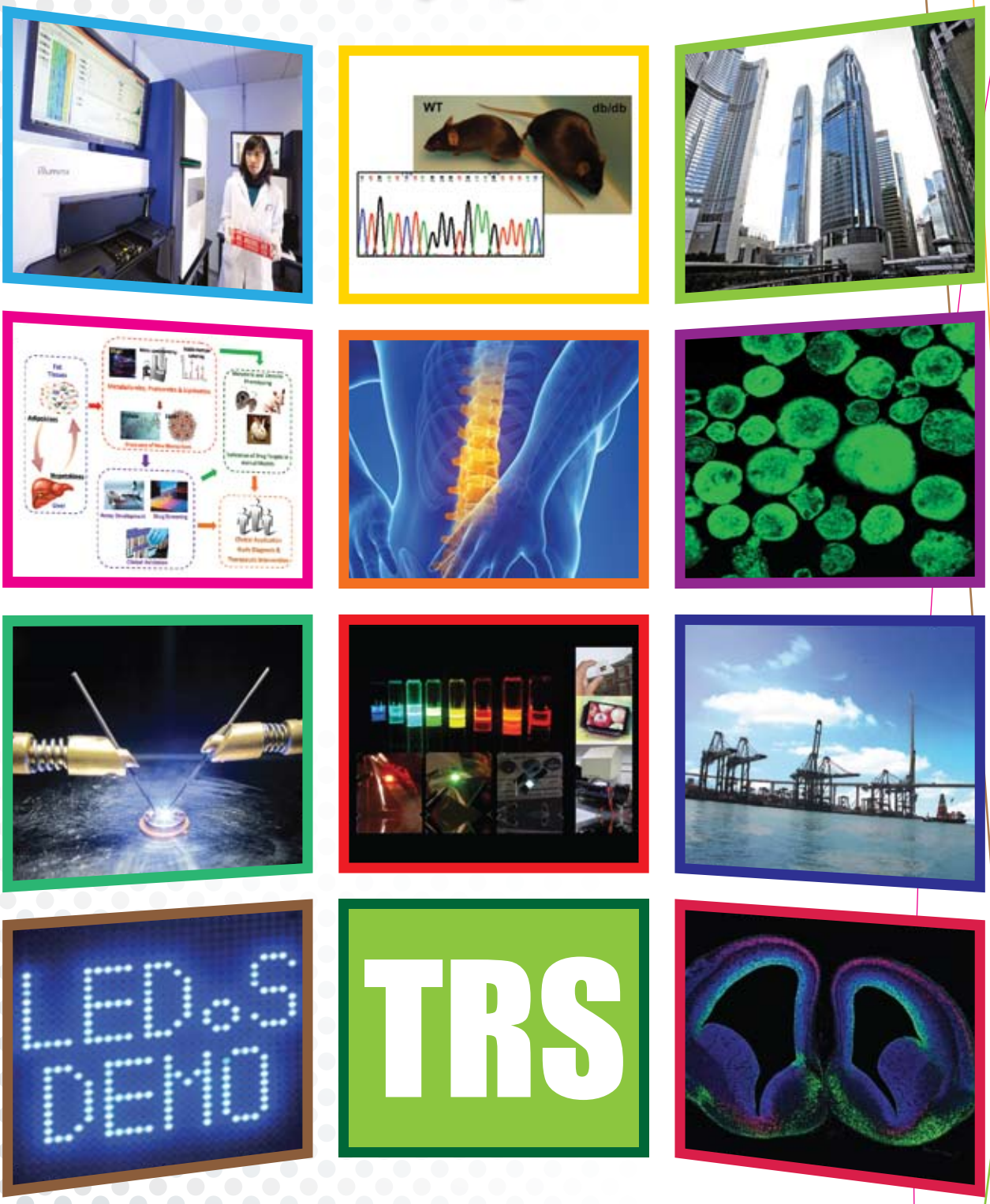
大學教育資助委員會
University Grants Committee

Theme-based Research Scheme Public Symposia 2013



14 December, 2013 (Saturday)
9:00 am – 4:05 pm, The University of Hong Kong

Theme-based Research Scheme

The Government set up a Research Endowment Fund (REF) with a one-off grant of $18 billion in 2009 to reaffirm its continued support to research and development. The investment income from up to $4 billion of the REF (around $200 million per year) is used to finance research projects on specific themes under the Theme-based Research Scheme (TRS). The objective of the TRS is to focus academic research efforts of the University Grants Comittee-funded institutions on themes of strategic importance to the long-term development of Hong Kong. The Scheme provides funding support for up to $75 million per project for a duration of up to five years. Three rounds of exercises have been completed.

The Government has identified the following three research themes for the Scheme:

(1) Promoting Good Health
(2) Developing a Sustainable Environment
(3) Enhancing Hong Kong's Strategic Position as a Regional and International Business Centre

Under the three themes, 11 grand challenge topics were identified. The topics for the first and second round exercises were:

Under the theme of "Promoting Good Health"

- Infectious Diseases
- Genomic Medicine
- Stem Cells and Regenerative Medicine

Under the theme of "Developing a Sustainable Environment"

- Water Pollution and Water Treatment
- Sustainable Built Environment
- Organic Photo-voltaic and Light Emitting Diodes[1]
- Air Quality

Under the theme of "Enhancing Hong Kong's Strategic Position as a Regional and International Business Centre"

- Hong Kong's Future as an International Financial Centre
- Promoting Hong Kong's Business Through Networking Capability
- Promoting Hong Kong as a Centre of Excellence for Business Services Innovation
- Entrepreneurship and Enterprise Organization

Public Symposia

Public symposia are held to communicate and share the achievements of the TRS projects amongst the research community and other stakeholders. This is the first round of symposia which covers the 11 projects funded in the first and second rounds of TRS in 2011/12 and 2012/13 respectively. The total funding awarded for the 11 projects under the first two rounds was $451 million.

1. Changed to "Energy Harvesting, Conversion and Conservation" in the Fourth Round

主題研究計劃

為支持及推動香港的學術研究，政府於2009年撥款港幣180億元成立了研究基金，其中40億元研究基金的投資收入（即約每年2億元）用於資助主題研究計劃，讓獲大學教育資助委員會(教資會)資助的各院校進行較長期並在策略上有利於香港發展的主題研究。

主題研究計劃下每個項目的資助金額上限約為7,500萬元。每個項目為期約5年。研究資助局已舉行了三輪研究計劃。

政府在主題研究計劃下選定了以下三個主題:
(1) 促進健康
(2) 建設可持續發展的環境
(3) 加強香港作為地區及國際商業中心的策略地位

在三個主題下設有11個具挑戰性的題目。以下為首兩輪計劃下的具挑戰性的題目:

在「促進健康」主題下有:
- 傳染病
- 基因組醫學
- 幹細胞與再生醫學

在「建設可持續發展的環境」主題下有:
- 水污染及水處理
- 可持續建築環境
- 有機光伏發光二極管[1]
- 空氣質素

在「加強香港作為地區及國際商業中心的策略地位」主題下有:
- 香港作為國際金融中心的未來發展
- 通過網絡能力推動香港商業發展
- 推動香港成為卓越的商業服務創新中心
- 企業家精神與企業組織

主題研究計劃研討會

研究資助局定期舉辦主題研究計劃研討會，讓學界及其他持份者透過參與討論，促進研究的進程和研究成果的應用。這次是研究資助局首次舉辦有關研討會，涵蓋第一輪計劃及第二輪計劃分別在2011/12年度及2012/13年度資助的共11個研究項目。該11個研究項目獲批撥款共4.5億元。

1. 在第四輪計劃改為「採集、轉化及節約能源」。

RESEARCH GRANTS COUNCIL

Theme-based Research Scheme (TRS) Public Symposia 2013

Time	Programme					
9:00-9:15	Opening Ceremony Venue: RHT					
	Theme 1 - Promoting Good Health		**Theme 2 - Developing a Sustainable Environment**		**Theme 3 - Enhancing Hong Kong's Strategic Position as a Regional and International Business Centre**	
	Presentation	Venue	Presentation	Venue	Presentation	Venue
9:20 - 10:00	T12-403/11 The Liver Cancer Genome Project: Translating Genetic Discoveries to Clinical Benefits Professor N. Wong (CUHK)	RHT	T23-713/11 Challenges in Organic Photo-Voltaics and Light-Emitting Diodes - A Concerted Multi-Disciplinary and Multi-Institutional Effort Professor V.W.W. Yam (HKU)	KB115	T31-717/12-R Enhancing Hong Kong's Future as a Leading International Financial Centre Professor D.W. Arner (HKU)	KB113
10:00 - 10:40	T12-404/11 Massively Parallel Sequencing of Plasma Nucleic Acids for the Molecular Diagnostics of Cancers Professor D.Y.M. Lo (CUHK)		T22-715/12-N Sustainable Lighting Technology: From Devices to Systems Professor S.Y.R. Hui (HKU)		T32-620/11 Transforming Hong Kong's Ocean Container Transport Logistics Network Professor C.Y. Lee (HKUST)	
10:40 - 10:55	Break					
10:55 - 11:35	T12-705/11 Personalized Medicine for Cardiovascular Diseases: From Genomic Testing and Biomarkers to Human Pluripotent Stem Cell Platform Professor H.F. Tse (HKU)	RHT	T23-612/12-R Cost-effective and Eco-friendly LED System-on-a-chip (SoC) Professor K.M. Lau (HKUST)	KB115	Poster Session (10:55 - 11:25)	RHT
11:35 - 12:15	T13-706/11 Cell-based Heart Regeneration Professor R.A. Li (HKU)		Poster Session	RHT		
12:15 - 13:30	Break					
13:45 - 14:25	T13-607/12-R Stem Cell Strategy for Nervous System Disorders Professor N.Y. Ip (HKUST)	RHT				
14:25 - 15:05	T12-708/12-N Functional Analyses of How Genomic Variation Affects Personal Risk for Degenerative Skeletal Disorders Professor K.S.E. Cheah (HKU)					
15:05 - 16:05	Poster Session					

Notes:
1. RHT: Rayson Huang Theatre, The University of Hong Kong
2. KB113 & KB115: Rooms 113 & 115, 1/F, Knowles Building, The University of Hong Kong

研究資助局
主題研究計劃研討會2013

時間	活動詳情					
9:00-9:15	開幕儀式 場地：RHT					
	主題1－促進健康		主題2－建設可持續發展的環境		主題3－加強香港作為地區及國際商業中心的策略性地位	
	研究項目簡介	場地	研究項目簡介	場地	研究項目簡介	場地
9:20 - 10:00	T12-403/11 肝癌基因組研究計劃：轉化基因發現為臨床應用 王昭春教授（中大）	RHT	T23-713/11 透過跨學科及多學院的協同努力迎接有機光伏打電池及發光二極管面臨的挑戰 任詠華教授（港大）	KB115	T31-717/12-R 提升香港全球競爭能力，打造世界一流金融中心 Professor D.W. Arner（港大）	KB113
10:00 - 10:40	T12-404/11 大規模平行測序在癌症分子診斷的應用 盧煜明教授（中大）		T22-715/12-N 「可持續」照明技術：從模塊到系統 許樹源教授（港大）		T32-620/11 振興香港海洋貨櫃運輸物流網 李忠義教授（科大）	
10:40 - 10:55	休息					
10:55 - 11:35	T12-705/11 心血管疾病個人化醫療：從人類基因及生物指標到幹細胞平台 謝鴻發教授（港大）	RHT	T23-612/12-R 低本高效、綠色環保的LED晶片系統 劉紀美教授（科大）	KB115	海報展示 (10:55 - 11:25)	RHT
11:35 - 12:15	T13-706/11 用萬能幹細胞複製「人類心臟」 李登偉教授（港大）		海報展示	RHT		
12:15 - 13:30	休息					
13:45 - 14:25	T13-607/12-R 神經系統疾病的幹細胞研究策略 葉玉如教授（科大）	RHT				
14:25 - 15:05	T12-708/12-N 基因組差異影響退化性骨骼疾病的個人風險的功能性研究 謝賞恩教授（港大）					
15:05 - 16:05	海報展示					

附註：
1. RHT：香港大學黃麗松講堂
2. KB113 & KB115：香港大學鈕魯詩樓113及115室

Grand Challenge Topic: Genomic Medicine

The Liver Cancer Genome Project: Translating Genetic Discoveries to Clinical Benefits

Project co-ordinator: Professor Nathalie Wong
The Chinese University of Hong Kong
Participating Institutions: CUHK, HKUST, HKU

Liver cancer is a highly aggressive tumor that is prevalent in China and Southeast Asia. An annual incidence of ~320,000 new patients has been reported, of which >50% occur in China. In Hong Kong, the mortality incidence from liver cancer is ~1,450 cases per year and it currently ranks the 3rd leading cause of cancer deaths. The dismal outcome for the majority of individuals diagnosed with liver cancer is largely attributed to (i) the lack of early diagnostic markers that render patients diagnosed late in the clinical course of disease progression; and (ii) most patients show low therapeutic efficiencies, which consequentially lead to an inferior survival prospect. The median survival for the majority of patients is estimated at about 11 months.

Like other cancer types, liver cancer is also a genetic disease. In the areas of liver cancer genome research, clinical diagnosis and treatment of patients, Hong Kong's researchers have broad and extensive experience. Since the 2011 exercise of the Research Grants Council Theme-based Research Scheme (first-round), Prof. Wong and research team have begun to comprehensively delineate the DNA and RNA sequence abnormalities in this cancer. The Project is a joint collaborative program of clinicians and basic researchers from The Chinese University of Hong Kong, The University of Hong Kong, The Hong Kong University of Science and Technology, Beijing Genomics Institute – Shenzhen and The State Laboratory of Oncology in South China. Understanding that current limitations in the clinical management of liver cancer patients is largely due to the paucity of information related to its malignant transformation from liver cirrhosis and the biology of liver metastasis, this Project proposes to conduct large-scale genome-wide analyses to define genetic events which discriminate tumor from cirrhosis and progression to metastatic disease. The deployment of innovative next generation sequencing will offer unprecedented depth, speed and capacity to widely elucidate somatic variations at the genome and transcriptome levels. The instigation of this 'Liver Cancer Genome Project' will have strategic importance in cataloguing the genetic blueprint of liver cancer which in turn will provide the foundation for research into identifying targets for therapies, biomarkers for early diagnosis, and prognostic indicators for predicting recurrence. This program is also expected to make significant impact in developing effective disease control strategies for this commonly fatal cancer.

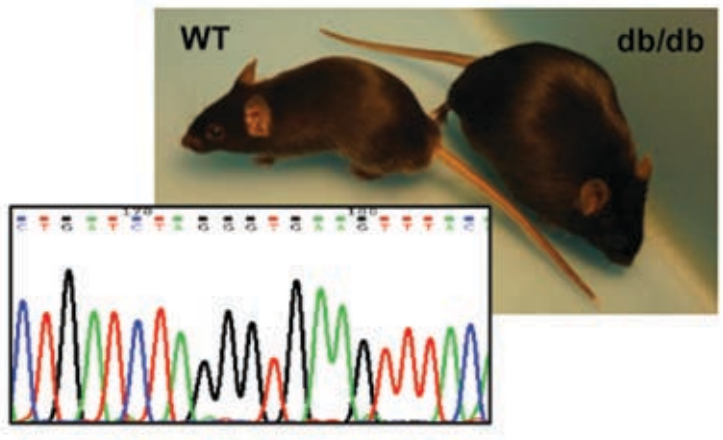
具挑戰性的題目：基因組醫學

肝癌基因組研究計劃：轉化基因發現為臨床應用

項目統籌人：王昭春教授
香港中文大學
參與院校：中大、科大、港大

肝癌是中國及東南亞常見的高度惡性腫瘤。全球每年約有32萬新增患者， 而中國佔半數以上案例。現時香港肝癌死亡率每年平均約為1450人，位列第三主要癌症死亡原因。對於肝癌患者的臨床治療，目前醫療人員面對兩個重要問題 : (1) 由於缺乏有效的早期診斷標誌物，多數患者確診時病情已進展為中期或晚期肝癌; (2) 肝癌患者的治療效果普遍較差，存活率低，造成大多數肝癌患者生存期短的主要原因 (中位數約為11個月) 。

肝癌和其他癌症都是由基因組突變引致的疾病。在肝癌的基因組研究及臨床診斷，治療等領域，香港研究團隊有深厚的基礎和經驗。自2011年度第一輪的主題研究計劃，王教授及團隊利用先進的DNA及RNA平行測序技術開始落實對肝癌基因組作出全面分析。此合作項目由多位來自香港中文大學，香港大學，香港科技大學，華大基因(深圳)研究所及華南腫瘤學國家重點實驗室的著名學者及醫生主持。現時治療肝癌病人的效果並不理想的主要原因是對肝硬化轉為肝癌及肝癌擴散的基因突變和生物機制的認識有限。此計劃針對這些問題而利用大規模平行測序技術建立肝癌的全基因組藍圖。先進的平行測序技術不但可以快捷有效地發現與肝癌有關的基因突變，更可全面分析其基因組結構變化及轉錄水平， 確定引致肝癌轉化及擴散的基因改變。構建肝癌基因藍圖將為建立嶄新治療技術，發展肝癌特有早期診斷，預後和復發預測方法提供重要基礎信息及研究線索。此研究計劃成果將在對有效控制肝癌作出重大貢獻，給肝癌患者帶來新希望。



Grand Challenge Topic: Genomic Medicine

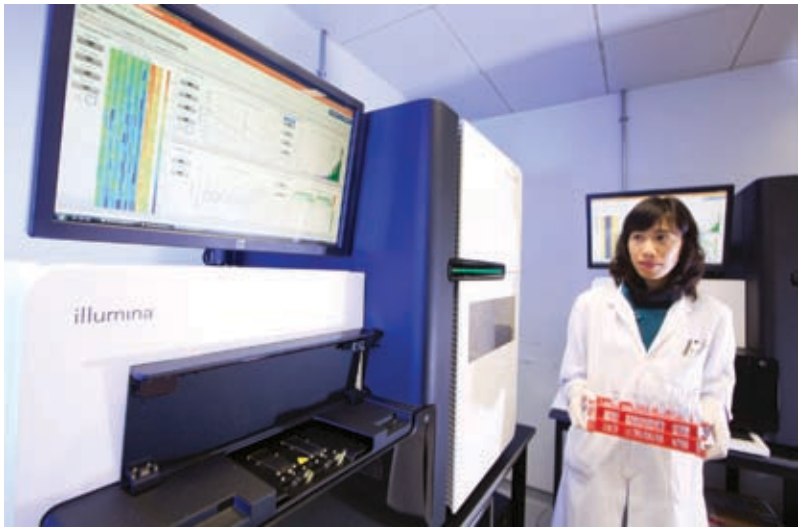
Massively Parallel Sequencing of Plasma Nucleic Acids for the Molecular Diagnostics of Cancers

Project co-ordinator: Professor Dennis Y.M.Lo
The Chinese University of Hong Kong

Cancer is the top killer in Hong Kong and many parts of the world. The lack of effective tools for the timely detection and dynamic monitoring of cancer has hindered efforts in combatting cancer. The Project Team is a world-leading group in the biology and diagnostic applications of plasma nucleic acids. The advent of massively parallel DNA sequencing has created a paradigm shift in genomics research. The group is among the first to demonstrate the use of massively parallel sequencing as a diagnostic tool. The group has pioneered a number of novel approaches for applying massively parallel sequencing for the detection and analysis of plasma nucleic acids at an unprecedented level of sensitivity, resolution and comprehensiveness. Tumour-derived DNA molecules have been known to exist in the plasma of cancer patients. In this project, the group proposed to develop technologies for applying massively parallel sequencing of plasma nucleic acids as a detection and monitoring tool for cancer. The team aimed to develop technologies that would allow a non-invasive genome-wide scan of cancer-associated genetic alterations in plasma. In a first study accomplished by the project team (Chan et al Clinical Chemistry 2013; 59: 211-224), the team achieved the genome-wide profiling of copy number aberrations and point mutations in the plasma of four patients with hepatocellular carcinoma and a patient with synchronous breast cancer and ovarian cancers. By detecting and quantifying the genome-wide aggregated allelic loss and point mutations, the team determined the fractional tumour-derived DNA concentrations in plasma and correlated those values with tumour size and surgical treatment. The team demonstrated that the approach was useful for the analysis of complex oncological scenarios by studying the patient with two synchronous cancers. Through the use of multi-regional sequencing of tumoural tissues and massively parallel sequencing of plasma DNA, plasma DNA sequencing was shown to be a valuable approach for studying tumoral heterogeneity. The team believed that a plasma-based approach for genome-wide scanning of cancer-associated genetic aberrations would allow the development of generic cancer detection tests with broad population coverage. Such an approach could be contrasted with other approaches available to date where only a subset of cancer-related molecular alterations would be targeted at each instance. The project team was the first to achieve the non-invasive detection of cancer-associated genetic changes in a genome-wide manner. The achievement was publicised by the media, for example in the Genomeweb (http://www.genomeweb.com/node/1141026?hq_e=el&hq_m=1378254&hq_l=1&hq_v=34f6359008#main-content). Subsequent to the team's publication, studies from two other groups have also confirmed the feasibility of the approach. The project team is currently improvising the technique to reduce its costs and to assess its applicability to other cancer types. The ultimate goal is to develop tests that enable the timely detection, real-time monitoring and accurate prognostication of cancer. These goals, when realised, would significantly impact cancer management and bring health benefits to the citizens of Hong Kong and worldwide. This project is also expected to generate valuable intellectual properties which would stimulate the developments of biotechnology in Hong Kong.

具挑戰性的題目：基因組醫學
大規模平行測序在癌症分子診斷的應用

項目統籌人：盧煜明教授
香港中文大學



癌症是香港及世界多個地區的頭號殺手，因為缺乏有效的快速檢測和動態監測方法，造成我們對抗癌症的障礙。本項目團隊在研發有關血漿核酸的生物學及診斷應用科技方面在國際上處於領先的地位。高通量平行定序的發展開創了基因組學研究上的模式轉變。我們是世界上最先將高通量平行定序技術應用到醫學診斷的團隊之一，並以多種新穎的方式將高通量平行定序應用於血漿核酸分析上，以達至前所未有的靈敏度，分辨率和全面性。由於我們已知源自腫瘤的DNA分子存在於癌症病人的血漿內，因此研究團隊提出將高通量平行定序分析血漿核酸的技術應用在癌症發現及監控方面，而團隊的目標是要發展非入侵性的血漿全基因組癌症相關變異基因普查。在團隊第一個完成的研究項目中 (Chan et al Clinical Chemistry 2013; 59: 211-224），我們實現了利用四名肝癌及一名同時患有乳腺癌和卵巢癌的患者血漿中測定出全基因組拷貝數變異及基因點突變，透過檢測和定量全基因組匯總的等位基因缺失及基因點突變，研究團隊確定了來自腫瘤的DNA濃度比例，並將此數據與腫瘤大小及手術療程得出關聯性。團隊發現這方法可用於分析複雜的臨床個案，例如檢測同步癌。通過比較多個位置的腫瘤組織測序及血漿核酸高通量平行定序，可以證明血漿核酸定序對於腫瘤的異質性研究特別有效。團隊認為以血漿分析為本的全基因組癌症相關變異基因普查能促進發展給普羅大眾採用的普及癌症檢測試驗。這方法與別不同之處在於其他現有方法只能檢測少數癌症相關變異基因，而我們是第一個研究團隊成功以非入侵性方法檢測出全基因組的癌症相關基因變異。這研究成果已被媒體報導，如 Genomeweb (http://www.genomeweb.com/node/1141026?hq_e=el&hq_m=1378254&hq_l=1&hq_v=34f6359008#main-content)。在我們的文章發表後後，已有另外兩組研究隊伍分別確認這方案的可行性。現時，研究團隊正改良檢測技術，以減低成本及評估其於其他癌症的適用性。當這目標實現時，我們有信心這技術將會深遠影響癌症的診斷及指引治理方針，及對香港和世界各地人民的健康帶來益處。這項目也預計能產生有相當價值的知識產權，促進香港的生物技術發展。

Grand Challenge Topic: Genomic Medicine

Personalized Medicine for Cardiovascular Diseases: From Genomic Testing and Biomarkers to Human Pluripotent Stem Cell Platform

Project co-ordinator: Professor H.F. Tse
The University of Hong Kong
Participating Institutions: CUHK, HKUST, HKU

Cardiovascular diseases (CVD) are leading global cause of morbidity and mortality. Despite recent advances in the management of cardiovascular risk factors such as hypertension, diabetes, dyslipidemia and obesity, the prevalence of CVD continues to increase worldwide especially in Asian country, including China and Hong Kong. Beside life-style and environmental factors, blood lipid levels are under tighter genetic control than the related CVD. This highlights the need for new approaches beyond monitoring of conventional serum lipid levels to prevent, identify and treat individuals who are at risk of developing CVD.

In this project, we sought to discover novel genetic markers that are associated with blood lipids and coronary artery disease (CAD) in our Chinese population cohorts. We have performed genotyping using a custom-made state-of-art human exome chip which can detect more than 0.3 million genetic variants in human. Our preliminary data have identified several potentially new genetic markers that are associated with abnormal lipid levels and CAD in our Chinese population in Hong Kong. We plan to further validate these initial findings using the exome chip in a large cohort of Southern Chinese subjects in Hong Kong and China.

In order to understand the potential important of these novel genetic markers, we have established human pluripotent stem-cell systems that allow us to generate different human tissues, including liver and heart cells in a dish (in-vitro). These human tissue platforms can allow us to study the relationship between those new genetic makers and cellular function in those tissues, and thus provide novel insights into the mechanisms of dyslipidemia and CVD. Currently, we have successfully generated patients-specific liver cells using our established pluripotent stem cell platforms from several families with severe familial hypercholesterolemia due to genetic mutation on low-density lipoprotein receptor that lead to premature CAD for disease modeling and drug testing. Moreover, we also successfully create a mice model of severe dyslipidemia due to the similar genetic mutation at the low-density lipoprotein receptor to validate our in-vitro study findings and for in-vivo assessment of the pathophysiology and drug testing for dyslipidemia.

Based on the new knowledge that we gain from these genetic and experimental studies, we are currently developing different novel genetic and biomarker-based diagnostic tools for risk stratification, prognosis and therapeutic monitoring of dyslipidemia and CVD. We have identified several hormones that secreted from human liver and adipose cells are associated with CVDs in Hong Kong Chinese. The potential clinical implications of these biomarkers for diagnosis and prediction of CVDs will be further investigated in our ongoing prospective human studies.

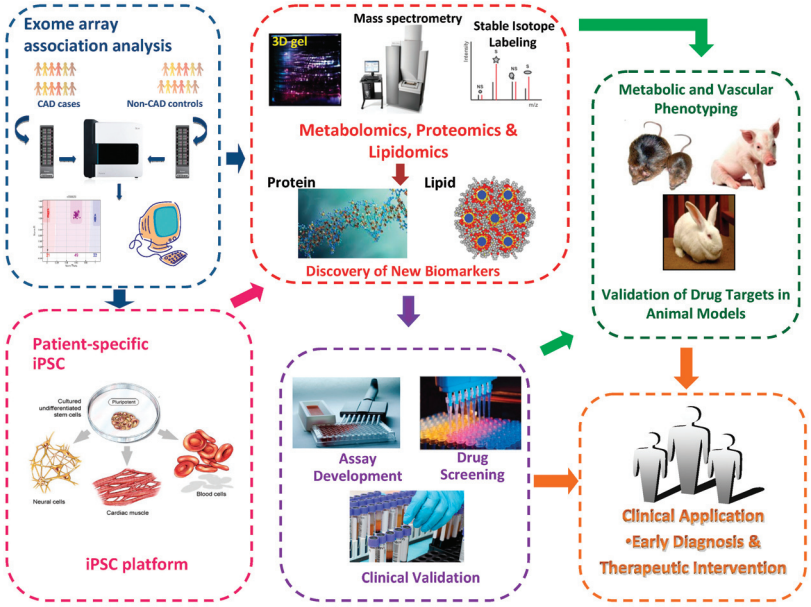
Taken together, our study should offer novel insight into the complex pathophysiology of dyslipidemia and CVDs that can potentially translate into new approaches to personalized medicine for prevention, diagnosis and treatment CVD.

具挑戰性的題目：基因組醫學

心血管疾病個人化醫療 ：從人類基因及生物指標到幹細胞平台

項目統籌人：謝鴻發教授
香港大學
參與院校：中大、科大、港大

心血管疾病是全球發病率和死亡率最高的疾病。儘管現今對心血管疾病危險因子的監控，如高血壓、糖尿病、血脂異常和肥胖，已經取得了很大的進展，心血管疾病的發病率仍然不斷提高，尤其在亞洲，包括中國和香港。除了生活方式和環境因素外，基因調控比心血管疾病本身對血脂水平的影響更為緊密。因此，要更有效預防，鑒定和治療心血管疾病，除常規血清脂質水平監測外，一套能識別、預防及醫治個別高危患者的完善疾病監控系統是不可缺少的。



在這項研究中，我們嘗試在中國人群中開發一種嶄新的，與血脂和冠狀動脈疾病有關聯的遺傳標記。我們利用一個先進的人類外顯子芯片進行了基因分型，它可以檢測超過三十萬個人類遺傳變異。我們的初步研究數據已經證明了幾個在香港人群中潛在的，與血脂異常和冠狀動脈疾病有密切關係遺傳標記。我們將使用外顯子芯片在香港及中國大陸南方人群中進一步驗證這些初步研究結果。

為了解這些新的遺傳標記的重要性，我們已經建立了人類多能幹細胞系統，使我們能夠在體外的培養器皿中定向分化成不同的人體組織，如肝臟和心臟細胞等。這些體外人體組織平台可以讓我們研究在這些組織中新的遺傳標記與細胞功能之間的關係，提供新的視野去探討血脂異常和心血管疾病的機制。目前，我們已經成功從幾個因低密度脂蛋白受體(LDLR)基因突變而引致的患有嚴重家族性高血脂和早發冠心病的家庭，獲得其多能幹細胞，並定向分化為肝細胞，從而建立疾病模型和藥物測試平台。此外，我們還通過低密度脂蛋白受體基因突變，成功地創建一個嚴重的血脂異常小鼠模型，用於驗證體外研究結果，以及體內評估血脂異常的病理生理過程和藥物測試。

從上述基因檢測和實驗研究的基礎上，我們目前正在開發一種嶄新的遺傳和生物標誌物的診斷工具，以助血脂異常與心血管疾病的風險評估 、預後和治療監測 。在香港人群中我們已證實了幾個從人體的肝臟和脂肪細胞分泌的激素與心血管疾病有緊密關聯。我們將進一步評估這些以生物標誌診斷和預測心血管疾病的臨床應用。

綜上所述，我們的研究提供新的視野去探討血脂異常和心血管疾病複雜的病理生理機制，並轉化為個性化醫療新方法，以用於預防 、診斷和治療心血管疾病。

Grand Challenge Topic: Stem Cells and Regenerative Medicine

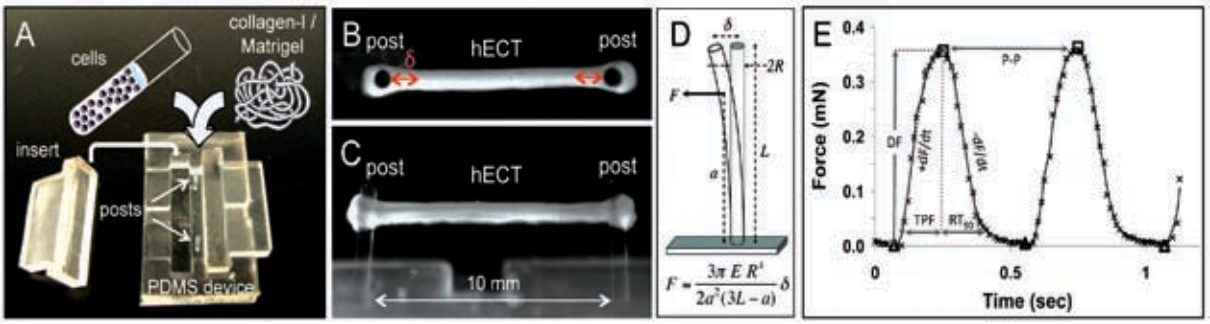
Cell-based Heart Regeneration

Project co-ordinator: Professor Ronald A. Li
The University of Hong Kong
Participating Institutions: CityU, CUHK, HKUST, HKU

Heart diseases are a major cause of death worldwide. Loss of cardiomyocytes (CMs) due to aging or diseases is irreversible. Current therapeutic regimes are palliative; in end-stage heart failure, transplantation remains the last resort but is significantly hampered by a severe shortage of donors. Human embryonic stem cells (hESCs) can self-renew while maintaining their pluripotency to differentiate into all cell types, including CMs. Direct reprogramming of adult somatic cells to induced pluripotent stem cells (iPSCs) has been achieved. The availability of hESC/iPSCs has enabled researchers to gain novel biological insights and to pursue heart regeneration.

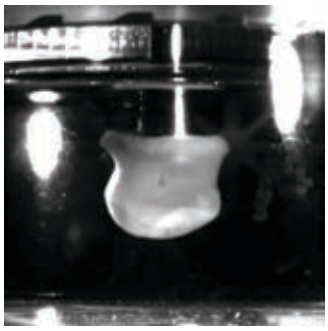
Despite these promises, substantial hurdles remain for translating into cell-based therapies and other applications (e.g., for disease modeling, cardiotoxicity and drug screening). Based on our team's own work in the past decade, we identified major gaps: hESC-CMs have immature properties, small physical size (~10x<adult CMs), absence of ordered organization, poorly-defined immunobiology and sub-lineage specification, uncertain safety and efficacy.

With the TRS support from HKSAR's RGC, we are making significant scientific and technological advancements to address these questions. For instance, we have now developed several patented technologies for mass producing ventricular muscle cells, engineering a range of custom-designed bio-artificial human heart tissues, from 2D cardiac patch and "disc" to 3D cardiac "micro-hair" for high-throughput screening and more physiological human heart muscle strips as well as chambers (a.k.a. mini-heart) that collectively serve as state-of-the-art in vitro diagnostic tools with higher sensitivities and accuracies, as well as future transplantable prototypes. In the process, we are also gaining invaluable fundamental insights into the underlying biology, adding values to the existing body of literature. Such effort in the past two years has resulted in a total of over 40 publications, and a cadre of locally trained stem cell biologists. It is our anticipation that our project will continue to significantly advance the field and lead to translations that benefit the community during the remaining funding period.



具挑戰性的題目：幹細胞與再生醫學
用萬能幹細胞複製「人類心臟」

項目統籌人：李登偉教授
香港大學
參與院校：城大、中大、科大、港大



心臟疾病是全球人類的主要死亡原因之一，因衰老或者疾病造成心肌細胞死亡是不可再生的。目前的治療方案均治標不治本，器官移植是晚期心衰病人的最終選擇，卻面臨嚴重缺乏器官捐獻的困境。人類胚胎幹細胞（Human embryonic stem cells)能夠自我更新並且保持分化成包括心肌細胞在內的所有細胞類型的能力。將成人體細胞直接重編程為多能幹細胞的技術也已被攻克。人類胚胎幹細胞和誘導性多能幹細胞為研究心臟再生提供了新思路。

盡管如此，細胞療法和幹細胞的其他應用，例如疾病模型（disease modeling)，心臟毒理(cardiotoxicity)和藥物篩選,還面臨著很多挑戰。我們團隊經過十多年的研究甄別出其中主要原因是：人類胚胎幹細胞分化而來的心肌細胞特性不成熟，體積小（比成人心肌細胞小約十倍），缺乏有序的組織，免疫反應不明，沒有子系鑒別，其安全性和有效性也沒有得到驗證。

在香港特區政府研究資助局（RGC）的主題研究（TRS）支持下，我們對上述課題的研究取得了長足的科學進展。我們已經研究出數項專利技術，例如批量制造心室肌細胞，一系列可以定制的人工心臟組織，包括二維的心肌片，細如發絲的用於高通量篩選的三維心肌組織，更加模擬生理環境的人類心臟束，以及人工心腔（即小型心臟），這些都可以用作高靈敏高準確性的體外診斷工具，或者未來用於移植的原型。與此同時，我們還正在對其中的生物機理做著深入的研究。在過去的二年我們發表了四十余篇論著，培養了一批幹細胞生物學者。我們相信我們的項目在今後的資助期內能夠繼續大力拓展該領域，並將基礎研究轉化為臨床和其他應用，從而造福社會。

Grand Challenge Topic: Stem Cells and Regenerative Medicine

Stem Cell Strategy for Nervous System Disorders

Project co-ordinator: Professor Nancy Y. Ip
The Hong Kong University of Science and Technology
Participating Institutions: CUHK, CityU, HKUST, HKU

In the adult mammalian brain, neurons are continuously generated from neural stem cells. These newly generated neurons are then integrated into the neural circuit. This observation has led to two promising approaches to treat various brain disorders: transplanting exogenous neural progenitors (precursors of neurons) and increasing endogenous production of neurons. Examples include replacing lost/damaged neurons by exogenous neural progenitors in Parkinson's disease, and promoting endogenous production of neurons to enhance the action of antidepressants in various psychiatric disorders such as clinical depression. However, the mechanism by which neural stem cells amplify, proliferate, and differentiate into neurons and integrate into the existing neural circuit remains unclear, and represents a major obstacle to developing therapeutic interventions.

This inter-disciplinary project has two goals: (i) to understand the process by which neurons are generated from neural stem cells and then integrate into the neural network; and (ii) to identify small molecules derived from traditional Chinese medicine (TCM) to treat brain disorders. We have made significant progress in the first year and some of the highlights are featured below.

First, we have identified a novel mechanism that regulates neurogenesis and cortical expansion, a finding which has significant implications in understanding the evolution of the brain and the pathophysiology of autism. There is an enormous production of neurons and growth in brain size during embryonic development, deregulation of neuronal production at the embryonic stage results in neurodevelopmental disorders such as autism. Development of the mammalian cerebral cortex has been thought to be regulated by the generation and differentiation of a specific type of neural progenitor cells known as intermediate progenitor cells. However, direct evidence to prove this has been elusive. Our recent studies show that precise regulation of amplification and differentiation of these neural progenitor cells controls the growth of the cerebral cortex and the brain. Additionally, we have successfully identified the key molecular signals that direct this process.

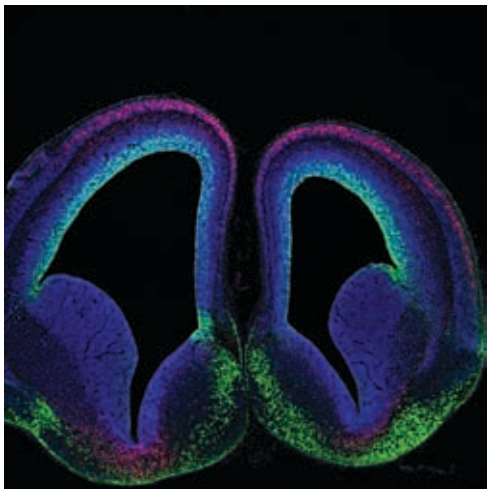
Proper integration of newborn neurons into the neural circuit is critical for normal brain functioning. To achieve this, the neurons need to migrate to the correct position. We have successfully identified new molecular controls that initiate the migration of these neurons. This important discovery will promote understanding of the pathophysiology of neurodevelopmental disorders such as autism and schizophrenia.

The third finding concerns a protein complex that controls the division and differentiation of neural stem cells. We have delineated the structures of several proteins in the complex at atomic resolution and obtained biochemical evidence of how the interaction of these proteins controls neuronal production. This will enable us to develop therapeutic interventions for diseases that require enhancement of endogenous neuronal production or neuron replacement therapy.

We have also successfully identified small molecules from TCM that can help neurons to connect with, and integrate into, the existing neural network. Furthermore, adult neurogenesis is functionally important for mood control and cognition, and we have demonstrated the beneficial effects of the small molecules in learning and memory as well as in mood control. Additional studies will determine their candidacy as cognitive enhancers or antidepressants.

具挑戰性的題目：幹細胞與再生醫學
神經系統疾病的幹細胞研究策略

項目統籌人：葉玉如教授
香港科技大學
參與院校：中大、城大、科大、港大



在成年哺乳動物的大腦中，神經細胞仍然可以由神經幹細胞源源不斷地製造出來。新生的神經細胞可以整合進入已有的神經回路去發揮功能。這些現象啓迪科學家們發展多種具有很大潛力的科學手段用來醫治腦疾病，其中包括移植外源性的神經幹細胞或者促進內源性神經細胞生成等方法。譬如說，我們可以用外源神經幹細胞產生的新生神經細胞來替代柏金遜症中受損的神經細胞，或者通過促進內源性神經細胞的再生來增强抗抑鬱藥物的治療效果。然而，目前對神經幹細胞增殖、分裂、分化和整合進神經回路機理的研究仍然欠缺，限制了治療手段的發展。

此跨學科項目希望達到以下兩大目標：（1）深入瞭解神經幹細胞產生神經細胞，並整合進入神經網絡的全過程；（2）從傳統中藥中篩選出小分子藥物用于治療腦疾病。在項目開始第一年的研究中，我們已經取得豐碩的成果。

首先，我們發現了一個調控神經細胞生成和大腦皮層擴張的新機理，對於揭示大腦的進化和自閉症的發病機理有重大意義。胚胎發育期伴隨著大規模的神經細胞生成和大腦體積的增長，而失控的神經細胞生成會導致神經發育性疾病，例如自閉症。有假說認為，一種名為“中間前體細胞”的神經前體細胞是調控大腦皮層的發育和擴張的關鍵。然而，在過往的研究中科學家們並沒有找到直接證據來驗證此假說。我們的發現首次證明了中間前體細胞的增殖和分化確實對大腦皮層的生長有調控作用，並成功的找到了控制這一過程的關鍵信號分子。

其次，我們成功發現新生神經細胞遷移的分子機理。新生神經細胞必須沿著一定的路徑遷移至正確位置。這是它們整合進入神經回路，並行使正常功能的必要條件。我們的成果將有助於瞭解自閉症和精神分裂症等神經發育性疾病的機理。

我們的第三個發現是關於一個調控神經幹細胞分裂和分化的信號分子復合物。我們在原子水平解釋了這一大分子蛋白復合物的結構，並用生物化學方法揭示了這些蛋白控制神經細胞產生的原理。這一研究將有助於我們開發促進神經細胞再生或者替代缺失細胞的方法用於治療相關的腦疾病。

我們還從傳統中藥裏篩選出能够幫助神經細胞整合進現有神經回路的小分子化合物。由于成年期神經細胞生成對於情緒調節和認知能力有重要功用，我們也確認了這些小分子有益於學習記憶以及情緒控制。我們將會繼續發掘這些小分子作為提升認知能力或者抗抑鬱藥物的潛力。

Grand Challenge Topic: Genomic Medicine

Functional Analyses of How Genomic Variation Affects Personal Risk for Degenerative Skeletal Disorders

Project co-ordinator: Professor Kathryn S.E. Cheah
The University of Hong Kong
Participating Institutions: CityU, HKU

Low back pain can make life unbearable for millions of people worldwide and presents a huge socioeconomic and health-care burden. Intervertebral disc degeneration (IDD) is a major cause of back pain. Although environmental and lifestyle factors can affect the onset, severity and progression of disc degeneration, family and twin studies have shown a strong genetic predisposition in the development of IDD. Because IDD is so common, almost everyone will have some degree by the time they are 50 years of age or older. Many genetic factors are thought to be involved, but so far only a few have been found and the disease mechanisms of IDD are poorly understood, hampering preventative measures and the development of therapies. The challenges are to define how genetic variations contribute to the risk, onset, severity and progression of IDD.

As an internationally recognized, leading multidisciplinary team of clinicians and scientists with a successful history of collaboration, we are building on our research on a Hong Kong population cohort, which is the world's largest. This cohort, an integral part of the programme, is comprised of approximately 3,500 individuals, collected over a decade, with DNA samples, spine MRI scans, demographic, environmental, lifestyle and clinical information. From our research we have already discovered several genetic risk factors that influence susceptibility to IDD.

To address the challenges, we aim to identify additional genetic risk factors that influence the onset, progression and severity and understand the mechanisms involved. The cells in the disc have their origins in the developing embryo during gestation. It is thought that the presence of embryonic-like cells in the centre of the young adult disc are protective against IDD but this is not proven. As it is hard to obtain normal human discs to study, knowledge of the normal development and process of degeneration of the human disc is limited. We therefore aim to understand the biology of the cells in the disc in normal embryonic development, in growth and in the degenerative process. We are using state-of-the-art technologies in genomics, generation of animal models, establishment of stem cells and cells of the intervertebral disc from animal and human tissues, and bio-engineered materials to understand the relationship between genes and disc cell function as well as cell survival to better understand the impact on IDD.

In the first year of the programme, we have obtained exciting new leads to additional genetic risk factors. Using the mouse as a model, we have obtained comprehensive genome-wide information on the genes that are expressed in early embryonic and newborn disc cells, which are already providing important insights into the developmental processes.

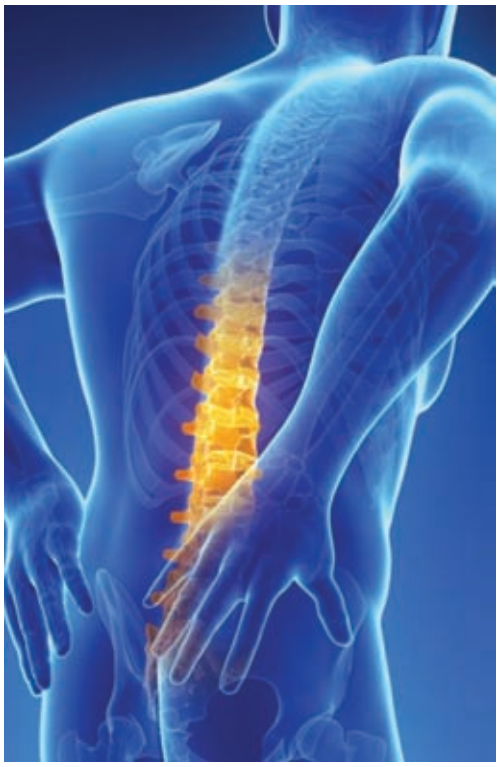
Through this programme of research, we will deepen knowledge of the biology of IDD and the signals responsible for maintaining a healthy disc, assess the functional impact of putative genetic risk factors and gain insight with implications for prognosis. By integrating this knowledge with clinical, environmental and lifestyle factors, we will be able to predict total personal risk for IDD that will improve prevention and disease management.

IDD cannot be treated by drugs and current cell-based therapies face considerable hurdles. Long-term applications include: prediction of total personal risk for IDD that will improve prevention and disease management; design of improved cell-based therapies to protect healthy discs from degeneration and retard or reverse the degenerative process.

具挑戰性的題目：基因組醫學

基因組差異影響退化性骨骼疾病的個人風險的功能性研究

項目統籌人：謝賞恩教授
香港大學
參與院校：城大、港大



腰背痛給數以百萬計的人帶來難以忍受的痛苦並造成龐大的社會和醫療負擔。椎間盤退化（IDD）是腰背痛的主因。雖然環境及生活方式等因素也可影響IDD的發生、發展及嚴重程度，家系及雙胞胎的研究表明IDD具有較強的遺傳易感性。由於IDD頗為常見，幾乎每人在50歲或以後都有某種程度的退化。雖然不少遺傳因子都被認為與此相關，目前僅找出少數而其病理機制仍很不清楚，無法據以提出預防措施，也阻礙了新療法的研制。本領域面臨的挑戰就是確定基因差異如何影響IDD的風險、發生、發展及嚴重程度。

我們的多學科團隊由臨床醫學專家和科學家共同組成，在國際上得到公認並具領導地位，有多年的成功合作經驗。我們的研究建基於從香港人口中收集到的全世界最大的樣品庫，此樣品庫的收集前後歷經十多年，共有近3500人份的DNA樣本，其脊柱磁力共振成像掃描圖、地域、環境、生活方式與臨床資料一應俱全。目前我們已發現若干個可影響IDD易感性的遺傳風險因子。

我們的研究目標是找出影響IDD發生、發展與嚴重程度的更多遺傳風險因子並闡明其機理。椎間盤的細胞來源於發育中的胚胎，據此認為在年輕的成人椎間盤的中央具有胚胎樣的細胞，可保護椎間盤免於退化，但這一學說尚未得到證實。由於較難獲得正常的人類椎間盤開展研究，有關人類椎間盤的正常發育及退化的知識仍十分有限。因此，我們要了解正常胚胎發育、生長及退化過程中椎間盤細胞的生物學。我們正採用現代基因組科技，構建動物模型，建立幹細胞及來自動物及人類組織與人造生物醫學材料的椎間盤細胞，從而揭示基因與椎間盤細胞功能和存活的關係及其對IDD的影響。

在本項目的第一年，我們已在找出更多遺傳風險因子方面取得重要的新進展。利用小鼠作為模型，我們已獲得在早期胚胎發育期間及新生兒階段的椎間盤細胞所表達基因的全基因組綜合分析數據，並以此揭示了椎間盤發育的重要原理。

透過本項研究我們將深化對於椎間盤生物學的認識，更好地理解負責維持椎間盤健康的信號，並評估所推斷的遺傳風險因子的功能性影響，以確定其診斷意義。將此與臨床及環境因子共同考慮，可望預測椎間盤退化的總體個人風險，提高IDD的防治水平。

IDD無藥可治，目前的細胞療法也有很大的局限。我們的研究成果的遠期應用包括預測椎間盤退化的總體個人風險，提高防治水平，設計和改進新的細胞療法，使健康椎間盤免於退化，並延緩甚至逆轉退化過程。

Grand Challenge Topic: Organic Photo-voltaic and Light Emitting Diodes

Challenges in Organic Photo-Voltaics and Light Emitting Diodes – A Concerted Multi-Disciplinary and Multi-Institutional Effort

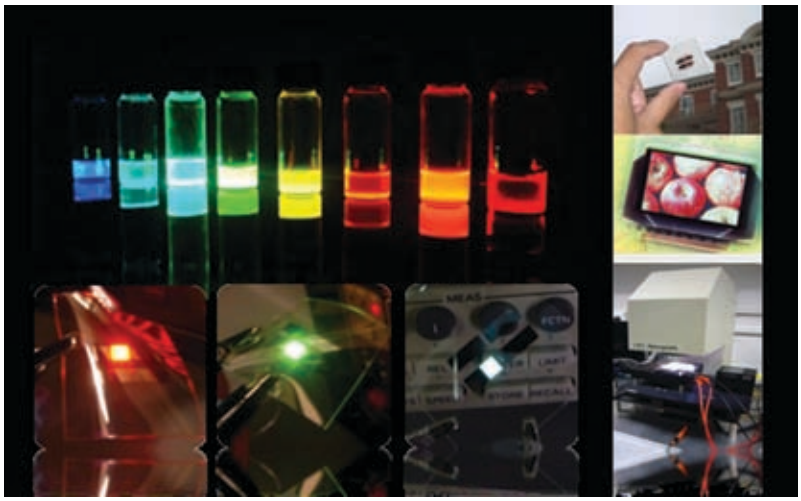
Project co-ordinator: Professor Vivian W. W. Yam
The University of Hong Kong
Participating Institutions: CityU, HKBU, PolyU, HKUST, HKU

With the huge and fast-growing population and an upcoming depletion of fossil fuels, there is an urgent need and pressing demand for a low carbon or carbon-neutral energy economy. Development of clean renewable energy and new measures for reducing the energy demand are definitely needed to meet the grand challenges. Organic light-emitting diodes (OLEDs) are recognized as a viable candidate for the launching of a more efficient solid-state lighting system, while the discovery and development of efficient organic photovoltaic (OPV) devices for solar energy conversion will have a major impact in addressing the energy issues. However, low power efficiencies, materials and device stability and relatively high manufacturing cost of OLEDs and OPVs present a major challenge for commercialization, and new breakthroughs in the development of new materials and fabrication processes that are much cheaper and more processable for efficient OLEDs and OPVs are highly desirable. This project integrates multi-institutional and multi-disciplinary efforts from The University of Hong Kong, The Hong Kong University of Science and Technology, Hong Kong Baptist University, The Hong Kong Polytechnic University, and City University of Hong Kong, and the complementary expertise of chemists, physicists, materials scientists, and device engineers to form a team, in order to meet the grand challenges related to energy. With the efforts and collaboration contributed by the team members and the funding support of the RGC Theme-based Research Scheme, significant progress has been made to address the grand challenges of the project over the past 18 months. New classes of robust and patentable phosphorescent OLED and OPV materials have been developed. Particularly, (i) a novel class of soluble gold(III) phosphors has been synthesized and demonstrated as phosphorescent dopants in solution-processable OLEDs, in which the performance is comparable to solution-processable OLEDs based on other transition metal complexes; (ii) new classes of green- and yellow-emitting platinum(II) complexes have been synthesized and superior device performances with high external quantum efficiencies of up to 26.4 % and small efficiency roll-offs have been achieved; (iii) new design strategy for achieving highly efficient fluorescent/phosphorescent hybrid WOLEDs with power efficiency of up to 82 lmW^{-1} has been developed; (iv) novel approach for harvesting infrared solar energy of up to 1300 nm by making use of the charge-transfer complex formed at the organic heterojunction has been demonstrated; (v) new classes of low bandgap OPV materials with high charge carrier mobilities have been designed and applied in the fabrication of OPV devices; and (vi) industrial-competitive technologies for fabricating highly efficient thin film transistors (TFTs) for active matrix OLEDs (AMOLEDs) have been successfully developed. In addition, a number of high-impact international SCI journals involving interdisciplinary and multi-institutional collaborations as a result of the collaborative efforts amongst team members and with local and national collaborators as well as Hong Kong-owned IP rights and patents have been generated. These technological know-how can definitely create new opportunities for knowledge and technology transfer to national and international industrial partners and lead to the development of high technology R&D consumer electronic industries related to OLEDs and OPVs in Hong Kong, the Mainland, especially the Guangdong Province region. It is envisaged that the success of our TBRS project would promote Hong Kong towards a low carbon economy and the development of a sustainable environment.

具挑戰性的題目：有機光伏發光二極管

透過跨學科及多學院的協同努力迎接有機光伏打電池及發光二極管面臨的挑戰

項目統籌人：任詠華教授
香港大學
參與院校：城大、浸大、理大、科大、港大



在人口迅速增長和化石燃料日漸短缺的情況下，當前有迫切需要推動低碳或碳中和經濟。為迎接未來的大挑戰，開發潔淨再生能源和節約能源的新方法是必需的。當中，有機電致發光二極管(OLED)被視為可行的新一代高效固態照明系統，而發展高效有機光伏打電池(OPV)來轉換太陽能也對解決能源危機起着關鍵性作用。但是，目前有機電致發光二極管及有機光伏打電池的功率效率偏低，加上材料和器件的穩定性低、生產成本高等問題，對產品商業化造成重大的挑戰，因此人們都希望透過開發低成本、可塑性高的高效新材料及其製備過程尋求突破。本研究項目結合香港大學、香港科技大學、香港浸會大學、香港理工大學和香港城市大學不同領域的專家，包括化學家、物理學家、材料科學家及器件工程師共同組成研究團隊，進行跨院校、跨學科協作研究，共同解決能源的挑戰。透過團隊研究員的努力和協作，以及研究資助局對本主題研究計劃項目的撥款支持，本團隊在過去的十八個月取得重大進展，包括成功研發新一類高穩健性、可取得知識自主產權的磷光有機電致發光二極管材料及有機光伏打電池材料。主要科研成果包括(1)合成新一類可溶解的金(III)磷光材料及展示其在可溶液加工的有機電致發光二極管作磷光摻染物的應用。研究結果顯示此類磷光材料的性能已達到以其他過渡金屬配合物製備的可溶液加工有機電致發光二極管之水平；(2)合成一系列嶄新發綠光及發黃光的鉑(II)配合物，其所製備的器件的外量子效率達26.4%及具有小效率衰減的特性；(3)研發新穎的設計策略以製備高效能螢光及磷光混合的白光有機電致發光二極管，其功率效率達 82 lmW^{-1}；(4)開創性地利用有機異質介面產生的電荷轉移絡合物收集波長達1300 nm的紅外線太陽能量；(5)設計和合成具有高導電載子遷移率和窄帶隙的新一類有機光伏打電池材料及開發其在有機光伏打電池的應用；和(6)研發具工業競爭力的技術以製備可用於主動式矩陣有機電致發光二極管(AMOLED)的高效薄膜晶體管(TFT)。此外，透過團隊研究員跨院校及跨學科的合作，以及與本地及國內合作夥伴的協同努力，本團隊在國際高影響因子SCI期刊發表了多篇文章及申請了多個香港知識自主產權和專利。預期本項目將不僅能為本地及國際工業夥伴創造知識和技術轉移新機遇，推動香港、內地（特別是廣東省地區）在有機電致發光二極管及有機光伏打電池相關的消費者電子工業的高技術研發，同時亦能促進香港邁進低碳經濟及可持續發展的環境。

Grand Challenge Topic: Sustainable Built Environment
Sustainable Lighting Technology: From Devices to Systems

Project co-ordinator: Professor Ron S.Y. Hui
The University of Hong Kong
Participating Institutions: PolyU, HKU

This project is related to the "sustainability" of lighting systems (used in buildings and cities' large-scale infrastructures such as road lighting) that consume 20% of electricity globally. Sustainable Lighting Technology proposed here deviates from the traditional Energy-Star concept which focuses only on energy saving. It stresses a new principle that includes (i) energy saving, (ii) long product lifetime and (iii) recyclability of product materials. It highlights the important point that "energy-saving technology is not necessarily environmentally-friendly if it generates lots of harmful electronic waste within a short product lifetime".

This project involves a new investigation into a new General LED System Theory for "multiple non-identical" Solid-State LED devices. By linking LED "device" theory to "system" theory, novel LED systems with not only high energy efficiency, but also lifetime exceeding 10 years and over 80% product materials recyclable will be studied and developed. The project will focus on an "integrated system approach" that covers (i) new white LED device structures and manufacturing processes, (ii) novel passive and active LED drivers and control techniques, (iii) current balancing techniques and (iv) novel device geometrically-staggered distribution and thermal designs, so that future LED systems can meet the 3 sustainability criteria.

This project is expected to lead to both theoretical & practical breakthroughs. The outcomes of this proposal include (1) a novel Generalized LED System Theory for "multiple non-identical" LED devices, (2) a new design methodology & tool for optimization of a new generation of highly efficient and sustainable lighting systems, and (3) practical realization of the new "Sustainable Lighting" principle that can replace traditional "Energy-Star" concept with the aim of drastically reducing electronic waste worldwide. With several major lighting research centers based in Hong Kong and over 1000 LED product manufacturers in South China, this project will bring significant benefits to Hong Kong and its nearby regions.

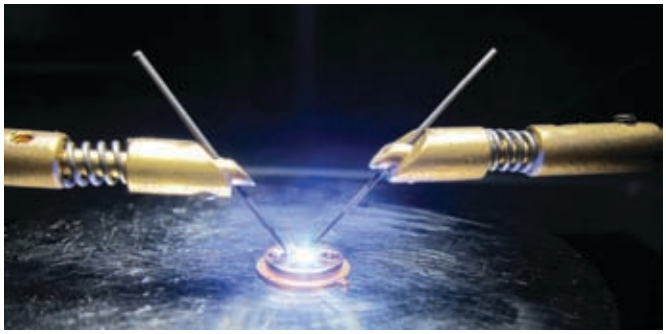
After one year of research, the joint research team has the following achievements:

- Riding on advances in laser processing, vertical thin-film LED devices have been developed based on the laser lift-off (LLO) process. Such devices exhibit enhanced performance, benefiting from significantly improved heat-sinking and current spreading.
- The photo-electro-thermal theory for LED systems has been successfully nurtured to incorporate the critical aspect of colour variations of the LED. This extended theory will provide a new design tool for lighting industry to optimize LED systems. This breakthrough will appear in the IEEE Transactions on Power Electronics.
- A comprehensive review and comparison of LED drivers has been completed. The results have been presented in the IEEE ECCE Conference, Denver, USA in September, 2013.
- A new current balancing technique has been successfully developed. The results have been presented in the IEEE IECON Conference in Vienna, Austria, in November, 2014.
- A power audit and analysis on the design limitations of a compact LED bulb has been conducted. The bottlenecks of such product design have been identified. The results will be presented in the IEEE APEC Conference in Fort Worth, Texas, Feb. 2014.
- A patent application on the colour control of LED systems has been filed.

具挑戰性的題目：可持續建築環境

「可持續」照明技術：從模塊到系統

項目統籌人：許樹源教授
香港大學
參與院校：理大、港大



「建築環境」泛指人造環境和建設，環境的定義包括家居、建築物、鄰近地區和城市;建設的定義包括建築設備如建築物的空調和照明系統和城市的道路網絡和街燈設備。「可持續發展」必須包含物料的循環再用、廢料和能源消耗的減少。

照明系統消耗全球百份之二十的電力，其電子控制電路已被確認為電子廢料的主要來源之一。自從近年發光二極管技術的突飛猛進，高光效和長壽命的發光二極管已經商品化。發光二極管有能力取代高損耗的鎢絲燈和含有水銀的螢光燈。發光二極管技術包括(一) 發光二極管模塊、 (二) 推動器、(三) 電力控制 和(四) 燈具的散熱設計。雖然發光二極管在裝飾、信號、顯示屏和招牌等應用上已經成功，它在普遍照明的應用上還未普及。雖然發光二極管模塊的技術進步很大，近代權威性的研究卻顯示「系統設計等因素」是發光二極管技術的瓶頸。例如: LED系統的壽命限制，並不取決於LED模塊(約80,000小時壽命)，而是取決於LED推動器內的電解電容(約8,000小時壽命) 。在2012年IEEE APEC會議中，「系統設計」瓶頸的嚴重性，成了LED工業界和生產商討論的主題。本研究是有關大型照明系統的「可持續發展」，這裏提出的可持續發展的照明技術，與傳統只單一考慮節能果效的「能源標籤」不同。可持續發展技術包括 (i) 節能、(ii) 長產品壽命、 (iii) 可循環再用三項要求。新「可持續發展」概念強調壽命短的電子照明技術，雖然節能，但不環保，因為它們在短時間內，會變成大量有毒的電子廢料。

本研究包括一項適合不同類型發光二極管模塊的LED系統理論，這套「從模塊到系統」的LED系統理論，可用來發展高功效、高光效、長壽命和可循環再用的發光二極管照明系統。我們會採用一種「結合式」的研究方法，結合(i) 白光LED模塊的結構和生產程序、(ii) 被動及主動式的LED推動器技術、(iii) 電流平衡技術、(iv) 模塊的排列和散熱 和(v) 新一代自動冷卻散熱器設計，目的是讓新一代的LED系統能符合「可持續發展」的三項要求。

我們期望本研究會達致理論和實際應用的突破，其結果將會包括(1) 適合各類LED模塊的發光二極管系統理論、(2) 改進散熱的LED模塊結構、(3)具有長壽命的特性的LED推動器的分類、(4) 新LED系統設計和優化方法及工具， 和(5) 實現「可持續」照明技術的概念，從而取代「能源標籤」，並達致大量減少電子廢料的目的。數間著名的國際照明公司在香港設有研究中心，南中國也有超過一千間LED產品生產商，所以這研究將為香港和鄰近地區帶來重大利益。除了有利工業界外，本研究亦會培養新一代的研究生及科技人材。

經過一年的努力，研究團隊獲得以下的成果：

- 完成具有改良光和熱功能的新型LED的初步結構。
- 成功將LED光、熱、電互動關系與顏色的互動關系統一。新理論將為照明工業提供一個優化設計工具。文章已採納於IEEE Transactions on Power Electronics.
- 完成LED推動器拓撲的檢討和比較，文章已發表於 IEEE ECCE Conference, Denver, USA, Sept. 2013。
- 成功研發新式LED電流平衡技術，文章已發表於 IEEE IECON, Vienna, Austria, Nov. 2013.
- 完成緊湊式LED燈泡的能源審計和設計限制的分析，結果將發表在IEEE APEC Conference, Feb. 2014 。
- LED顏色控制技術申請一項 。

Grand Challenge Topic: Organic Photo-voltaic and Light Emitting Diodes

Cost-effective and Eco-friendly LED System-on-a-chip (SoC)

Project co-ordinator: Professor K.M. Lau
The Hong Kong University of Science and Technology
Participating Institutions: HKUST, HKU

In August 2011, the Hong Kong government launched a public consultation on restricting the sale of energy-inefficient incandescent light bulbs (ILB), based on the overseas experience in the past few years (www.enb.gov.hk/bulbs_consult.html). The consultation ended in November 2011 with many supportive responses. An estimated annual reduction of electricity consumption by up to 390 GWh, or HK$390 million saving in electricity bill assuming a tariff of $1 per kWh annually, and a reduction in carbon emission by 273,000 tons is achievable. As part of its energy savings initiative for a sustainable environment, HK needs to become an active participant in this endeavor. The current solution of energy-efficient light-bulbs (EELB) using compact fluorescent lights (CFL) posts environmental concerns if the ban of ILB is in full effect. As an alternative to CFL, we should play an active role in the Solid-State Lighting (SSL) revolution that has gone into full swing worldwide. On a broader level, our mission is to accelerate the adoption of the eco-friendly SSL in HK and the world by unleashing the intrinsic LED efficacy with innovative device fabrication and packaging technologies. With the embedded integrated circuits in our developing microsystems, we plan to significantly improve the efficacy of LED-based lighting sources. As such, our technology provides both the environmental and commercial incentives that hasten the transition to an LED-lighted world. A generation of multidisciplinary researchers is being trained and new ventures are being spawned, contributing to the transformation of Hong Kong to a knowledge-based economy.

Through decades of research and development, semiconductor-based light emitting diodes (LEDs) have taken great leaps in performance (efficacy >200 lm/W in labs and >100 lm/W for commercially available LEDs) and manufacturing yield. However, the adoption rate is still slower than previously projected as the general public is yet to be convinced that the higher initial cost of LED lighting makes economic sense. Unfortunately, the environmentally friendly nature of LEDs over the mercury-containing fluorescent lights was not a sufficient reason for switching, added to the unfavorable consumer experience of unreliable LED products flooding the market. Technically speaking, the GaN-based LED is the light source of choice for SSL because of its high efficiency, stable nature and maturing technology. Despite the popularity of GaN-based LEDs, their current status is similar to the transistors in the 1950s. Most LED chips are individually or group packaged and used as a small light source. Poor package designs for thermal management, optics and electrical drive systems resulting in significant loss have impacted the realization of the inherent LED performance, misleading consumers about the true efficacy and reliability of LED products. We have made progress towards our goals to overcome this barrier by utilizing silicon IC technologies in LED lighting and develop an integrated optimization from device design to lighting systems. In parallel, our integrated approach has enabled novel projection systems with higher light utilization efficiency while decreasing system form factor and total cost of ownership with increased reliability. To lower the manufacturing cost, our platform is focusing on novel direct growth of LEDs on silicon wafers to allow for high volume production (on 200mm wafers) leveraging the mature Si IC technology with the cost advantages of CMOS scaling. We have demonstrated high-performance blue, green and yellow LED directly grown on silicon substrates.

具挑戰性的題目：有機光伏發光二極管
低本高效、綠色環保的LED晶片系統

項目統籌人：劉紀美教授
香港科技大學
參與院校：科大、港大

2011年8月，香港政府在總結過去幾年海外經驗的基礎上，推出了一項關於限制出售能源效率低的白熾燈泡的公眾調查（www.enb.gov.hk/bulbs_consult.html）。該調查在2011年11月份結束之前，獲得了積極的回應。按照每度電收費1港幣估算，香港政府每年可以減少用電量高達3.9億度，或者說可以節省3.9億港元的電費，並減少273,000噸的碳排放量。香港政府應該為建設一個可持續發展的環境而做出積極地動作。目前如果全面禁止白熾燈泡的話，螢光燈（CFL）會成為節能燈（EELB）的選擇之一。另外一個選擇則是目前正在全世界範圍內取得革命性發展的固態照明（SSL）。我們應該在香港和全世界範圍內為推動固態照明的發展貢獻自己的一份力量---通過器件製備技術和封裝技術的創新來提高LED的效率。我們在本項LED片上系統（SOC）中所提出的嵌入式積體電路可以顯著地提高LED照明設備的效率，並且拓寬了LED的應用範圍。這些應用包括：有源選址微顯示器，智慧LED交通燈以及新型可見光通訊系統。我們的技術將大大加快LED照明產品在全世界範圍內的普及速度。我們正在培養新一代的科學研究人員，並且將會催生出新型的企業，以促進香港向知識型經濟的轉型。

智慧財產權的價值-經過幾十年的研究和開發，LED性能已經取得了突破性的提高（實驗室LED效能>200流明/瓦,商業LED效能>100流明/瓦）。然而由於初始成本較高的原因，目前LED照明產品仍然未能為公眾所完全接受。並且和汞蒸汽節能燈相比，LED的天然優勢-無汞無污染的特性目前並未能完全為公眾所認識。另外，目前市場上充斥著很多安全係數不高的LED產品。這些性能低劣的產品也降低了LED產品在公眾心目中的形象。從技術上講，氮化鎵基的LED器件具有效率高，壽命長，技術成熟等天然優勢，從而成為固態照明產品的不二之選。目前LED的狀況很像20世紀50年代的電晶體。大部分LED晶片單獨封裝，或者組合封裝作為一個光源。散熱，光學和驅動的設計會大大影響LED的發光效率，從而影響LED產品的性能。我們正在克服這個問題。利用LED照明和矽基積體電路組合成為一個優化設計的智慧照明系統，並且降低了系統的外形尺寸並且大大降低了製造成本。與此同時，我們的技術應用於新型投影機系統以提高其光利用率和可靠性，同時降低系統的外形尺寸和生產成本。為了降低製造成本，我們的技術開發平臺專注于直接在矽襯底上生長高性能的藍光，綠光和黃光LED，並將其與成熟的矽基積體電路技術結合起來，實現低成本大批量（200毫米晶圓）的生產。

Grand Challenge Topic: Hong Kong's Future as an International Financial Centre

Enhancing Hong Kong's Future as a Leading International Financial Centre

Project co-ordinator: Professor Douglas W. Arner
The University of Hong Kong
Participating Institutions: CUHK, PolyU, HKU

By the end of the 20th century, Hong Kong had emerged as one of the world's major international financial centres. Today, while finance remains central to Hong Kong's future, it is facing unprecedented challenges, both in China and globally. In the context of China, the continuing process of economic reform and financial development raises many opportunities but at the same time brings into question Hong Kong's traditional role as the primary intermediary between China and the global financial system. At the same time, the global and European financial crises have raised fundamental questions about finance, exchange rate systems, the global position of China, and the future role of the renminbi, including Hong Kong's role therein. Reflecting the centrality of finance to Hong Kong, Article 109 of the Hong Kong Basic Law, ascribes the Hong Kong Government an obligation "to provide an appropriate economic and legal environment for the maintenance of the status of Hong Kong as an international financial centre." However, it has yet to take a comprehensive approach to this obligation or to consider its strategic and practical implications. This project, built around a team of internationally recognized experts from economics / finance, geography, law, and international relations, will analyze the elements required not only to maintain, but also enhance, Hong Kong's future as an international financial centre, focusing on its role in China's ongoing financial liberalization and economic development.

具挑戰性的題目：香港作為國際金融中心的未來發展
提升香港全球競爭能力，打造世界一流金融中心

項目統籌人：Douglas W. Arner 教授
香港大學
參與院校：中大、理大、港大

在20世紀末，香港已成為世界上主要的國際金融中心。金融業是香港發展未來的核心產業，然而現時不論是在中國或全球，金融業正面臨著前所未有的挑戰。在中國經濟發展的大環境下，持續的經濟改革和金融發展過程中造就了許多機會予香港的經濟發展，但在同一時間給香港作為中國與全球金融體系主要中介人的傳統角色帶來了重要的問題。同時，全球和歐洲的金融危機引起了探討有關根本的金融制度問題，包括匯率制度、中國在全球金融發展的位置、人民幣在未來的角色及香港在其中的作用。香港基本法第109條反映金融中心對香港經濟的重要性和核心性，要求香港特別行政區政府「提供適當的經濟和法律環境，以保持香港的國際金融中心地位」。但是，當局目前尚未採取全方位的方式履行這一義務，或考慮其戰略意義和實際價值。因此，本研究項目將建立一支包含世界經濟/金融、地理、法律以及國際關係的國際專家團隊，不僅將分析維持及提升香港作為國際金融中心的基本元素，但也重點討論香港在中國正進行的金融自由化和經濟發展中的角色和作用。

Grand Challenge Topic: Promoting Hong Kong's Business Through Networking Capability

Transforming Hong Kong's Ocean Container Transport Logistics Network

Project co-ordinator: Professor C.Y. Lee
The Hong Kong University of Science and Technology
Participating Institutions: CityU, HKUST, HKU

The logistics industry plays a critical role in Hong Kong, not only for its direct contribution to the economy, but also for other business opportunities enabled by logistics such as trading, financial and professional services. Having been a leading regional hub for decades, the Hong Kong ocean container industry now faces fierce competition from nearby cities. With the continuing trend of economy globalization, the ocean container industry is deemed to maintain its strong growth and important role in global supply chains. This is an important moment for Hong Kong to regain its regional leading position by reinforcing its advantages and identifying new directions.

The project aims to conduct a thorough investigation for the ocean container industry, so as to provide operational solutions, managerial guidance, and business policy insights to support the sustained growth of Hong Kong's ocean container industry. The project has two major goals. i) To establish Hong Kong as the research hub for maritime logistics and supply chain management. A team of world-class researchers, led by Chair Professor Chung-Yee Lee of the Department of Industrial Engineering and Logistics Management of the Hong Kong University of Science and Technology, is geared toward generating state-of-art research in this area. ii) To develop an in-depth understanding of Hong Kong's role as a port city and its future direction. The team plans to address the issues from different and inter-correlated angles: Tactical and Strategic issues on Ocean Container Logistics Supply Chain Networks, Hong Kong's Strategic Future Direction as well as Integrated Decision Support System.

In the first two years of the project, the research team has made a series of achievements towards their goals. The team has been working closely with industry stakeholders such as OOCL, HIT,…, to name a few, to develop the most advanced tools to support managerial decision making. To pursue academic excellence, the team has been collaborating with leading international scholars in the field to develop new theories in ocean container logistics and supply chain management. The outcomes of the project are disseminated using several means, including journal and book publications, academic and industry conferences, and online, to generate impact at academic, industry and governmental levels. In the first two years, the research results have produced twenty academic papers, five keynote speeches in international conferences, and a monograph to be published in 2014. A number of results have also been embedded in their teaching materials to groom the development of the next generation of industry leaders.

具挑戰性的題目：通過網絡能力推動香港商業發展
振興香港海洋貨櫃運輸物流網

項目統籌人：李忠義教授
香港科技大學
參與院校：城大、科大、港大

物流業在香港經濟中扮演至關重要的角色，不僅是因為它對經濟的直接貢獻，而且通過物流開啟了其他的商業機會，如貿易，金融和專業服務等。幾十年來本港一直是領先的區域樞紐。然而香港海洋貨櫃運輸業如今正面臨臨近城市的激烈競爭。隨著經濟全球化的趨勢仍在持續，海洋貨櫃運輸業必須保持其強勁的增長和在全球供應鏈中發揮重要作用。這是一個對香港恢復其區域領先地位和通過強化自身的優勢確定新方向的重要時刻。

本項目旨在對海洋貨櫃運輸業進行一次深入的研究調查，從而提供運營解決方案，管理指導和對業務政策的見解，以支持香港海洋貨櫃運輸業的持續增長。本研究項目有兩個主要目標。 第一，把本港提升為環球海運物流及供應鏈管理的科研樞紐。由香港科技大學工業工程及物流管理系李忠義講座教授帶領的頂尖研究團隊，正致力開展各項具高度學術價值的研究。 第二，對本港作為港口城市的角色定位及未來方向做深入理解和分析。研究團隊計劃於從不同的和相互聯繫的角度解決以下問題：海運物流供應鏈網絡，香港的未來戰略方向，以及綜合決策支持系統的戰術和戰略問題。

本項目的最初兩年，研究小組已經朝著既定的目標取得了一系列的科研成果。項目組一直必須保持與領域相關企業界如OOCL，HIT.. 的密切合作，開發最先進的工具以支持管理決策。為了追求學術卓越，團隊已經與國際頂尖知名學者合作在該領域發展海洋貨櫃物流和供應鏈管理的新理論。項目成果將會以期刊和圖書出版，學術和企業會議，網絡平台等方式傳播。致力於在學術，企業和政府層面產生影響。在最初兩年，本項目的研究成果已經產生20餘篇學術論文，在國際學術會議上提供五個主題演講，並將在2014年出版一本專著。多項研究成果也被學者們引入他們的教學材料以培養發展下一代的企業領導者。

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