ONE HEALTH

Developing and integrating interdisciplinary, problem-based research collaboration and communication in all aspects of health-related issues, particularly those involving the complex interactions and inter-dependencies of animal and human populations and the environment.

Professor Dirk Pfeiffer and Professor Sophie St-Hilaire

One Health Approach to Prevent Another Pandemic

While the world is still trying to cope with the Covid-19 pandemic, **Professor Dirk Pfeiffer**, Chow Tak Fung Chair Professor of One Health at the Jockey Club College of Veterinary Medicine and Life Sciences (JCC) and Director of the Centre for Applied One Health Research and Policy Advice (OHRP), warned that the next pandemic could be even worse. The whole world must learn the lessons from the current pandemic, and one of them is that we need to adopt the "One Health" approach to better manage and ideally prevent such pandemics, and to deal more effectively with other global human, animal and environmental health issues, he said.

"One Health is not just about medics working together with vets and virologists. It needs to be based on a truly interdisciplinary approach to research and policy development, which means generating integrated knowledge by bringing together different scientific disciplines, including the social sciences," emphasised Professor Pfeiffer, who is a veterinary epidemiologist and has provided scientific expertise to international organisations and governments, including the World Organisation for Animal Health and the Food and Agriculture Organization of the United Nations. "There are many ways to control a pandemic, but a key driver is human behaviour," he said.

Wet market issues: social science perspective

He mentioned wet markets as an example. Wet markets with different livestock and poultry species being freshly slaughtered and sold are regarded as a hotbed for new infectious diseases associated with animal-human transmission, he said. These include severe acute respiratory syndrome (SARS), avian flu (H5N1 and H7N9) and the current Covid-19. "But why do people still prefer to buy raw meat from wet markets? Is it based on a traditional cultural perception or fresh meat tasting better? How can you manage changes in people's behaviour? To understand this better we need to adopt social science approaches," he explained.

With the establishment of the JCC and the OHRP, Professor Pfeiffer believes CityU can contribute by improving our understanding of what the drivers of infectious disease emergence are and recommending interventions using the "One Health" approach to reduce the risk of future pandemics.

AMR: another global threat

Antimicrobial resistance (AMR) is another pressing issue that he thinks needs to be addressed using the "One Health" approach. The World Health Organization declared AMR one of the top 10 global public health threats facing humanity. The misuse and overuse of antimicrobials, as well as poor infection and disease prevention and control in healthcare facilities and livestock production, are some of the main drivers in the development of AMR.

"For both humans and animals, antimicrobials should be used only for treating clearly identified bacterial diseases, but not for prevention," explained Professor Pfeiffer. "Otherwise, as drug-resistant pathogens continue to spread, we will have more and more infections that are untreatable using currently available antibiotics. And it is unlikely that new antibiotics will become available in the short to medium term."

With support from the Sustainable Agricultural Development Fund, Professor Pfeiffer is leading two research projects to improve pig and poultry health and production in Hong Kong. One of the key missions of these projects is to help local pig and poultry farmers reduce the use of antimicrobial drugs. The team works with farmers to develop an understanding of each farm's drug usage and the antimicrobial resistance level, so that the team's veterinarians can prescribe effective medications for pigs and poultry, when such treatment is required.

Providing clinical services for pig, poultry and fish farms

The pig and poultry veterinary teams provide professional clinical services for farms and take samples of serology from pigs and poultry during their regular visits. By producing reports on the productivity of each farm and the level of different infectious diseases, farmers can make strategic decisions about health and production management. The veterinary teams provide tailor-made advice to farmers in these areas, which can include more effective control of temperature and ventilation, and strengthen farm biosecurity to prevent diseases and other pests from entering the farms.

"Our teams are dedicated to improving farmers' biosecurity awareness and strengthening their animal husbandry and general farm management knowledge so that we can reduce their reliance on antimicrobials," he said. "While we realise that it will take time to change mind-sets and behaviours, our collaboration with farmers during the past one and a half years has shown us that it will be possible to develop sustainable pig and poultry farming in Hong Kong without having to compromise the health of humans, animals or the ecosystem."

In addition, **Professor Sophie St-Hilaire**, Professor of Aquatic Animal Health at the JCC and a member of the OHRP, is leading a project to provide veterinary diagnostic and disease-prevention services for marine fish and pond fish culture operators in Hong Kong, with support from the Sustainable Fisheries Development Fund (SFDF). The fish team has established a pharmacy for fish farmers to purchase medications for fish under the supervision of the team's veterinarians. They evaluated the purity of antibiotics commonly used in fish farms in Asia and found emamectin benzoate, an insecticide, can be an effective alternative treatment for reducing the level of sea lice in fish farms in Hong Kong.

With another round of funding from SFDF, they are continuing to improve the sustainability of the Hong Kong aquaculture industry by increasing the fish health veterinary capacity regionally, preventing infectious disease spread, and addressing key limitations the industry facing through applied research and outreach.

Major Awards

Professor Dirk Pfeiffer

- The President's Award 2019, CityU
- Roger Morris Award for Outstanding Contribution to Veterinary Epidemiology and Economics 2018

Key Projects

Professor Dirk Pfeiffer

- Sustainable Agricultural Development Fund:
  - Improving Pig Health and Production in Hong Kong
  - Improving Poultry Health and Production in Hong Kong
- Research Matching Grant Scheme: Applied Food Safety and Quality Research

Professor Sophie St-Hilaire

- Sustainable Fisheries Development Fund:
  - Improving Fish Health and Production in Hong Kong
  - Improving Fish Health and Production in Hong Kong in 2020

Selected Publications

- Vergne, T., Guinat, C. & **Pfeiffer, D.U.** 2020, "Undetected circulation of African swine fever in wild boar, Asia", *Emerging Infectious Diseases*, vol. 26, no. 10.
- Willgert, K., Meyer, A., Tung, D.X., Thu, N.V., Long, P.T., Newman, S., Thuy, N.T.T., Padungtod, P., Fournié, G., **Pfeiffer, D.U.** & Vergne, T. 2020, "Transmission of highly pathogenic avian influenza in the nomadic free-grazing duck production system in Viet Nam", *Scientific Reports*, vol. 10, no. 1.
- Dixon, L.K., Stahl, K., Jori, F., Vial, L. & **Pfeiffer, D.U.** 2020, "African swine fever epidemiology and control", *Annual Review of Animal Biosciences*, vol. 8, pp. 221-246.
- Wada, M., Lam, C.T., Rosanowski, S., Patanasatienkul, T., Price, D. & **St-Hilaire, S.** 2020, "Development of simulation models for transmission of salmonid rickettsial septicaemia between salt water fish farms in Chile", *Transboundary and Emerging Diseases*.
- Leung, K.C., Huang, Q., **St-Hilaire, S.**, Liu, H., Zheng, X., Cheung, K.B. & Zwetsloot, I.M. 2020, "Fraudulent antibiotic products on the market for aquaculture use", *Preventive Veterinary Medicine*, vol. 181.
- Vergne, T., Meyer, A., Long, P.T., Elkholly, D.A., Inui, K., Padungtod, P., Newman, S.H., Fournié, G. & **Pfeiffer, D.U.** 2019, "Optimising the detectability of H5N1 and H5N6 highly pathogenic avian influenza viruses in Vietnamese live-bird markets", *Scientific Reports*, vol. 9, no. 1.
- Høg, E., Fournié, G., Hoque, M.A., Mahmud, R., **Pfeiffer, D.U.** & Barnett, T. 2019, "Competing biosecurity and risk rationalities in the Chittagong poultry commodity chain, Bangladesh", *BioSocieties*, vol. 14, no. 3, pp. 368-392.
- Kim, Y., Biswas, P.K., Giasuddin, M., Hasan, M., Mahmud, R., Chang, Y.-., Essen, S., Samad, M.A., Lewis, N.S., Brown, I.H., Moyen, N., Hoque, M.A., Debnath, N.C., **Pfeiffer, D.U.** & Fournié, G. 2018, "Prevalence of avian influenza A(H5) and A(H9) viruses in live bird markets, Bangladesh", *Emerging Infectious Diseases*, vol. 24, no. 12, pp. 2309-2316.

Building a Quality, Efficiency-driven Healthcare Delivery System

The CityU research team provides infection-control education and distributes anti-epidemic items, such as masks and hand sanitizers, to older people with poor social support, who were identified during the team's comprehensive geriatric assessment in collaboration with NGOs.

Given the rapidly ageing population and an overstretched public healthcare system in Hong Kong, a CityU-led interdisciplinary team comprised of experts from various institutions has offered a new perspective on healthcare system monitoring and management in a big data environment.

The Theme-based Research Scheme (TRS) project, led by **Professor Frank Chen Youhua**, Dean of the College of Business and Chair Professor of Management Sciences at CityU, was undertaken by a strong collaborative team made up of researchers from CityU's Department of Management Sciences, School of Data Science and College of Engineering, as well as the Jockey Club School of Public Health and Primary Care (JCSPHPC) of the Chinese University of Hong Kong (CUHK).

To develop a quality, efficiency-driven healthcare delivery system in Hong Kong, they focused on two areas: improving public hospital resources management to maximise limited resources and cope with increasing demand; and providing better integrated community elderly care to enhance their self-management skills and minimise the need for hospitalisation.

Healthcare data analytics and AI

With the use of data analytics and artificial intelligence (AI) technologies, the team processed vast amounts of data collected from healthcare delivery and management systems. They achieved tremendous results, including over 115 articles published in reputable, refereed journals and the following research output:

i) identified target elderly patient segments for the most effective and affordable post-discharge care portfolios in the community;

ii) developed machine-learning models to predict the onset of critical chronic diseases, including heart failure, mitral regurgitation, acute myocardial infarction and dementia, and to conduct suicide and depression risk assessments;

iii) developed advanced machine-learning models to predict future high-cost patients, such as those with chronic obstructive pulmonary disease or infectious diseases;

iv) applied algorithms for predicting the re-hospitalisation of discharged patients to reduce emergency department admissions, compare public-private partnership (PPP) subsidy schemes to reduce waiting time for public healthcare services, and analyse and allocate hospital resources;

v) designed a personalised telehealth monitoring system for community-dwelling older people, utilising sensor technology to monitor their health, including general wellness, blood pressure, gait and balance, for comprehensive evaluation of health conditions and fall risk prediction; and

vi) proposed a general framework for health system monitoring and management, covering continuous surveillance, analysis, and interpretation of related data.

The AI and data analytics tools developed in the project can have an additional social impact. For instance, by applying their newly developed algorithms to the Hong Kong-wide Electronic Health Records, made accessible by the Hospital Authority Data Collaboration Lab, the team was able to characterise district-specific profiles of high-risk residents and their secondary and tertiary prevention needs. With further development, these tools can be used for service planning for upcoming District Health Centres in Hong Kong. Also, the CityU team, led by **Professor David Li Yanzhi**, has been commissioned by the Hospital Authority to prepare the planning and provision of patient transport services to cope with service demand in the next 10 years.

"The completion of the TRS project is just the start of a new phase of healthcare management research in Hong Kong," said Professor Chen. "With these AI-driven service innovations for community care, we can help expand the capacity of our primary care resources and better utilise them to provide coordinated care for older people and deploy community nurses in the neighbourhood."

Homecare to promote ageing with dignity

A team comprising faculty members from the College of Business and the JCSPHPC is currently working towards transforming the existing ecology of institutional elderly care and centre-based health management to the actualisation of ageing-in-place with sufficient support from quality homecare, to fulfil the desire of older people to live at home rather than in a nursing home.

Through piloting a world-renowned innovative community nursing model - *Buurtzorg* - in Hong Kong, the team led by CityU is exploring a PPP home-based care scheme prototype in collaboration with local non-governmental organisations (NGOs) and an acute hospital, with the introduction of self-steering nursing teams and care coordinators, who will be equipped with case management skills and health-coaching qualifications.

The localised model will be tech-enabled, with an IT platform for care coordination and integration, and portable and mobile app-based solutions to facilitate home-based care, such as telemedicine and an electronic pillbox.

"Our ultimate goal is to develop a comprehensive solution that can provide sustainable and affordable holistic home-based care to help individual older people live with dignity, despite the gradual deterioration of their body functions," said Professor Chen. He added that with modifications, their AI and data analytics tools could be applied outside Hong Kong.

Key Projects

- Theme-based Research Scheme: Delivering 21st Century Healthcare in Hong Kong – Building a Quality-and-Efficiency Driven System
- BOCHK Centenary Charity Programme: HomAge: Home-based Aging for Transformative Community Care
- Public Policy Research Funding Scheme: Development of a Longitudinal Database on Adult Development and Aging

Co-Principal Investigators and collaborators from CityU and CUHK: (front row, from second left) Professor Yan Houmin, Professor Fung Hong (advisor, CUHK), Professor Frank Chen Youhua and Professor Tsui Kwok-leung from CityU; (second row, second right) Professor Yeoh Eng-kiong and (third row, second right) Professor Eliza Wong Lai-yi from CUHK.

Selected Publications

- Lin, S., **Zhang, Q.**, **Chen, F.**, Luo, L., Chen, L. & Zhang, W. 2019, "Smooth Bayesian network model for the prediction of future high-cost patients with COPD", *International Journal of Medical Informatics*, vol. 126, pp. 147-155.
- Zhou, J., Wang, X., Lee, S., Wu, W.K.K., Cheung, B.M.Y., **Zhang, Q.** & Tse, G., 2020, "Proton pump inhibitor or famotidine use and severe COVID-19 disease: A propensity score-matched territory-wide study", *Gut*, *(in press)*.
- Wang, H., Zhao, Y., Yu, L., Liu, J., Zwetsloot, I.M., Cabrera, J. & **Tsui, K.L.** 2020, "A personalized health monitoring system for community-dwelling elderly people in Hong Kong: Design, implementation, and evaluation study", *Journal of Medical Internet Research*, vol. 22, no. 9.
- **Tsui, K.L.**, **Zhao, Y.** & Wang, D. 2019, "Big data opportunities: System health monitoring and management", *IEEE Access*, vol. 7, pp. 68853-68867.
- **Xu, Z.**, **Zhang, Q.**, Li, W., Li, M. & Yip, P.S.F. 2019, "Individualized prediction of depressive disorder in the elderly: A multitask deep learning approach", *International Journal of Medical Informatics*, vol. 132.
- **Zhu, H.**, **Chen, Y.**, **Leung, E.** & **Liu, X.** 2018, "Outpatient appointment scheduling with unpunctual patients", *International Journal of Production Research*, vol. 56, no. 5, pp. 1982-2002.

Health Technology Ecosystem to Tackle Cardiovascular Diseases

Cardiovascular disease (CVD) is the world's leading killer. To address this health challenge, **Professor Zhang Yuanting**, Chair Professor of Biomedical Engineering at CityU, is leading a health engineering team to develop ground-breaking health technologies, from wearable sensing devices to artificial-intelligence (AI)-based early diagnostic and monitoring systems. His long-term goal is to establish an innovative health technology system for effective disease prevention and therapy in Hong Kong and beyond.

According to the World Health Organization, cardiovascular diseases, including strokes, are the number one cause of death globally, claiming an estimated 17.9 million lives every year.

There are a variety of heart and blood vessel disorders, including coronary heart disease, rheumatic heart disease, stroke and vascular dementia. They have remained the major causes of morbidity and mortality globally in the past 15 years, and it is estimated that the increasing trend of CVDs will continue.

"Despite major advances in the treatment of CVDs, a large number of patients appear to be healthy but suddenly die without any prior symptoms. A major cause of this sudden death is the rupture of vulnerable plaque in an artery, blocking the blood flow and leading to heart attack or stroke," explained Professor Zhang. "However, there are insufficient screening and diagnostic methods to identify such at-risk patients before the tragedy happens, so it is difficult to provide prevention or medical treatment in a timely manner."

Application scenarios of wearable devices, unobtrusive sensors and tele-health systems during pandemics. (X. -R. Ding et al., "Wearable Sensing and Telehealth Technology with Potential Applications in the Coronavirus Pandemic," in *IEEE Reviews in Biomedical Engineering*, doi: 10.1109/RBME.2020.2992838.)

Wearable sensing devices for disease monitoring

Professor Zhang's research focuses cover cardiovascular health engineering, as well as unobtrusive sensing and wearable devices. Together with collaborators from top universities and research institutes, his team is working on different studies to address the major gaps in early diagnosis and condition management of CVDs.

In particular, they are working on the development of wearable, soft sensing devices, made of flexible and stretchable materials, together with a system that can monitor cardiovascular condition and associated risks based on physiological models.

They are developing affordable biomedical devices that are highly sensitive to CVD-related biomarkers, so that more people can have access to this useful technology for CVD prevention. "These wearable devices can help us identify the CVD risks as early as possible," he said.

To enhance the screening of at-risk patients, they are also investigating new imaging technologies for more precise evaluation of vulnerable plaque.

Given the complex medical data collected from these monitoring devices and screening tools, a system is needed to put them together for analysis and evaluation. Therefore, the team is designing an AI-based platform for integrating all the CVD markers for early prediction and diagnosis of acute CVDs. They are also developing a closed-loop drug-delivery device based on wearable technologies for vascular intervention and therapy to provide timely treatment for acute CVD patients. In the long run, Professor Zhang hopes to build an integrated system of health technology for effective disease prevention and therapy in Hong Kong and the Greater China region.

International joint study on mobile health tech

Earlier, Professor Zhang participated in a 60-person expert task force organised and led by a team from the Harvard Medical School, which published a joint study on how mobile health technologies can help mitigate the effects of the Covid-19 pandemic. The task force identified technologies that could be deployed in response to the Covid-19 pandemic and would likely be suitable for future pandemics. They found that wearable-based mobile health technologies are viable options for monitoring Covid-19 patients who are instructed to self-quarantine at home or who have mild symptoms and undergo monitoring in community treatment facilities. They can be used to predict symptom escalation for intervention as early as possible.

"To mitigate and control diseases effectively, whether it is Covid-19 or CVDs, there is an urgent need to develop an innovative health management system that can integrate different health technologies, such as wearable health monitoring devices, biosensors, medical imaging and AI. This will enable early prediction and detection, as well as early diagnosis and intervention, for disease prevention and management," said Professor Zhang.

Professor Zhang Yuanting

Major Awards

- IAMBE Fellow
- IEEE Fellow
- AIMBE Fellow

Selected Publications

- Ding, X., Clifton, D., Ji, N., Lovell, N.H., Bonato, P., Chen, W., Yu, X., Xue, Z., Xiang, T., Long, X., Xu, K., Jiang, X., Wang, Q., Yin, B., Feng, G. & **Zhang, Y.** 2020, "Wearable sensing and telehealth technology with potential applications in the coronavirus pandemic", *IEEE Reviews in Biomedical Engineering, (in press)*.
- Zhang, G., Mei, Z., Zhang, Y., Ma, X., Lo, B., Chen, D. & **Zhang, Y.** 2020, "A noninvasive blood glucose monitoring system based on smartphone PPG signal processing and machine learning", *IEEE Transactions on Industrial Informatics*, vol. 16, no. 11, pp. 7209-7218.
- Bonato, P., Chen, Y., Chen, F. & **Zhang, Y.** 2020, "Guest editorial: Flexible sensing and medical imaging for cerebro-cardiovascular health", *IEEE Journal of Biomedical and Health Informatics*, vol. 24, no. 11, pp. 3189-3190.
- Yang, G., Pang, Z., Rahmani, A.M., Dong, M., **Zhang, Y.**, Deen, M.J. & Lovell, N. 2020, "Guest editorial: Enabling technologies in health engineering and informatics for the new revolution of healthcare 4.0", *IEEE Journal of Biomedical and Health Informatics*, vol. 24, no. 9, pp. 2442-2443.
- Liu, Y., Zhao, L., Avila, R., Yiu, C., Wong, T., Chan, Y., Yao, K., Li, D., **Zhang, Y.**, Li, W., Xie, Z. & Yu, X. 2020, "Epidermal electronics for respiration monitoring via thermo-sensitive measuring", *Materials Today Physics*, vol. 13.
- Adans-Dester, C.P., Bamberg, S., Bertacchi, F.P., Caulfield, B., Chappie, K., Demarchi, D., Erb, M.K., Estrada, J., Fabara, E.E., Freni, M., Friedl, K.E., Ghaffari, R., Gill, G., Greenberg, M.S., Hoyt, R.W., Jovanov, E., Kanzler, C.M., Katabi, D., Kernan, M., Kigin, C., Lee, S.I., Leonhardt, S., Lovell, N.H., Mantilla, J., McCoy, T.H., Luo, N.M., Miller, G.A., Moore, J., O'Keeffe, D., Palmer, J., Parisi, F., Patel, S., Po, J., Pugliese, B.L., Quatieri, T., Rahman, T., Ramasarma, N., Rogers, J.A., Ruiz-Esparza, G.U., Sapienza, S., Schiurring, G., Schwamm, L., Shafiee, H., Kelly Silacci, S., Sims, N.M., Talkar, T., Tharion, W.J., Toombs, J.A., Uschnig, C., Vergara-Diaz, G.P., Wacnik, P., Wang, M.D., Welch, J., Williamson, L., Zafonte, R., Zai, A., **Zhang, Y.**, Tearney, G.J., Ahmad, R., Walt, D.R. and Bonato, P. 2020, "Can mHealth technology help mitigate the effects of the COVID-19 pandemic?" *IEEE Open Journal of Engineering in Medicine and Biology*, vol. 1, pp. 243–248.

Microfluidic Technology for Accelerated Screening of Anti-Cancer Drugs

Professor Michael Yang Mengsu

New medicines can save and improve lives, but drug discovery is an extremely long and expensive process. One of the top scientists at CityU is developing an integrated system based on his internationally recognised, award-winning biochip technology, with the aim of providing a novel drug-screening tool with greatly reduced drug development time and cost.

Professor Michael Yang Mengsu, Yeung Kin Man Chair Professor of Biomedical Sciences and Vice-President (Research and Technology), has focused on the study of the biological processes involved in cancer, and the development of biochip technology and nanotechnology for molecular diagnostics and therapeutic applications, with the aim of improving people's lives by converting high-quality research into clinical applications. The Research Impact Fund project conducted under his leadership is working on a microfluidics-based technology platform for efficient screening of potential drug candidates.

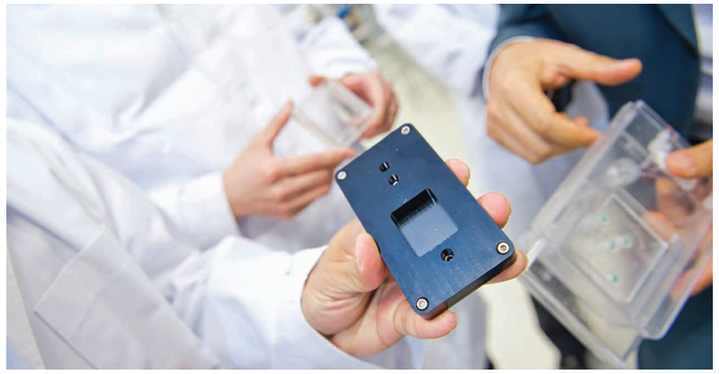
Efficient screening of drug candidates

"Drug screening is the first step in the long process of drug development," explained Professor Yang. "It identifies lead compounds and eliminates false candidates from thousands to millions of compounds, which is critical in the subsequent steps."

Two commonly used technologies are high-throughput screening (HTS) and high-content screening (HCS). HTS enables the screening of millions of chemicals for their biological or pharmacological activity to identify active compounds, which serves as a starting point for drug design and development. HCS allows the evaluation of biochemical and morphological parameters in intact cell-based biological systems, which is complementary technology to HTS.

Despite their wide applications, both technologies have drawbacks: HTS is expensive, requiring heavy use of reagents, and HCS suffers from low throughput, slow speed, and a lack of microenvironments to accurately reflect the effects of a compound on cellular behaviour. For efficient and cost-effective screening of potential drug candidates, there is great demand for new high-throughput, high-content platforms, which reduce reagent consumption and mimic the in-vivo environment to which cells are exposed.

Combining the strengths of HTS and HCS, the research team led by Professor Yang has been developing an integrated microfluidics platform that can mimic the physiological and pathological microenvironments for cell-based assays. That will facilitate the simulation of in-vivo conditions of cell growth, communication and migration for high-throughput, high-content screening of drugs that target and affect cell-cell interactions.



Microfluidics array technology with nano-amplification for drug screening and molecular diagnosis, developed by a research team led by Professor Yang.

The platform will integrate multiple parallel channels and docking structures for high-throughput formation of cell and particle arrays by fluid dynamic control. The specially designed microfluidic chip enables tumour cell and spheroid arrays to be formed for screening anti-cancer drugs with different concentration gradients and combinations. It can test the effectiveness of currently available treatments, and identify the most efficient drugs and optimal dosage.

Sensitive detection of cancer cells

Previously, Professor Yang and his team developed a microfluidic chip which can be used for highly sensitive multiplex detection of gene mutations and pathogens on barcoded microbead arrays integrated with nanoparticle-based signal amplification. Detecting gene mutations helps identify drug targets for precise medicine, and identifying pathogens contributes to early diagnosis and treatment of infectious diseases.

This patented technology won Professor Yang and his team the Gold Medal at the 47th International Exhibition of Inventions Geneva in Switzerland. It has been licensed to Cellomics International Limited, a CityU spin-off company, which was co-founded in 2018 by PhD students who graduated from Professor Yang's laboratory. The technology has been developed into products for disease detection and diagnosis in hospitals and clinical laboratories. For example, it is used for accurate identification of tumour cells circulating in the blood, enabling early screening for cancer cells through blood tests.

Professor Yang has already turned several research projects into clinical applications, including the previously developed DNA chip technology for the early detection of cervical cancer. "By translating new discoveries and findings generated in our laboratories into innovative technologies and products for clinical applications, we hope to contribute to improving the health and wellbeing of the people," said Professor Yang.

Major Awards

- Gold Medal, 47th International Exhibition of Inventions Geneva, 2019
- Wuxi AppTech Life Science and Chemistry Award, 2016
- Natural Science Award, Ministry of Education, 2015

Key Projects

- Research Impact Fund: Development of an Integrated Microfluidics System for Multi-level High Content Screening of Anti-tumor Drugs
- Innovation and Technology Fund – Public Sector Trial Scheme: Rapid Detection of SARS-CoV-2 Virus Using Isothermal Nucleic Acid Lateral Flow Assay (IsoNALFA)
- General Research Fund: Development of an Integrated Microfluidic-Based System for Single Cell Mutation Analysis and Drug Sensitivity Test of Circulating Tumor Cells/Cell Clusters

Selected Publications & Patent

- Liu, D., Hong, Y., Li, Y., Hu, C., Yip, T.-C., Yu, W.-K., Zhu, Y., Fong, C.-C., Wang, W., Au, S.-K., Wang, S. & **Yang, M.** 2020, "Targeted destruction of cancer stem cells using multifunctional magnetic nanoparticles that enable combined hyperthermia and chemotherapy", *Theranostics*, vol. 10, no. 3, pp. 1181-1196.
- Kan, T., Wang, W., Ip, P.P., Zhou, S., Wong, A.S., Wang, X. & **Yang, M.** 2020, "Single-cell EMT-related transcriptional analysis revealed intra-cluster heterogeneity of tumor cell clusters in epithelial ovarian cancer ascites", *Oncogene*, vol. 39, no. 21, pp. 4227-4240.
- Xu, T., Fu, H., Li, Y., Chen, X., Cheuk, W., Li, C.-W., Zou, H., Yue, W., Au, S.-K., Wang, Y. & **Yang, M.** 2019, "Single cell target gene mutation analysis by arc-edge-channel monolithic valve microfluidic cell isolation and locked nucleic acid-based PCR detection", *Sensors and Actuators, B: Chemical*, vol. 293, pp. 224-234.
- Li, H., Liu, P., Kaur, G., Yao, X. & **Yang, M.** 2017, "Transparent and gas-permeable liquid marbles for culturing and drug sensitivity test of tumor spheroids", *Advanced Healthcare Materials*, vol. 6, no. 13.
- Yu, W.-K., Wang, Z., Fong, C.-C., Liu, D., Yip, T.-C., Au, S.-K., Zhu, G. & **Yang, M.** 2017, "Chemoresistant lung cancer stem cells display high DNA repair capability to remove cisplatin-induced DNA damage", *British Journal of Pharmacology*, vol. 174, no. 4, pp. 302-313.
- **Yang, M.** & Liu, D., "Nanoparticle composition for use in targeting cancer stem cells and method for treatment of cancer", US patent US10,682,421B2, granted 2020.

Sustainable Aquaculture Techniques to Revitalise the Marine Fish Culture Industry

To protect the marine ecological environment and facilitate the sustainable development of the marine economy in Hong Kong, a CityU-led marine research team has developed a new aquaculture technique by establishing a floating, indoor weatherproof fish farm with a seawater recirculating system to replace conventional fish rafts. The promising results, including increased productivity and improved food safety, will contribute to supporting the livelihood of fish farmers and revitalising the local marine culture industry.

Hong Kong's traditional marine aquaculture industry, which provides about 5% of local demand for live marine fish, relies on good seawater quality in designated fish culture zones and their surroundings. One main challenge faced in recent years is the frequency and occurrence of harmful algal blooms, commonly referred to as "red tides", which cause oxygen depletion in seawater and the death of farmed fish. Toxic algal blooms spreading across Hong Kong waters in 1998 and 2015 resulted in massive fish kills and economic losses. The seasonal occurrence of parasites, followed by microbial infections, also put stress on cultured fish. Juveniles (i.e. fish fry) are particularly vulnerable.

Addressing the threat of red tides

These incidents have discouraged local fish farmers from investing in cultivating fish fry. Many fish rafts were abandoned or their operators were forced to switch their usage to recreational activities.

Supported by Sustainable Fisheries Development Fund from the Agriculture, Fisheries and Conservation Department, the team from the State Key Laboratory of Marine Pollution (SKLMP) at CityU worked on developing better culture techniques for raising the juveniles of fish like the giant grouper *(Epinephelus lanceolatus)* with the use of a seawater recirculating system, housed inside a floating fish farm. There are three main decks inside this floating fish farm: the lowest deck houses a complex water-filtration system, and the other two are "fish fry chambers", which consist of tanks for raising fish fry. The new techniques have demonstrated encouraging results by reducing the chance of microbial and parasitic infections, as well as the use of antibiotics.

A batch of giant grouper fry, which the research team has reared in the fish fry chamber for three months since August 2020, has a survival rate of nearly 100%. No apparent microbial or parasitic infections have been recorded. This represents a remarkable improvement compared to what is commonly seen in open-sea-cage fish rafts without a seawater filtration system, with 30% or above mortality of newly imported fish fry.

In addition, the issue of antimicrobial resistance can be mitigated. Fish cultured under these conditions are safer for human consumption, as less or even no medical treatment such as antibiotics is needed.

Professor Kenneth Leung Mei-yee (left) and Professor Paul Lam Kwan-sing in front of the newly established indoor floating fish farm (the green structure) in the fish culture zone of Lamma Island.

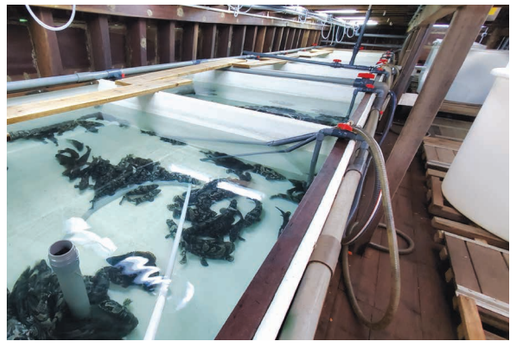
Improvement in fish and marine health

The productivity of fish rafts has also increased with the use of new fish feed. Instead of using trash fish, the team uses only dry pellet feed, which significantly reduces pollution caused by traditional fish feed and improves both feed efficiency and fish health.

"This project is a very good example of the One Health concept, how we can achieve optimal health for humans, animals and the ecosystem with technologies and innovations," said **Professor Paul Lam Kwan-sing**, Jeanie Hu Professor of Science, Chair Professor in the Department of Chemistry and SKLMP member, who led the study. The team plans to demonstrate these techniques to local fish farmers and supply healthy fish fry to them. The "fish fry chamber" concept can be adopted in any fish culture zone in Hong Kong and other places in Asia.

Established in 2009, the SKLMP is a consortium of seven universities, with CityU the leading institute. "Capitalising on a multi-disciplinary team and its collective expertise, we strive to protect the marine environment of Hong Kong and southern China by identifying major threats, such as harmful algal blooms and contaminants of emerging environmental concern, and developing tools, technologies and policies to address these problems," said **Professor Kenneth Leung Mei-yee**, Director of the SKLMP. "We look forward to more collaboration with different institutions and laboratories, as well as the industry, to tackle the complex environmental challenges together."

To support marine water quality management in the Greater China region and beyond, SKLMP also endeavours to scientifically derive water quality criteria (WQC) for chemical contaminants that represent safe environmental concentrations at or below which the marine ecosystem is safeguarded. For instance, Professors Lam and Leung recently established a set of interim WQC for 21 chemicals of emerging concern to help protect marine ecosystems in the Greater Bay Area of China. Professor Leung has also helped the international Nickel Producers Environmental Research Association (NiPERA) generate toxicity data with tropical marine organisms and derive the WQC of nickel for the Southeast Asia and Melanesia regions.



Fish tanks are supplied with filtered and sterilised seawater inside the fish fry chamber.

Key Projects

- Sustainable Fisheries Development Fund: Establishment and Demonstration of Recirculation Aquaculture System for Fry Culture on Rafts
- Theme-based Research Scheme: Assess Antibiotic Resistome Flows from Pollution Hot-spots to Environments and Explore the Control Strategies
- Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai): Coastal Changes and Material Transports in the South China Sea
- CityU's Start-up Fund: Global Estuaries Monitoring (GEM): Occurrence and Environmental Risks of Pharmaceuticals in the Major Estuaries Around the World

Selected Publications

- Lee, J.H.W., Guo, J.H., Chan, T.S.N., Choi, D.K.W., Wang, W.P. & **Leung, K.M.Y.** 2020, "Real time forecasting and automatic species classification of harmful algal blooms (HAB) for fisheries management", *Hydrolink*, vol. 4, pp. 109-113.
- Farzana, S., Ruan, Y., Wang, Q., Wu, R., Kai, Z., Meng, Y., **Leung, K.M.Y.** & **Lam, P.K.S.** 2020, "Developing interim water quality criteria for emerging chemicals of concern for protecting marine life in the Greater Bay Area of South China", *Marine Pollution Bulletin*, vol. 161.
- Gissi, F., Wang, Z., Batley, G.E., **Leung, K.M.Y.** , Schlekat, C.E., Garman, E.R. & Stauber, J.L. 2020, "Deriving a chronic guideline value for nickel in tropical and temperate marine waters", *Environmental Toxicology and Chemistry*, vol. 39, no. 12, pp. 2540-2551.
- Wang, Z., Yeung, K.W.Y., Zhou, G.-J., Yung, M.M.N., Schlekat, C.E., Garman, E.R., Gissi, F., Stauber, J.L., Middleton, E.T., Lin Wang, Y.Y. & **Leung, K.M.Y.** 2020, "Acute and chronic toxicity of nickel on freshwater and marine tropical aquatic organisms", *Ecotoxicology and Environmental Safety*, vol. 206.
- **Leung, K.M.Y.** , Yeung, K.W.Y., You, J., Choi, K., Zhang, X., Smith, R., Zhou, G.-J., Yung, M.M.N., Arias-Barreiro, C., An, Y.-J., Burket, S.R., Dwyer, R., Goodkin, N., Hii, Y.S., Hoang, T., Humphrey, C., Iwai, C.B., Jeong, S.-W., Juhel, G., Karami, A., Kyriazi-Huber, K., Lee, K.-C., Lin, B.-L., Lu, B., Martin, P., Nillos, M.G., Oginawati, K., Rathnayake, I.V.N., Risjani, Y., Shoeb, M., Tan, C.H., Tsuchiya, M.C., Ankley, G.T., Boxall, A.B.A., Rudd, M.A. & Brooks, B.W. 2020, "Toward sustainable environmental quality: Priority research questions for Asia", *Environmental Toxicology and Chemistry*, vol. 39, no. 8, pp. 1485-1505.