

Life Sciences & Healthcare



Invigorating
Synergy

Addressing your Unmet Needs through

Innovation

About The Hong Kong Polytechnic University To Learn and to Apply, for the Benefit of Mankind

The Hong Kong Polytechnic University (PolyU) is the largest government-funded tertiary institution in Hong Kong, with total student numbers of more than 25,000. Through our faculties and schools – the Faculty of Applied Science and Textiles, Faculty of Business, Faculty of Construction and Environment, Faculty of Engineering, Faculty of Health and Social Sciences, Faculty of Humanities, School of Design, and School of Hotel and Tourism Management, the University **connects education and research to the real world** as manifested in our motto “To learn and to apply, for the benefit of mankind”. Our applied research and innovations have been applauded and honored worldwide for meeting the evolving needs of society and making the world we live in a better place. The University has also maintained a **close partnership with industrial and commercial sectors, and collaborated with numerous universities worldwide** in order to contribute to the society with its expertise, state-of-the-art technology and resources. All these efforts have enabled PolyU to bring about significant impacts to the development of Hong Kong, the nation and the world.





Research and Innovation @ PolyU

Being one of the strategic areas of development at PolyU, **knowledge transfer** has always been awarded its meed of attention and due focus from the University. It has marked numerous footprints in the University's history. PolyU has spared no efforts in sustaining its long-established eminence particularly in this area of excellence. Our **application-oriented innovation and technology development** serves to address people's needs and the community's advancement along the continuum of research through knowledge transfer to its ultimate creation of **high impacts** to the society. We are keen to **foster partnerships among universities, government, industry and public** at large and **minimize the gap in technology readiness** between research outcomes and society's needs.

To this end, the **Research and Innovation Office (RIO)** as a forward-looking department in the University, is devoted to propelling the University's technology development and advances to benefit the society by providing all-rounded support to facilitate research endeavours within the PolyU community, and foster partnerships among universities, industries, governments, supranational bodies, and the public.

Life Sciences & Healthcare Technology Collaborative Platforms @ PolyU

Steered by its pioneering vision, "Be a leading university that advances and transfers knowledge, and provides the best holistic education for the benefit of Hong Kong, the nation and the world", PolyU is destined to deliver its mission "**to pursue impactful research that benefits the world.**". It lays down a solid foundation initiating knowledge transfer, enlightening innovation as well as nurturing technology development from which PolyU capitalizes on sustaining its applause winning achievements.

We pioneer advances in numerous areas and here are some of our footprints on the trail of innovation in **Life Sciences & Healthcare**.





1 Joint Center for Immunotherapy

PolyU joins forces with Axis Therapeutics to establish a joint venture by two global biopharmaceutical companies – Athenex, Inc. and Xiangxue Pharmaceutical, to foster the research and development of translational medicine by setting up a Joint Center for Immunotherapy. The Center is set to conduct collaborative research on cancer immunotherapy, with an aim to develop new cancer treatments. PolyU will provide full support for the research on novel technologies and genetics models to develop cancer immunotherapy technologies, and is committed in transferring pioneering research to real-life applications for the benefits of mankind.



2 PolyU - Fraunhofer-Gesellschaft - Karlsruhe Institute of Technology Life Sciences and Engineering R&D Platform

PolyU joins force with the Fraunhofer-Gesellschaft (Fraunhofer) and the Karlsruhe Institute of Technology (KIT), two leading research organisations in Germany, to drive collaborative applied research and technology development in the area of life sciences and engineering for the benefits of the global community. This collaboration will bring in significant innovations in chronic diseases, immunomodulation, traditional Chinese medicines, and translational medicine, and thus to bring about more translational deliverables to the society.



3 Biotechnology and Translational Medicine International Collaboration among US · Guangdong – Hong Kong – Macau Greater Bay Area

PolyU, together with alliance partners from the Guangdong – Hong Kong – Macau Greater Bay Area including Sun Yat-sen University, Shenzhen University, and Macau University of Science and Technology, initiate the first biotechnology and translational medicine research platform with The State University of New York at Buffalo (SUNY Buffalo) and Roswell Park Comprehensive Cancer Center. This collaboration puts together expertise from the collaborating parties and their networks to foster more applied research in biotechnology, and bring cutting-edge innovations in the areas of cancer, genomics, translational medicine, and other related areas in biotechnology.



4 Joint Institute of Translational Medicine

The Joint Institute of Translational Medicine was established by PolyU and the Banan District of Chongqing Municipal Government in April 2016. It aims to advance, in a collaborative manner, translational medicine researches in China through the effective transfer of research outputs into treatments for diseases. Taking advantages of the clinical and research strengths from both parties, the Institute will focus on projects such as anti-cancer drugs, medical imaging and genetic diagnosis and thus to develop related medication and diagnostic devices. It not only deepens international collaboration and industry partnerships in translational medicine, but is also expected to accelerate the offering of cost-effective medical solutions to patients.



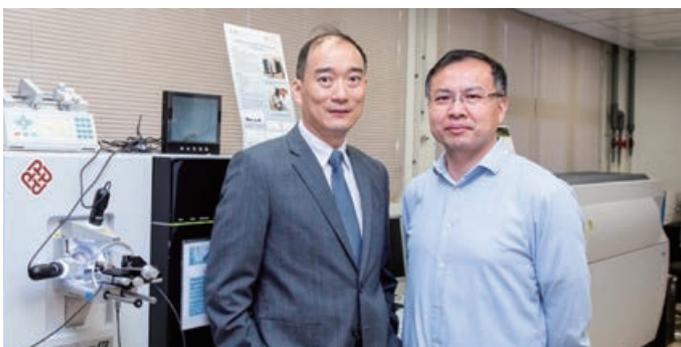
5 Respiratory Virus Research Foundation

Jointly established by PolyU and The University of Hong Kong in November 2015, the Respiratory Virus Research Foundation is to lead respiratory viral infection research and their corresponding translational research in Hong Kong. With the support of various donors, the teams from the two universities will collaborate actively with the industry to develop technologies and translate the results into clinically applicable products - products that will help the clinical management of patients with acute respiratory viral infections; from diagnostics, vaccines, vaccine adjuvants, to treatment. It is hoped that this collaboration will help to provide greater protection to the community in Hong Kong and beyond.



6 Space Biology Experiment

Riding on the support and collaboration with China Aerospace Science and Technology Corporation, Space Biology Group, China Resources Life Sciences Group and various other research partners, PolyU is keen to develop forward-looking research projects for future space missions. PolyU has a strong research track record in space technology, with our researchers having been involved in a number of national and international space exploration projects since the 1990s. From participating in space biology experiment to the nation's plan for space exploration to Mars, PolyU looks forward to collaborate with various research partners to develop other forward-looking research projects for future space missions.



7 Technology Exchanges

Apart from collaborative platforms, we connect with global leading scientific institutions, industrial partners and universities in technology exchange meetings, organize international conferences, seminars, networking receptions and other activities to share PolyU's technology expertise and knowledge and facilitate technology development of high-impact and collaborative researches.



COMBAT COVID-19

Infectious diseases represent an important portion of global public health concern, in particular with regard to the global outbreak of novel coronavirus (SARS-CoV-2). It is vital that we learn from our experience and equip ourselves with the best technologies available. To this end, PolyU researchers have been providing our community full support in the fight against the epidemic with innovation and scientific research.



1 Most Comprehensive Rapid, Automated Multiplex Diagnostic System for Detecting Infectious Respiratory Pathogens

The challenge of frontline diagnosis in hospitals, clinics and ports is that infectious diseases could exhibit similar symptoms or can be asymptomatic. PolyU has developed an automated multiplex diagnostic system (the System) which includes a fully automated machine and a multiplex full-screening panel for the point-of-care genetic testing (POCT) of respiratory infectious disease including the SARS-CoV-2.

In one single test and within approximately one hour, the System can identify 30 to 40 pathogens including seasonal influenza viruses, such as influenza A subtypes H1, H2 and H3, avian influenza viruses H5, H7 and H9, human respiratory syncytial virus, severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV) and 2019-nCoV. Leveraging the current polymerase chain reaction (PCR) technology, the system is fully automated from sample nucleic acid extraction and amplification, to signal detection and analysis. The System adopts patent-pending microfluidic and biochemical technologies that achieve ultra-sensitive detection (down to 5 gene copies) and simultaneous differentiation of various pathogens with extremely high specificity. It is also user-friendly and fully automated.



2 A New 3D-printed Face Shield for Hospital Authority, Protecting Frontline Medical Staff

In the fight against the coronavirus epidemic, there is extremely high demand on personal protective equipment (PPE) such as face shields and disposable gowns. With a view to alleviate the imminent need for protective gear amongst frontline medical professionals, PolyU has been collaborating with Queen Elizabeth Hospital (QE) and the Hospital Authority (HA) respectively to design and produce 3D-printed eye shields and face shields.

Since the face shield is a one-off disposable item, a less expensive PLA filament material would be used to develop the 3D printed frame and attached it with a plastic clear film. Studies of PolyU's School of Design in the comparison of head size between Asians and Westerners was also leveraged in order to design a face shield that better fits Chinese wearers. Design, mould-making and finally production took just a fortnight. The exceptionally short time taken in manufacturing the face shields allowed for a swift solution in filling up the stockpile to meet urgent medical needs.



3 New General Use Face Shield for the Public

Two new reusable face shields, namely the “General Use Face Shield” and “Extra Protection Face Shield” have been designed to provide enhanced protection for the public in their daily lives and working environment thus minimising the risks of virus transmission in the community.

Both types of face shield are reusable after cleaning as they are made of lightweight and environmentally-friendly PET (Polyethylene Terephthalate) plastic material using the vacuum forming technique, which helps to lower production costs. Research team used 3D printing technology to develop a prototype and has conducted multiple rounds of tests and modifications. The design of face shield would not fog up easily because of their unique designs that help to maintain visual clarity, while also providing a comfortable wearing experience for users. The “General Use Face Shield” is suitable for everyone; while the “Extra Protection Face Shield” offers broader protection by covering the forehead and hair.



4 A Vaccine Targeting the RBD of the S protein of SARS-CoV-2 Induces Protective Immunity

The novel Coronavirus SARS-CoV-2 causes a respiratory illness called COVID-19 leading to a pandemic. An effective preventive vaccine against this virus is urgently needed. Since the early days of the outbreak, PolyU and Macau University of Science and Technology (M.U.S.T), in collaboration with other Chinese institutions, have been devoted in the development of a COVID-19 vaccine. At the most critical step during infection, SARS-CoV-2 uses its Spike protein receptor-binding domain (S-RBD) to engage with the host cell receptor angiotensin-converting enzyme 2 (ACE2). In this study, the research team found that a recombinant vaccine comprising residues 319-545 of the S-RBD could induce a potent functional antibody response in the immunized mice, rabbits and non-human primates (*Macaca mulatta*) as early as 7 or 14 days after a single dose injection. The sera from the immunized animals blocked RBD binding to ACE2 expressed on the cell surface and neutralized the infection by SARS-CoV-2 pseudovirus and live SARS-CoV-2 in vitro. Importantly, the vaccination also provided protection in non-human primates from SARS-CoV-2 challenge in vivo. The elevated RBD-specific antibodies were also found in the sera from patients with COVID-19. Several immune pathways and CD4 T lymphocytes were implicated in the induction of the vaccine antibody response.

According to the study, the vaccine had given potent and complete protection to the vaccinated animals including monkeys. Our finding highlights the importance of the RBD domain in the SARS-CoV-2 vaccine design and provides the rationale for the development of a protective vaccine through the induction of antibody against the RBD domain.



5 Clinically Applicable AI System for Accurate Diagnosis, Quantitative Measurements, and Prognosis of COVID-19 Pneumonia Using Computed Tomography

Many COVID-19 patients infected by SARS-CoV-2 virus develop pneumonia (called novel coronavirus pneumonia, NCP) and rapidly progress to respiratory failure. However, rapid diagnosis and identification of high-risk patients for early intervention are challenging.

PolyU has been collaborating with the Macau University of Science and Technology (M.U.S.T.) to use a large computed tomography (CT) database from 3,777 patients and develop an AI system that can diagnose NCP and differentiate it from other common pneumonia and normal controls. The AI system can assist radiologists and physicians in performing a quick diagnosis especially when the health system is overloaded. Significantly, this system identified important clinical markers that correlated with the NCP lesion properties. Together with the clinical data, an AI system was able to provide accurate clinical prognosis that can aid clinicians to consider appropriate early clinical management and allocate resources appropriately. It has been made available globally to assist the clinicians to combat COVID-19.



6 Mathematical Models to Help the Fight against the COVID-19 Pandemic

The research team from Department of Applied Mathematics (AMA) and the School of Nursing (SN) are among the first in the world to estimate the transmission rate, case fatality rate, and gender disparity of COVID-19. Using statistical models, the underreport of COVID-19 cases in Wuhan during early January when the testing capacity for SARS-CoV-2 virus was limited has been investigated.



The population flow data was further utilised to estimate the cases exported from Wuhan to major cities of mainland China, and found that at the early stage, the number of outbound trips from Wuhan was highly associated with the number of confirmed cases of COVID-19 in 10 city-clusters in China, including Beijing, Shanghai and Chongqing. The study on domestic travel load also revealed a strong association between the daily number of domestic passengers travelling by train and the number of infected cases.

The team have published 11 peer-reviewed papers in medical journals and the findings have added important evidence for risk assessment to support the decision-making of mitigation strategies.

More research projects and studies on COVID-19...

- 3R rehabilitation management of COVID-19 survivors using centre-based and online-based approaches
- Whole-genome sequencing of COVID-19 cases in Hong Kong: development of a geophylogenetic database and characterisation of SARS-CoV-2 variants circulating in the community
- AI-empowered chest X-ray and CT quantitative analysis for COVID-19 patient management
- A low-cost handheld device for decentralised detection of SARS-CoV-2 and host response in COVID-19 patients: development and evaluation
- Characterisation of the distribution of aerosols released from drainage ventilating pipe of public housing buildings
- Psychological trauma and unsafe behavior during the COVID-19 pandemic: a mixed method study of people's emotion, knowledge, attitude and behaviour
- Blended Gaming COVID-19 Training System (BGCTS) with WHO guidelines for staff in residential care
- Public compliance with disease prevention and public health measures to control COVID-19
- Study Shows One in Eight Not Wearing Face Masks Properly - Almost 80% of People Reusing Them
- Experts Urge Users to Wear Face Masks Correctly and Formulate Guidelines on Reuse to Minimise Contagion Risks

For the most updated PolyU efforts on COVID-19, please visit our website:

<https://www.polyu.edu.hk/combatact19/>



Featured Technologies

Our life sciences and healthcare technologies span across areas such as **drug research and development, drug delivery, biomedical engineering, medical devices and diagnostics, biomedical science, gerontechnology, optometry, engineering and medicine**, and a collection of other innovations developed by our experts.



1 Drug Research and Development, Drug Delivery

The advancement in molecular biology poses a revolutionary impact on drug discovery and its complexity. In recent years, PolyU has grown major research strengths in molecular biosciences – on our radar you could find molecular genomics, chemistry, pharmacology, new techniques on chemical imaging and biosensing, and many other research initiatives for supporting research in cancer, neurodegenerative diseases, regenerative medicine, nanotechnologies, and the like.

a. New Drug Development

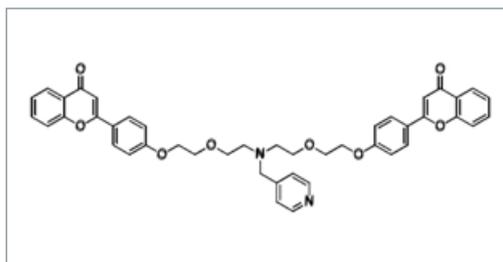
The very first drug candidates developed in Hong Kong receiving U.S. Food and Drug Administration Investigational New Drug (IND) approval, including two effective novel anti-cancer drugs developed through engineering arginine-depleting enzyme, were either developed by PolyU or were supported by PolyU during its development. Our Portfolio continues to expand in identifying newer and better therapeutic agents for treating different types of cancers.



b. Novel Flavonoid Dimers for Reversing Cancer Drug Resistance

A new class of effective, safe and specific flavonoid dimers designed, synthesized and characterized for reversal of multidrug resistance in chemotherapy through inhibition of ATP-binding cassette transporters with a candidate compound identified for preclinical studies. This apigenin flavonoid dimer has already been licensed to a global oncology specialist company for further research and development.

c. Novel Flavonoid Dimers against Cutaneous and Visceral Leishmaniasis



Synthetic flavonoid dimers with potent anti-promastigote and anti-amastigote activities towards *Leishmania*'s cutaneous and visceral strains, in vitro and in vivo. Inhibition of ATP-binding cassette transporters pumping activity results in increased intracellular drug accumulation and thereby reversing drug resistance in Leishmaniasis.

d. Amphiphilic Core-Shell Nanoparticles for Biomedical Applications

A novel and versatile method of providing a safe, efficient, targeted delivery in gene therapy based on a new class of Polyethyleneimine (PEI)-based core-shell nanoparticles; able to complex and protect nucleic acids of different molecular weights, have lower toxicity yet higher gene delivery efficiency, and are more effective than liposome-based vectors for some cell lines.



e. Pharmaceuticals for Women's Health: Prodrugs of Epigallocatechin Gallate (EGCG)

Overcoming the limitations of using EGCG due to its poor bioavailability, instability and facile metabolic degradation. Candidate compounds exhibit improved bioavailability, enhanced antitumor and antiangiogenic activity in several important tumor cell pathways, without significant perturbation of normal cells.

f. Tiger Milk Mushroom Extract Inhibits Breast Cancer

Highly stable selenium nanoparticles synthesized using mushroom polysaccharide-protein complexes isolated from the sclerotia of *Pleurotus tuber-regium*, found to remarkably inhibit growth of human breast carcinoma by apoptosis induction while possessing cancer-specific cytotoxicity.

g. Development and Application of Lanthanide Luminescent Materials

Design and synthesis of a series of new lanthanide complexes and nanoparticles which exhibit long-excited wavelength, high quantum efficiency, non-toxicity and water solubility; to be used as fluorescence marker with high efficiency and stability for in vitro or in vivo imaging.

2 Biomedical Engineering

Biomedical engineering improves the life quality via the application of existing and emerging technologies. PolyU has excelled in the interdisciplinary research in the area through collaborations across our internal departments as well as with other institutions locally and globally, offering new technologies and direct expert services to the community. We are at the core of biomedical engineering activities, which have gained recognition from beyond the territory.

a. KineLabs for Elderly Exercise and Stroke Rehabilitation

Coordinated upper limb, lower limb and trunk balance training tasks for elderly exercise and stroke rehabilitation; performance data and 3D information of body segments of the players could be captured and analyzed using a specifically designed evaluation platform.

b. PolyJBot - Rehabilitation Driven by Human Intention

A robotic system providing therapeutic exercise for elderlies and stroke patients which involve active interaction between users and the robotic system, with user intention being captured through muscle activities from signals measured by the EMG electrode placed on the body.

c. Exoskeleton Hand Robotic Training Device

A novel design of a hand function task training robotic system developed for active stroke rehabilitation, through detection of hand opening or closing from the stroke patient using muscle signals measured from the hemiplegic side, allowing activity using their own intention to practice daily living tasks.

d. Functional Electrical Stimulator for Stroke Patients

A programmable multi-channel functional electrical stimulator system for stroke rehabilitation through stimulation of paralyzed muscles for functional movements; improves arm and foot motor functions, reduce spasticity, prevent muscle contractures and with potential applications on spinal cord injuries and cerebral palsy patients.

e. Brain Training Device for Neurorehabilitation after Stroke

A motor function training system for active stroke rehabilitation by detecting voluntary motor intention from the correlation between the brain and the muscles in the affected side by using surface electroencephalography and electromyography.

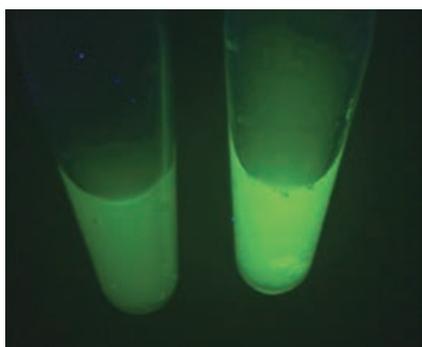
3 Medical Devices and Diagnostics

Platform technologies with the potential for further development to suit different applications, non-invasive medical devices, and other improvements of current medical technologies are in great demand to tackle ever-increasing problems in modern healthcare and food safety. To effectively maximize their impacts, PolyU is taking the initiative in exploring their applications in the field.

a. Molecular Diagnostics

The automated multiplex diagnostic system (the System) includes a fully automated machine and a multiplex full-screening panel for the point-of-care genetic testing (POCT) of respiratory infectious disease. In one single test and within approximately one hour, the System can identify 30 to 40 pathogens including seasonal influenza viruses, such as influenza A subtypes H1, H2 and H3, avian influenza viruses H5, H7 and H9, human respiratory syncytial virus, severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV) and COVID-19.

Leveraging the current polymerase chain reaction (PCR) technology, the system is fully automated from sample nucleic acid extraction and amplification, to signal detection and analysis. The System adopts patent-pending microfluidic and biochemical technologies that achieve ultra-sensitive detection (down to 5 gene copies) and simultaneous differentiation of various pathogens with extremely high specificity.



b. Development of Ultra-sensitive and Super-rapid Biosensors

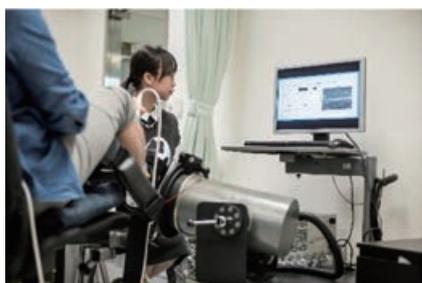
A versatile platform for detection of antibiotics, lipids, small molecules, and for drug screening. A tailor-made fluorescent biosensor constructed by rational approach to sense a specific molecule which is a ligand or substrate for a particular protein or enzyme, allowing the development of a universal protein-based biosensor construction method to detect a large variety of important small molecules.

c. Non-invasive Glucose Detection in Saliva with Organic Transistors

An ultra-sensitive organic electrochemical transistor (OECT)-based biosensor fabricated with a glucose oxidase enzyme (GOx) layer which could specifically detect the level of glucose in saliva by non-invasive approaches. Low detection limit of 10^{-5} mmol/L and can be fabricated on flexible substrates, with the potential for developing into wearable electronics.

d. Scolioscan Air

Scolioscan Air is a portable ultrasonic imaging device developed to achieve comparable accuracy with X-ray scan for mass screening among school children to diagnose and monitor the progression of scoliosis. It is radiation-free and can produce 3D ultrasound image for clinical use and highly accessible, which can fit in school or small clinic setting.

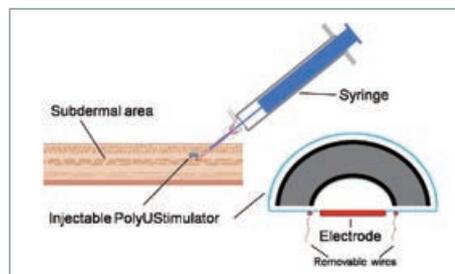


e. Viewing Muscle Vibration with Ultrasound Imaging

A novel method for imaging the dynamics of muscle contraction using ultrafast ultrasound. With ultrasound, muscle vibration can be observed at high time- and spatial-resolution, which is not possible with use of traditional methods such as MMG. This technology will be valuable for studies of neuromuscular diseases in the future.

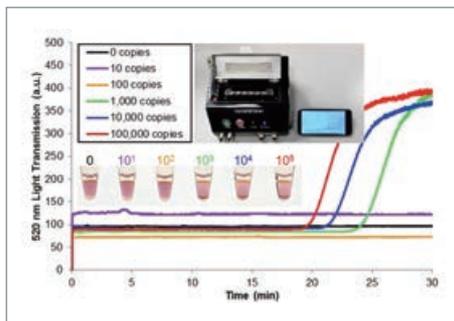
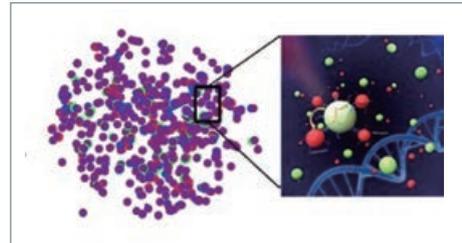
f. Piezoelectric Stimulation

Electroceuticals are the new frontier of bioelectronic medicine. Existing electroceutical stimulators are bulky due to the battery, while wireless power delivering to the implants remains a critical challenge due to the transmission efficacy and safety. To overcome this challenge, a battery-free, ultrasonically powered, piezoelectric stimulator, called PolyU Stimulator, has been developed.



g. Nanoprobe Based Multi-scale Spatiotemporal Single-cell in-situ Analysis

An integrative approach is targeted to address the main challenges for single-cell analysis with the development of single-cell in-situ analysis platform based on super-resolution barcoding of various types of multicolor fluorescence resonance energy transfer (FRET) probes for multi-scale spatiotemporal single-cell analysis.

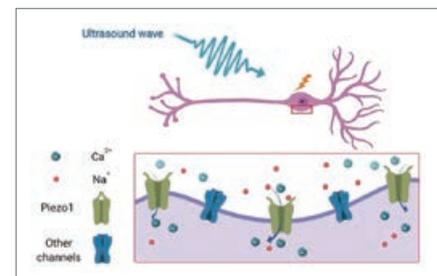


h. Point-of-Care Nucleic Acid Testing

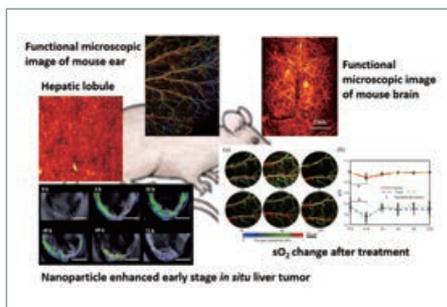
A palm-sized and low-cost nucleic acid testing device is developed, which is ideally suited for decentralized applications. The assay platform features a first-of-its-kind gold nanoparticle-based colorimetric real-time loop-mediated isothermal amplification. It is highly sensitive (down to 500 copies, ~40 aM) and rapid (30 minutes).

i. Ultrasound Theranostics

A non-invasive ultrasonic methodology for modulation of brain activities is being studied to understand brain functions and treat brain disorders, investigate translational ultrasound technologies for treating cancers and diabetes, and explore nanotechnology-based molecular imaging and precision and personalized therapy.



j. Shining New Light into Deep Tissue via Wavefront Engineering and Photoacoustics



Light is almost ideal to probe and treat biological tissues yet encounters inevitable trade-off between resolution and penetration depth due to scattering diffusivity in tissue. High-resolution optical focusing, imaging, and stimulation at depths in tissue via technology innovations such as wavefront engineering and photoacoustics have been developed, which may potentially reshape the landscape of utilizing light in biomedicine.

4 Biomedical Science

PolyU pioneers in the design and development of new biomedical imaging modalities, diagnostic technologies and sensors, devices, screening methods, and treatment approaches. Various biomedical ultrasound instrumentation and applications are under rigorous development and deployment. Biomedical sensing including development of nano- and micro- biosensors, microfluidic devices, nanoporous membranes and smart drug delivery devices plus other biomedical advances such as application of genomics are underway.

a. Late-onset Alzheimer's Disease

Late-onset Alzheimer's disease (AD) is the most common type of dementia among older adults, usually occurring after 60 years of age. Its symptoms, for sample gradual deterioration of memory, loss of cognitive function as well as self-management poses significant health issues to an aging society. Research is now being done on a proposed intermediate phase – "mild cognitive impairment" (MCI) between normal cognition and dementia.

b. Atopic Dermatitis

Atopic dermatitis (eczema) is increasingly affecting the population in Hong Kong. The lack of complete epidemiology data on both childhood and adult AD and the lack of complete understanding on the genetic and environmental factors associated makes the effectiveness of treatment relatively low. Genetic profiles could disclose important aspects and form important basis for the future studies of AD and for the development of targeted therapeutics.

c. 3D Ultrasound Imaging for Various Applications

i. Scoliosis Diagnosis

A mobile, radiation-free system for evaluation of scoliosis based on 3D ultrasound imaging, with measurements taken as frequently as required without any radiation hazard. The effectiveness of cure can be continuously monitored during treatment period.

ii. Breast Ultrasound Imaging & Breast Cancer Diagnosis

The world's most compact ultrasound elasticity imaging system for breast cancer diagnosis which is accessible to the community at large and ready to be adopted in hospital, clinics and healthcare centers. A novel automated 3D annotation method for breast ultrasound imaging also aids screening and diagnosis.

iii. Corneal Assessment

Optical coherence tomography (OCT), a non-invasive, non-contact imaging technology developed to obtain tissue cross-section image with high resolution is combined with a novel air-jet method for assessing the mechanical properties of cornea in ophthalmology and optometry.

iv. Scar Evaluation

A device for the objective assessment of burn and surgical scars before and during treatment, including measurement of thickness and stiffness. The device could also be used for evaluation of other tissues requiring simple operation and low cost, such as fat thickness measurement.

v. Sonomyography

A novel assessment method adopting ultrasound to detect real-time architectural change signals of muscles during contraction which could be applied on muscle function assessment, human-machine interface for control purposes, as well as the control of prosthesis using residual limb of amputees.

vi. Elasticity Evaluation for Diabetic Foot & Liver Fibrosis

A novel ultrasound foot scanner based on ultrasound indentation and other techniques for foot plantar tissue assessment of diabetic patients, providing a regular check-up method on the feet to avoid diabetic foot ulcerations; also used as a research tool and a clinical device for foot assessment.

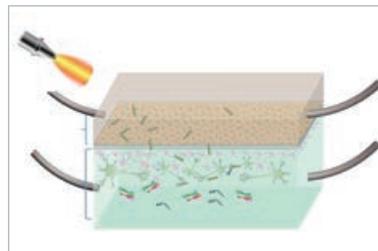
d. Human-on-leaf-chip: A biomimetic Vascular System Integrated with Chamber-specific Organs

A human-on-leaf-chip system is developed with biomimetic multiscale vasculature systems connecting vascularized organs, mimicking the complex in vivo architectures of the human cardiovascular system. The native organ-to-organ crosstalk is well recapitulated, implicating a strong potential for harnessing the leaf chip for circulatory-related studies such as metastasis.



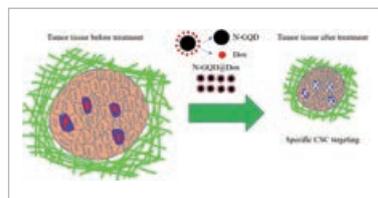
e. Shining light on Alzheimer Disease on-a-chip: Near Infrared (NIR) Based Functional Nanoprobes for Phototherapy of Alzheimer's Disease in a Brain-on-a-chip

Near-infrared (NIR) light induced combinational photo-inhibition of A β aggregation via a hybrid brain-targeting peptide (RVG) conjugated nanoprobes is reported to largely enhance photo-inhibition efficiency of A β inhibition as well as attenuate neurotoxicity under NIR light exposure in a Alzheimer disease on-a-chip model (AD-on-a-chip). This research provides a promising approach to study NIR based synergistic phototherapy of Alzheimer disease in the future.



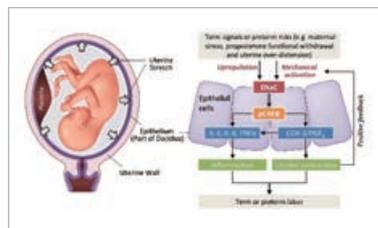
f. Harnessing Cell Mechanics for Nanoparticle-based Mechanotargeting of Soft Cancer Stem Cells

It is reported that soft CSCs exhibit considerably higher uptake of nitrogen-doped graphene quantum dots (N-GQDs) than bulk tumor cells. Softening/stiffening cells enhances/suppresses nanoparticle uptake through activating/inhibiting endocytosis. Drug-loaded N-GQDs inhibit tumor but not animal body growth and specifically eliminate breast CSCs in vitro and in vivo, which reduces the tumorigenicity of xenograft cells. This research unveils a new mechanism by which cell mechanics can be harnessed in nanoparticle-based mechanotargeting for specific CSC elimination.



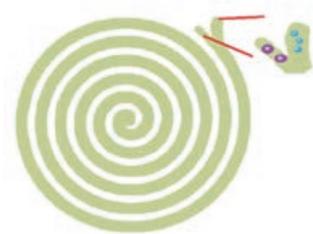
g. Ion Channels and Transporters in Human Health and Diseases

The research aims to elucidate mechanisms underlying the roles of ion channels, particularly those originally identified in epithelial cells, in various physiological processes (e.g. reproduction, endocrinology, development) and pathological disorders (e.g. infertility, metabolic diseases, age-dependent bone problems), as well as to develop them into diagnostic or therapeutic targets.



h. Spiral Microfluidic Chip: High-throughput Low-cost Separation of Cells that Stopped Dividing from Healthy Cells

Senescent cells that stops dividing are larger in size compared to healthy dividing cells. Due to the balance of dean drag force and inertial lift force inside the channel, larger senescent cells are dragged inward to the inner wall of channel while smaller healthy cells are pushed outward. This chip has promising potential to be readily used for screening of senolytic drug compounds or improving efficacy of cell-based therapy.



5 Gerontechnology

a. eNightLog, a Multi-function Monitoring System for Prevention of Fall and Wandering of Elderly with Dementia

The non-contact and non-invasive eNightLog system is embedded with event sequence tracking and different kinds of remote sensing and imaging technologies, based on an innovative algorithm developed by the BME team of PolyU. Tracking user's sleeping positions and postures, detecting minor motions, collecting the bed-ambient measurements and controls helps caregivers monitor the elderly remotely and prevent fall or wandering.



b. Smart Interactive Doll, a Doll Therapeutic Tool for Improvement of Emotional State, Reduction of Challenging Behaviours and Facilitation on Social Interactions of Users

The interactive doll with a patented design consists of three components: an external cover, internal structure and circuit, and internal structure surrounding. The skeleton embedded with sensors can sense the actions taken by users and provide programable feedbacks to achieve training and/ or therapy for people in needs. It can be used individually or in groups of elderly, elderly with dementia, people with mental disabilities.



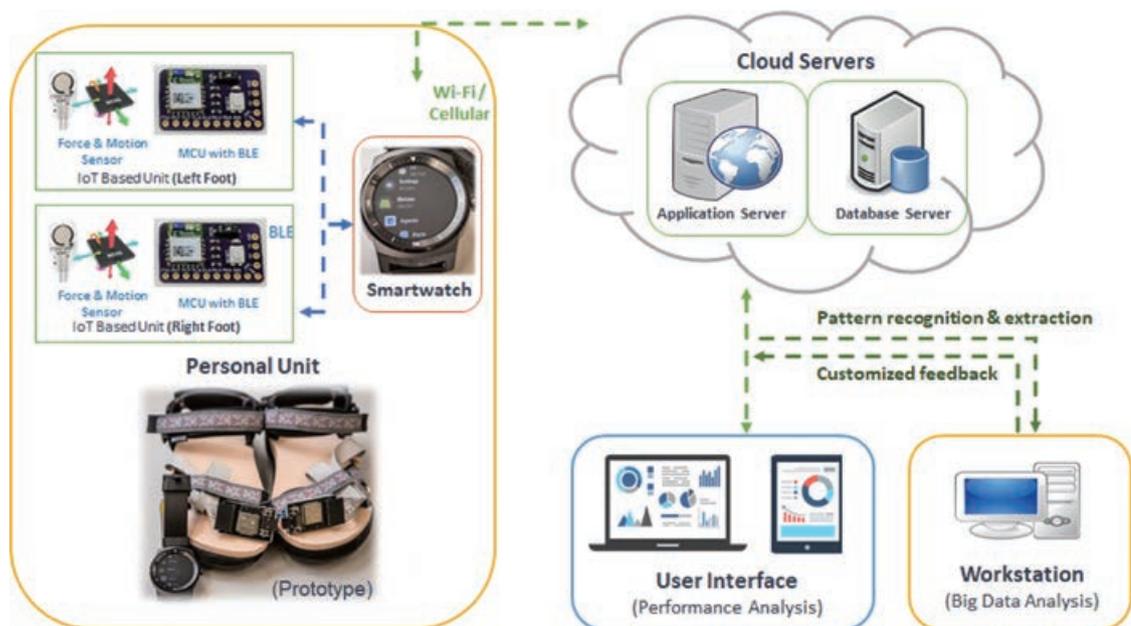
c. Social / Companion Robot, a Cantonese-speaking Accompany Doll for People with Mild Cognized Impairments

The localized social/ companion robot contains a single board computer with network connection, microphone speaker array, speaker, and rechargeable battery is designed for accompanying people with mild cognized impairments. It allows customization in both appearance and content. Features including customized daily schedule and task reminders (for mealtime, bedtime), personalized memory preset dialogue and report of useful information such as date & time, weather or festivals are equipped for providing companionship to mild cognized impairments users and motivate them to engage in social interaction.



d. Smart Balance Training Insole System, Advanced Cloud-based Insole for Improvements on Postural Balance and Walking Ability of Elderly

The reported shoe insole system consists of 1) instant postural stability analysis and monitor, 2) standardized reminder for postural correction, and 3) Cloud-based data storage for remote monitor and big data analytics. Each piece of the insole has a foot motion capture module with eight thin-film force sensors measuring plantar force distribution and one inertial motion unit measuring foot angle. The insoles are wirelessly connected with a smart watch which provides instant corresponding reminder and sends captured data to Cloud. The postural reminder feature can provide additional scientific references to doctors/therapists and facilitate telerehabilitation in different clinical settings.



6 Optometry

Myopia and ageing eye research are the two foci of PolyU's optometry research. With the anticipated increase in our ageing population, more people will suffer from age-related general health problems as well as eye diseases. Myopia is also assuming epidemic proportions in South East Asia over the past few decades and it is common to find young adults with over 5D of myopia in Hong Kong and other Asian regions including Singapore, Taiwan and Southern China. High myopia is frequently associated with retinal degeneration, peripheral retinal breaks and glaucoma, which may lead to permanent visual loss and blindness. PolyU is set out to find better ways in managing and curing these eye conditions, so as to preserve vision in our community and beyond.

a. Novel Optical Method for Retarding Myopia Progression

The novel Defocus Incorporated Soft Contact (DISC) lens takes advantage of the natural homeostasis of the eye and can be incorporated into wide-accepted forms of contact lens, providing clear vision and retarding myopia progression in children and youngsters. It also opens up new opportunity for treating other refractive error such as hyperopia using suitable defocus.



b. Defocus Incorporated Multiple Segments Spectacle Lens

The principle of myopic defocus is to produce a clear image on the retina and another defocused or blurred image in front of the retina. The Defocus Incorporated Multiple Segments (DIMS) Spectacle Lens takes advantage of the natural homeostasis of the eye; the wearer can enjoy a clear and comfortable vision while myopia progression is being controlled. Jointly developed by PolyU and its research collaborator Hoya Corporation, the DIMS lens won the Grand Prize (overall championship), a Grand Award and a Gold Medal with the Congratulations of Jury at the 46th International Exhibition of Inventions Geneva, Switzerland, in 2018.



7 Engineering and Medicine

The inclusion of engineering ideas and multidisciplinary approaches expand infinitely the possibilities of medical advances and facilitates precision diagnostics and therapeutics to improve healthcare.

PolyU is committed in advancing knowledge and innovations for the prevention, diagnosis, monitoring, treatment, and rehabilitation of diseases and various medical conditions through interdisciplinary research and technology transfer. We collaborate with various partners to develop forward-looking research projects in healthcare applications.

State Key Laboratories





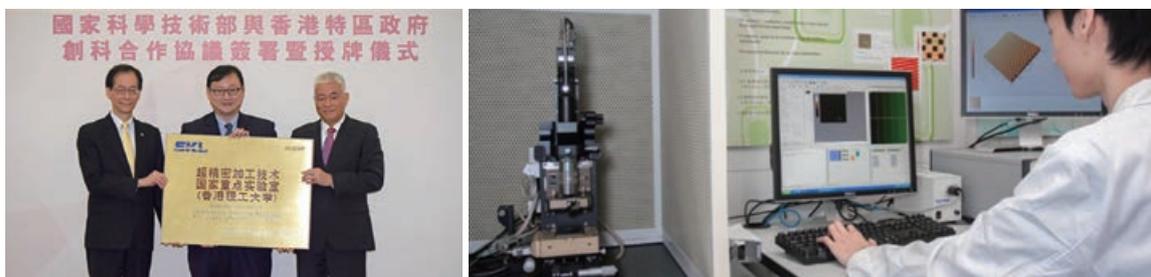
1 State Key Laboratory of Chemical Biology and Drug Discovery (The Hong Kong Polytechnic University)

The State Key Laboratory of Chemical Biology and Drug Discovery (formerly as Partner State Key Laboratory of Chirosciences) has been working on drug discovery and synthesis for many years. The first drug developed by the State Key Laboratory was a liver cancer drug, which has undergone the phase two clinical trials. A number of catalysts developed for chiral synthesis in this laboratory have been successfully licensed to industries in Hong Kong, the Chinese mainland and overseas. The structure of an important protein related to autophagy and tumour development, Beclin 1, has been determined and the result published in *Nature Communications* in 2012. Articles have also been published in high-impact journals such as *Cancer Research*, *Journal of the American Chemical Society* and *Angewandte Chemie*.



2 State Key Laboratory of Ultra-precision Machining Technology (The Hong Kong Polytechnic University)

Ultra-precision machining technology is one of the most critical research areas in manufacturing technology of advanced optical components and precision mechanical parts for many high-end industries. These include aerospace, biomedical, semiconductor, and precision machinery industries with stringent requirements on the accuracy and tolerance of products down to the nanometer range. The Laboratory is a regional leader in the frontier research it undertakes and in nurturing human resources. It is also the first of its kind in South East Asia and the Chinese mainland to support the industry in pioneering the design and manufacture of freeform elements and optical microstructures for photonics and telecommunication products. According to ISI Web of Knowledge (Thomson Reuters), the project team has authored the highest number of publications in the field of ultra-precision machining, precision optics, precision machining, and freeform measurement.



3 State Key Laboratory of Chinese Medicine and Molecular Pharmacology (Incubation), Shenzhen

The Key Laboratory focuses on modernized Chinese medicine research, in terms of the pre-clinical studies of drugs or health food. Chemical composition and action mechanisms responsible for the efficacy of Chinese medicine on the prevention and treatment of geriatric and chronic diseases are of focus, and by multidisciplinary researches in analytical chemistry, pharmacology, system biology and other fields, the Key Laboratory aims at demonstrating the science of traditional Chinese medicine using modern scientific approaches and providing related evidence for clinical applications. Located at the Shenzhen Hi-tech Industrial Park with an area of 2,000^m², the facility is equipped with state-of-the-art equipment in various functional laboratories such as the Specific Pathogen Free (SPF) Animal Laboratory, Pharmacology Laboratory, Tissue Culture Laboratory, Analytical Chemistry Laboratory and NMR Laboratory.

4 Shenzhen Key Laboratory of Food Biological Safety Control

The Laboratory was set up in Shenzhen in 2011 to conduct food safety testing and research within the Pearl River Delta region, with the aim of upgrading food safety standards with research-based quality assurance. The Laboratory's top priority is to establish risk evaluation and early warning system on food safety, so as to identify and predict the major pathogens causing infections, food poisonings, and outbreaks. The Laboratory also develops novel technologies such as portable DNA biosensors for bacterial pathogen detection, and food packaging technologies with improved performance. The research findings shall be shared for industry reference in identifying high-risk foods and explore measures to tackle related problems.





University Research Facilities

1 University Research Facility in 3D Printing (U3DP)

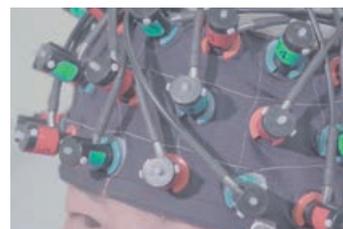
3D Printing, also known as Additive Manufacturing (AM) is a process of producing a physical model layer by layer in accordance with the geometrical data derived from a 3D digital or CAD (computer-aided design) model. Parts (3D objects) made by 3D Printing can be further applied to or post-processed by other technologies or processes to meet different needs and requirements. The use of different and new materials is also expanding the possibilities of 3D Printing applications in manufacturing and the entire world.



The U3DP is Hong Kong's largest research centre in 3D Printing, in terms of range and quantity of facilities. It is also the first and only of its kind among the local higher education institutions which can provide all-round support to students and researchers to excel their research works to life.

2 University Research Facility in Behavioral and Systems Neuroscience (UBSN)

UBSN plays a primary role in providing state-of-the-art equipment and technological platforms for neuroscientists to conduct high impact studies and train research students. Cross-species and cross-modality research are the key to the UBSN's success. Cross-species research undertakes invasive animal studies to reveal underlying neural mechanisms, and this knowledge is then combined with translational methods to test the findings on human subjects. The ultimate goal is to enable researchers to create and apply knowledge to solve real-life problems in areas such as ageing, child development, neurological rehabilitation, language development and mental health.



3 University Research Facility in Big Data Analytics (UBDA)

UBDA is the first university-level research facility in Big Data Analytics in Hong Kong for cross-disciplinary research collaborations, teaching, and learning, as well as a partnership with industry. It provides a dedicated, secure, and scalable 24/7 big data platform to store and analyze data for finding the hidden patterns, exploring unknown correlation, improving prediction, supporting decision making, recommending services, and products and other analytic solutions.



4 University Research Facility in Chemical and Environmental Analysis (UCEA)

UCEA is an interdisciplinary platform between chemical and environmental research, it acquired a total of 18 major equipment ranging from high resolution mass spectrometer, solid state Nuclear Magnetic Resonance (NMR) spectrometer to third generation DNA sequencer and more. The collection of cutting edge equipment encourages the research atmosphere and nurture collaboration from experts in different background.



5 University Research Facility in Life Sciences (ULS)

ULS provides state-of-the-art equipment to support PolyU's world-class research in Life Sciences. Workstations supporting stem cell research, immunology, microbiology, molecular biology provide platforms for high-resolution imaging, DNA analysis, metabolite analysis, protein analysis, etc. to facilitate high-impact multidisciplinary life science researches.



6 University Research Facility in Materials Characterization and Device Fabrication (UMF)

UMF consists of four laboratories including Cleanroom, Centre for Electron Microscopy (CEM), Micro/Nano Device Fabrication and Sensing Technologies (DFST) and Materials Research Centre (MRC) which enable a wide variety of disciplinary and interdisciplinary research projects. The laboratories cover topics from Optoelectronic to up-conversion, Ferroelectric to Pyroelectric, alloys to ceramics, polymers to biomaterials, photolithography, device fabrication and measurement, materials synthesis, characterization and processing, etc to underpin research developments in materials science and technology within PolyU.



Our Life Sciences & Healthcare-related Faculties and Departments

At PolyU, we embrace **collaborative research and development** during our innovation process. Whatever your unmet needs are, we have a team of experts ready to help you tackle your challenges.



Faculty of Applied Science and Textiles

- **Department of Applied Biology and Chemical Technology**
 - New Materials and Nanotechnology
 - Drug Discovery and Traditional Chinese Medicine
 - Cancer Research
 - Organometallic and Catalysis
 - Renewable Energy and Sustainable Development
 - Chemical Imaging and Biosensing
 - Food Safety and Technology
- **Department of Applied Physics**
 - Nanomaterials
 - Photonic Materials and Devices
 - Smart Materials and Devices
- **Department of Applied Mathematics**
 - Mathematical Modeling of Infectious Disease Spreading
- **Institute of Textiles and Clothing**
 - Textile and Micro-encapsulation for Drug Delivery
 - Smart Therapies

Faculty of Engineering

- **Department of Computing**
 - Pattern Analysis and Machine Intelligence
 - Software Engineering and Systems
 - Mobile and Network Computing
- **Department of Industrial and Systems Engineering**
 - Advanced Materials Processing
 - Products Design and Miniaturization
- **Department of Mechanical Engineering**
 - Fluid-Structure Interactions
 - Integrated Product Development
- **Department of Biomedical Engineering**
 - Medical Imaging, Bioinstrumentation and Biosensing
 - Neuromusculoskeletal Science and Engineering
 - Prosthetics and Orthotics
 - Rehabilitation Engineering
- **Department of Electrical Engineering**
 - Power systems
 - Railway systems
 - Transportation systems
 - Software engineering
 - Electrical installations of buildings
- **Department of Electronic and Information Engineering**
 - Electronics
 - Communications
 - Multimedia / information technologies
 - Artificial Intelligence
 - Optoelectronics
 - Photonic systems and devices
- **Department of Aeronautical and Aviation Engineering**
 - Aircraft services engineering
 - Aviation information systems
 - Aircraft component design and manufacture

Faculty of Health and Social Sciences

- **Department of Applied Social Sciences**
 - Psychology, Mental Health, and Health
 - Family, Child, Youth, and Ageing Studies
- **Department of Health Technology and Informatics**
 - Cancer Genomics and Bioinformatics
 - Complex Diseases and Microbial Infections
 - Healthy Ageing: Dietary, Environmental and Lifestyle Influences
 - Applications of Radiation Science in Cancer
 - Imaging Research in Metabolic and Vascular Diseases
- **Department of Rehabilitation Sciences**
 - East Meets West in Rehabilitation Sciences
 - Neuroscience and Neurological Rehabilitation
 - Musculoskeletal and Sports Rehabilitation
- **School of Nursing**
 - Ageing and Health
 - Family and Community Health
 - Transitional, Supportive and Palliative Care
- **School of Optometry**
 - Myopia and Astigmatism
 - Glaucoma and Others

Life Sciences & Healthcare-related Research Centres

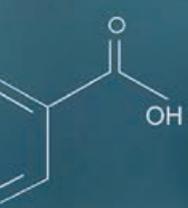
- **Food Safety and Technology Research Centre**
- **Materials Research Centre**
- **Lo Ka Chung Centre for Natural Anti-Cancer Drug Development**
- **Biometrics Research and Innovation Centre**
- **Centre for Myopia Research**
- **Advanced Manufacturing Technology Research Centre**
- **International Research Centre for the Advancement of Health Communication**
- **Research Centre for Language, Cognition, and Neuroscience**
- **Research Centre for Smart Wearable Technology**
- **The PolyU-HKBU-SDU Joint Research Center on Financial Mathematics**
- **Photonics Research Centre**
- **Photonic Sensors Research Centre**
- **Power Electronics Research Centre**
- **Research Centre for Fluid-Structure Interactions**

The Industrial Centre...

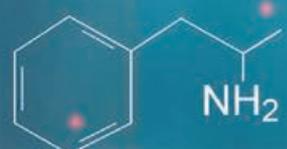
Multi-disciplinary expertise and technologies under one roof

The Industrial Centre (IC) of PolyU is the training centre for professional engineers, as well as a one-stop technical solution provider during the innovative process. IC has a large range of technical experts who possess real industrial application experience and knowledge, who are capable of integrating PolyU's multi-disciplinary innovations with the best technical advice and solution for our partners - turning your innovative concepts and ideas into workable industrial design or even real products and systems to meet your special needs.





Status: Analysis



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