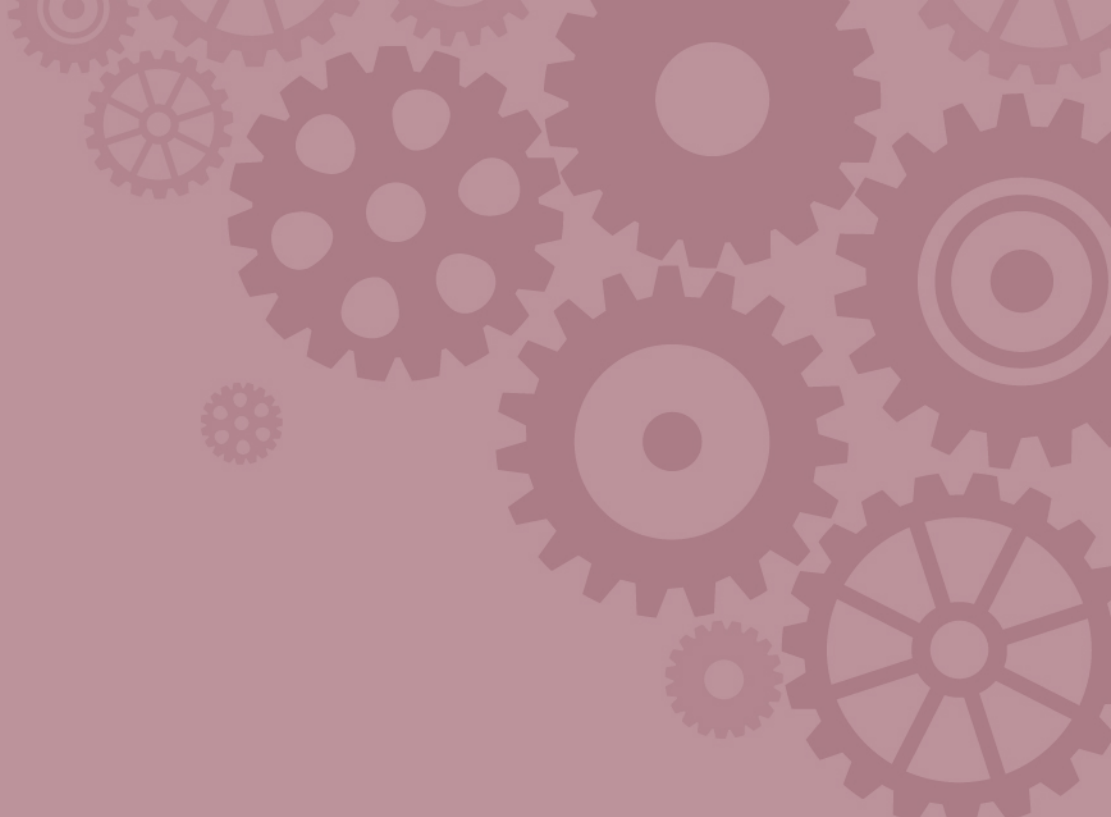
HKU scientists are focusing on genome design and construction. They are currently working to redesign and synthesise the first eukaryotic genome (a yeast genome) to help understand genome design principles, and are re-engineering the *Salmonella* genome for a bacterial treatment for cancer.

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China

Our researchers consider China's transformation into a significant world power and the cultural, economic, political and social questions related to this rapid development.

- China Business and Economics
- China-West Studies
- Contemporary China

China Business and Economics

China's spectacular growth over the past 35 years has seemingly defied the conventional wisdom that economic institutions, such as private property rights and independent legal bodies, are fundamental to economic growth. There is still much to learn about the causes and effects of China's growth and HKU is well-placed to lead the way.

The China Business and Economics SRT considers big questions of interest to businesses, academics, governments and organisations around the world: What are the mechanisms underpinning China's economic growth and the reform and development of its sectors and regions? And what are the implications of these for business strategy?

The SRT team, with members drawn from the Faculties of Business and Economics, Law and Social Sciences, is considering these issues in three key areas of China's development. The first relates to the country's economic institutions, firm strategy and economic performance. They will investigate China's market economy model and examine such topics as the role of government in the economy, the continuing dominance and role of state ownership, and the nature of state capitalism.

Second is the reform of China's financial sector, which has traditionally provided low-cost capital to the state sector at the expense of the private sector. Researchers will look at the impacts on growth and stability of the liberalisation of interest rates, exchange rates and capital accounts, and the internationalisation of the RMB.

And third is China's urbanisation and industrial transformation, in particular local protectionism, regional economic institutions, the urbanisation drive,

and industrial upgrading. These matters will also be studied by the team.

The SRT team's ultimate aim is to not only provide insights on China's economy but also strengthen Hong Kong's competitiveness. Team members have a strong track record in their field, including securing funding for an Area of Excellence project (now completed) for the Hong Kong Institute of Economics and Business Strategy.

Related major work at the University includes a Theme-based Research Scheme project on 'Enhancing Hong Kong's Future as a Leading International Finance Centre'.



“There is increasing and significant interest in understanding the Chinese economy and its implications for business strategy. Our aim is to make HKU one of the world's leading centres of research on China business and economics and by doing so, contribute to the long-term competitiveness of Hong Kong's economy.”

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China-West Studies

China and the West are interacting more than ever before. But what do they make of each other in cultural terms? Researchers at HKU are among the best-placed in the world to investigate this question.



The China-West Studies SRT places the rapidly increasing interactions between China and the West under a cultural lens. As these two realms engage in ever more exchanges of trade and knowledge, they are also sharing and experiencing each other's cultures. And that in turn may be having an impact on their own culture.

In this SRT, the researchers are looking at what happens when these two major civilisations come into contact. That contact could be seen as the mutual influences the cultures have exerted on each other, more productively, as the interpretations each culture has made of the other, and the dialectical way these changing interpretations continue to modify each culture's sense of itself.

The SRT focuses on four areas:

- The China diaspora.
- Language and culture (encompassing linguistic and cultural and philosophical understanding).
- Visual, literary and music arts.
- Rule of law development.

The researchers come from the Faculties of Arts, Law, Social Sciences and Education and their work is resulting in a number of international conferences, books and other publications, and a wide range of research grants. They are also actively collaborating with scholars from other universities in Hong Kong and overseas.

They have been exploring a wide range of topics, such as Chinese masculinity, the relationship between Western popular music sounds and images and Chinese nationalism, East-West perspectives on happiness, China's early trade relationship with the US, its strategic relationship with Europe, and the Chinese diaspora after the rise of China.

In this current SRT round, the team plans to open up more opportunities for interdisciplinary and inter-institutional collaboration and continue exploring the possibilities of not only transferring knowledge, but also making discoveries and new interpretations in the fields encompassed by the theme.



We are not content with Hong Kong's historical function as a point of access for traffic between China and the West. Instead, we see HKU as a zone of contact that is substantial in its own right, a place of intellectual creativity.

Professor S.Y.W. Chu, Convenor



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Contemporary China

All eyes are on China as it continues its rapid development and evolution into a global power. But what impact is all this having on China's society, politics and economy? HKU scholars have adopted a broad remit to better understand the changes underway in the country.

The Contemporary China SRT covers a vast topic, as vast as China itself. Yet it offers a gateway to understanding the deeper, broader currents of change occurring on the Mainland.

The SRT began in 2007 and cast its net wide to embrace a wide variety of research from the social sciences. Now it is consolidating its focus, bringing scholars with similar research interests closer together to promote greater collaboration and develop new avenues for understanding China. Three key groupings have been established based on existing strengths and potential impact:

- Urban development, under which there are specialisations in urban development in the Pearl River Delta, urban governance, and financing urbanisation.
- Social transformation, which encompasses poverty, social exclusion and security issues.
- China and the globalising world, in particular China's place in the region and the global system with a particular focus on security, trade, and bilateral relations with key powers such as the US, Japan and Southeast Asia.

The SRT has a bottom-up strategy to encourage researchers to initiate new projects, symposia, workshops and other activities. One new initiative is the Contemporary China Studies Public Lecture in which leading scholars from around the world give lectures in Hong Kong on such topics as Chinese governance in an era of rising expectations, Chinese capital in Africa, and the implications of immorality in today's China.

Participants in the Contemporary China SRT come from the Faculties of Architecture, Business and Economics, Education, Law, and Social Sciences.



“ HKU has a cadre of China experts, recognition for its research on contemporary China, and the advantages of its location. Hong Kong is part of China but separate from the Mainland, which means we have proximity, cultural affinity and a ready availability of Chinese-language materials.

Professor J.P. Burns, Convenor

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Related Major Projects

The work of the strategic research themes (SRTs) and emerging SRTs is closely related to projects at the University funded from a range of external sources, including (but not limited to) the following major funding schemes of Hong Kong and Mainland China.

<i>Project</i>	<i>Related SRT(s)/emerging SRT(s)</i>
Areas of Excellence (AoE)¹	
Center for Nasopharyngeal Carcinoma Research	Cancer
Control of Pandemic and Inter-Pandemic Influenza	Public Health
Developmental Genomics and Skeletal Research	Development and Reproduction (primary) Genomics (secondary)
Institute of Molecular Functional Materials	New Materials
Theory, Modeling, and Simulation of Emerging Electronics	Computation and Information
Theme-based Research Scheme (TRS)²	
Cell-based Heart Regeneration	Stem Cell and Regenerative Medicine
Challenges in Organic Photo-Voltaics and Light Emitting Diodes — A Concerted Multi-Disciplinary and Multi-Institutional Effort	New Materials
Enhancing Hong Kong's Future as a Leading International Financial Centre	China Business and Economics
Functional Analyses of How Genomic Variation Affects Personal Risk for Degenerative Skeletal Disorders	Development and Reproduction (primary) Genomics (secondary)
Personalized Medicine for Cardiovascular Diseases: From Genomic Testing and Biomarkers to Human Pluripotent Stem Cell Platform	Ageing
Sustainable Lighting Technology: From Devices to Systems	Clean Energy
Partner State Key Laboratories (Partner SKLs)³	
Brain and Cognitive Sciences	Neuroscience
Emerging Infectious Diseases	Infection and Immunology / Public Health
Liver Research	Cancer
Pharmaceutical Biotechnology	Ageing
Synthetic Chemistry	Drug
National Key Basic Research Development Program (973 Program)⁴	
Brain Mechanisms Underlying Chinese Language Processing and the Neurogenetic Basis for Its Disorder	Neuroscience
Excited States of Metal Complexes: Basic and Practical Researches	New Materials

¹ **AoE:** Launched by Hong Kong's University Grants Committee in 1997 and now administered by the Research Grants Council, the AoE scheme aims to nurture areas of international excellence through high-quality research and inter-institutional collaboration. HKU AoE projects: www.hku.hk/research/areas_excellence.html

² **TRS:** The TRS, launched in 2010 by the Research Grants Council, aims to focus academic research efforts on themes of strategic importance to the long-term development of Hong Kong. HKU TRS projects: www.hku.hk/research/theme_based.html

³ **Partner SKLs:** SKLs are regarded as key components of China's science and technology research system, and Partner SKLs in Hong Kong work closely with mainland research institutes. HKU Partner SKLs: www.hku.hk/research/state_key_lab.html

⁴ **973 Program:** The 973 Program of the Ministry of Science and Technology of the People's Republic of China aims to strengthen basic research in line with national strategic targets. Members of the HKU-Shenzhen Institute for Research and Innovation are eligible to apply for funding.

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