Appendix

List of funded CUHK researchers and research projects

NSFC/RGC Joint Research Scheme

1. **Professor Chan Ting-fung, Associate Professor, School of Life Sciences**

Project title: Unravelling Fusarium Wilt Resistant Gene(s) in Cavendish Banana and Exploring the Underlying Resistance Mechanisms

Bananas are the developing world's fourth most important staple crop and the second most grown fruit worldwide. This project will combine experts in genomics and banana crop breeding teams to tackle one of the most destructive and expensive crop pathogens, the Foc-TR4 soil-borne fungus. The project's mainland researchers have successfully selected the Zhongjiao 8 (ZJ-08) cultivar with high Foc-TR4 resistance. This study will attempt to apply the latest long-read sequencing and high-throughput chromosome conformation capture techniques and use the CUHK team's expert resources in optical genome mapping to assemble the genomes of ZJ-08 and ZJ-01 (a Foc-TR4-susceptible cultivar). The team will then pinpoint the corresponding genetic loci and the resistance (R) genes, and will further validate the candidate genes using CRISPR-Cas9 and transgenic technologies. The study will benefit overall banana-related research and improve future crops. The Mainland Principal Investigator is Professor Deng Guiming from the Guangdong Academy of Agricultural Sciences.

2. **Professor Chan Wai-yee, Li Ka Shing Professor of Biomedical Sciences, School of Biomedical Sciences**

Project title: Study the Roles of Mitochondrial DNA Methylation in Regulating Nucleoid Phase Separation and Transcription Modulation

The mitochondrial nucleoid is a special sub-organelle responsible for mitochondrial DNA (mtDNA) storage, replication and transcription. However, the mechanism of nucleoid assembly and function is still poorly understood. Based on their previous discoveries, the team will further study how mtDNA methylation regulates nucleoid assembly and transcription. The project aims to identify the phase separation remodelling by mtDNA methylation in pluripotent stem cells (PSCs) and somatic cells such as cardiomyocytes, and to reveal the mechanism through which mtDNA methylation regulates mitochondrial transcription via phase separation. This study seeks to reveal novel mechanisms of mitochondrial nucleoid structure and function, which will promote studies on cell fate and embryonic development. The Mainland Principal Investigator is Professor Liu Xingguo from the Guangzhou Institutes of Biomedicine and Health under the Chinese Academy of Sciences.

3. **Professor Duan Liting, Assistant Professor, Department of Biomedical Engineering**

Project title: Red Light-Gated Optogenetic Control of Calcium Signal for Cancer Immunotherapy

To address the current limitations of T cell therapy, the study proposes opto-immunotherapy that uses red light signals to instruct the cancer-killing activities of T cells in vivo for improved anti-tumour efficacy and decreased toxicity. This proposal is built on three stages. (1) It will develop a highly sensitive red light-gated optogenetic controller of Ca^{2+} signals (RedCa). Using red light as the switch, RedCa can remotely and non-invasively activate Ca^{2+} signalling. (2) It will use RedCa to control the cancer-killing activities of T cells, and engineer primary T cells so that red light can enhance the cytotoxicity and anti-cancer cytokine/antibody expression of T cells. (3) By transferring the engineered primary T cells into mouse tumour models, it will use red light to precisely control the cancer-killing activities of T cells in

vivo at the desired times and locations, and with desired dosages for effective, safe, easily controlled precision cancer therapy. The Mainland Principal Investigator is Professor Ye Haifeng from East China Normal University.

4. **Professor Jiang Yangzi, Research Assistant Professor, Institute of Tissue Engineering and Regenerative Medicine / School of Biomedical Sciences**

Project title: Grancalcin+ Immune Cells in Osteoarthritis: Cellular and Molecular Targets for Future Intervention

Osteoarthritis (OA) is the most common form of arthritis, leading to chronic pain and disability, and significantly decreasing the patient's quality of life. Recently, the team discovered that a group of grancalcin-positive (GCA+) immune cells, mainly neutrophils and macrophages, accumulated in the bone marrow during ageing and secreted GCA that promoted skeletal ageing. This study hypothesises that this cell population plays a significant role in OA development. It will investigate the role and mechanism of GCA+ immune cells in OA using comprehensive models, including gene and cell conditional knockout animals and human cartilage organoids. It will also explore the strategy of intervening in GCA's interaction with its downstream targets to alleviate OA in animal models and human chondroid organoids. The results will provide not only novel insights into OA pathology, but also a new therapeutic target against which to develop effective interventions for OA treatment. The Mainland Principal Investigator is Professor Li Changjun from Central South University.

5. **Professor Kang Byung-ho, Associate Professor, School of Life Sciences**

Project title: Characterization of the Endoplasmic Reticulum-Mitochondria Contact Site in Plant Cells and its Function in Mediating Mitochondria Recycling

Autophagy is a process that can degrade intracellular materials including unwanted organelles or pathogens, while mitophagy refers to the autophagy that specifically degrades intracellular mitochondria. Recent studies on plant autophagy support the idea that the endoplasmic reticulum (ER) may serve as a hub for nucleating autophagy signalling and supply lipids for autophagosome membranes. The team's preliminary data indicate that the mitochondria and ER proteins are involved in uncoupler-induced mitophagy and mitochondria turnover during metabolic switching. This study will further investigate the ER-mitochondria contact sites (EMCSs) for mitophagy and mitochondria division. It will determine the components of EMCSs and characterise their working mechanisms. The team expects to publish papers in top-notch journals, foster academic exchange and train future researchers to enhance agriculture research quality in Hong Kong and mainland China. The Mainland Principal Investigator is Dr Wang Pengwei from Huazhong Agricultural University.

6. **Dr Lam Wai-kei, Assistant Professor, Department of Chemical Pathology**

Project title: Analysis of Plasma Epstein-Barr Virus (EBV) DNA and EBV Antibody for Early Detection of Nasopharyngeal Carcinoma and Protocol Optimisation

Nasopharyngeal carcinoma (NPC) is a prevalent cancer in southern China, ranking among the 10 most common types of cancer among men in Hong Kong. Solid evidence has shown that NPC patients enjoy a better chance of survival if their disease is discovered early. Unfortunately, the majority (~80%) of NPC patients present with advanced-stage disease, with a five-year overall survival rate of only 50%, while that of early-stage NPC is above 90%. Previous studies demonstrated that plasma Epstein-Barr virus (EBV) DNA testing could identify early-stage NPC. The serum EBV antibody has also been validated for screening of NPC. This project aims to systematically evaluate the diagnostic performances of serum EBV antibody and plasma EBV DNA for screening of NPC through concurrent testing of both biomarkers in

the same study cohort. Based on such knowledge, it aims to devise an optimal EBV biomarker-based screening protocol in terms of diagnostic performance and cost-effectiveness. The Mainland Principal Investigator is Professor Chen Mingyuan from Sun Yat-sen University.

7. **Professor Li Gang, Professor, Department of Orthopaedics and Traumatology**

Project title: The Role and Mechanism of Focal Adhesion Protein Kindlin-2 in Distraction Osteogenesis

Distraction osteogenesis (DO) effectively stimulates the formation of new bone tissues through slow mechanical stretching, and has been widely applied in orthopedic surgery. However, the molecular mechanisms of how extracellular mechanical stretching signals translate into intracellular biochemical signals during the DO process and how these signals promote bone formation remain poorly defined. Based on previous study results, this project hypothesises that DO may promote bone formation by upregulating Kindlin-2 in osteocytes. The team will use their unique, well-established transgenic mouse models with Kindlin-2 overexpression or knockout, mouse and rat DO models to determine the roles and molecular mechanisms of Kindlin-2 regulation of bone formation in DO. The results will lead to a better understanding of the biological mechanisms of DO, in particular the roles of Kindlin-2, and the further development of new strategies for targeting Kindlin-2 to improve outcomes of DO clinical applications. The Mainland Principal Investigator is Professor Xiao Guozhi from Southern University of Science and Technology.

8. **Professor Ng Chun-yu, Assistant Professor, Department of Physics**

Project title: Study of Very High Energy Gamma-Ray Radiation from the Sun Based on LHAASO Observation

This project proposes to observe the Sun with the Large High Altitude Air Shower Observatory (LHAASO). It aims to expand the observation of the Sun into the very high-energy regime, which will produce a picture of the Sun with the highest possible energy. These observations are expected to reveal the characteristic magnetic fields that are responsible for the production of solar gamma rays, and thus will provide the first direct link between solar magnetic fields and gamma-ray data. In addition to providing an important perspective for solving the solar gamma-ray puzzle, this will also allow gamma rays to be a novel probe of the solar magnetic fields that have not been observed before. The improved understanding of solar magnetic fields could ultimately allow scientists to better understand solar dynamics and space weather, and better safeguard infrastructure from explosive solar activity. The Mainland Principal Investigator is Professor Li Zhe from the Particle Astrophysics Division and the Institute of High Energy Physics under the Chinese Academy of Science.

9. **Professor Ren Hongliang, Associate Professor, Department of Electronic Engineering**

Project title: Robotic Capsule Endomicroscopy and Diagnosis of Gastric Intestinal Metaplasia

Gastric intestinal metaplasia (GIM) is a precancerous lesion of the gastric mucosa. Its early diagnosis and accurate evaluation are important for preventing gastric cancer. Most patients with GIM are asymptomatic or have non-specific digestive symptoms such as abdominal distension, abdominal pain and heartburn. It is therefore highly desirable to investigate a novel modality for GIM screening that can make an accurate diagnosis more efficiently and comfortably. This project addresses the clinical difficulties of accurate screening and monitoring follow-up of asymptomatic people with intestinal metaplasia of the gastric mucosa. The team will develop innovative robotic capsule endomicroscopy based on optical microscopic imaging for observation and tissue sampling. It will use artificial intelligence quality control and real-time targeted biopsy for minimally invasive, painless, accurate diagnosis and evaluation of GIM. The Mainland Principal Investigator is Professor Li Zhen from Qilu Hospital of Shandong University.

10. **Professor Chester Shu Ching-tat, Professor, Department of Electronic Engineering** (to be confirmed by Professor Shu)

Project title: Silicon Photonic Integrated Circuits Enabled Intelligent Multi-Dimensional Optical Signal Processing for High-Capacity Communication Systems

To cope with the bottleneck in the capacity of optical communications, the space domain of light waves is playing a vital role in multidimensional multiplexing fibre-optic communications. In particular, multidimensional multiplexing optical transmission using optical vortex modes has been widely reported. Unfortunately, there is a lack of matching optical processing technologies. Traditional optical processing is limited to a single dimension, and the compatibility for integration and intelligence are limited. This project works on silicon photonic integrated circuits that enable intelligent multidimensional optical signal processing for high-capacity communication systems. It will focus on critical scientific issues in the fundamental theory, key functional devices, and technology applications. The project will enable Hong Kong and the Mainland to develop long-term cooperation in designing and fabricating silicon photonic integrated circuits, and in processing optical signals intelligently in multiple dimensions. The Mainland Principal Investigator is Professor Wang Jian from Huazhong University of Science and Technology.

11. **Professor Zou Jun, Choh-Ming Li Professor of Mathematics, Department of Mathematics**

Project title: Mathematical and Numerical Studies of Linear and Nonlinear Time-Harmonic Maxwell Systems with Singularities and Oscillations

This project aims to carry out a systematic mathematical and numerical study of time-harmonic Maxwell systems with singularities and oscillations, one of the most popular and important mathematical models, which has been widely used in applications that involve scattering and propagation of electromagnetic waves. It will develop stable, efficient edge element methods, especially interior penalty edge element methods and adaptive methods based on a posteriori error estimates. A large number of numerical simulations will illustrate and help improve these methods. Furthermore, the project will develop a general mathematical theory to help analyse the stability, accuracy and optimal convergence of these methods, and to help understand how the high wavenumber, nonlinearity and singularities affect numerical stability and accuracy. The Mainland Principal Investigator is Professor Duan Huoyuan from Wuhan University.

NSFC/RGC Collaborative Research Scheme

1. **Professor Liu Renbao, Professor, Department of Physics**

Project title: Superradiant Time-crystal Maser and Applications in Quantum Metrology

This project will demonstrate a novel class of out-of-equilibrium quantum matters, superradiant time-crystal masers, and develop ultra-precise quantum metrology using them. Lasers and masers in coherent states are important quantum matters and the basis of many metrological technologies. Coherent emitters can collectively radiate photons, leading to so-called superradiance. Superradiant lasers and masers' coherence time increases with the density of emitters. However, the interactions and disorder in materials with high-density emitters destroy the coherence. To address this issue, the team proposes to develop a superradiant time-crystal maser. Time crystals feature long-lived collective coherence and, more importantly, the interactions and disorder can contribute to sustaining the quantum oscillations, turning a disadvantage into an advantage. The discovery of new out-of-equilibrium quantum matters and the development of unprecedented quantum metrology will have long-term impacts on fundamental physics and quantum information technologies. The Mainland Principal Investigator is Professor Rong Xing from The University of Science and Technology of China.

2. **Professor Michael Song Zheng, Professor, Department of Economics**

Project title: Measuring China's Industrial Policies and Evaluating Their Effects in a Unified Quantitative Framework

This project will initiate a comprehensive quantitative analysis of industrial policies in China, where many industrial policies have been carried out by the central and local governments. The project consists of three parts. It will first scrape all the online documents released by the major departments of the central and local governments and use textual analysis methods to extract the relevant information on industrial policies. This will constitute a novel dataset that provides a panoramic view of all kinds of industrial policies planned by the Chinese government. The second part will develop a unified quantitative framework that can quantify the various industrial policies implemented from firm-level data in an internally consistent way. It will be able to structurally interpret key moments in the firm-level data for their importance to industrial policy, and provide an external validity check of the consistency between planned and actual industrial policies. For the final part, it will take measurements to evaluate the effects of industrial policy in the unified framework, and rank the industrial policies by their local, national and global welfare effects. It will also discuss the implications of this study for the development of the Greater Bay Area and the policies targeting major technology bottlenecks. The Mainland Principal Investigator is Professor Bai Chongen from Tsinghua University.