

Life Sciences and Healthcare Innovations



2022



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Research and Innovation at PolyU

The Hong Kong Polytechnic University (PolyU) commits to research excellence and addresses global challenges with practical innovation.

Our commitment to interdisciplinary research has led to innovative discoveries for a more sustainable tomorrow. We uncover knowledge and transform research excellence into impactful innovation through multi-disciplinary collaborations. We open up new horizons in space, improve human health and wellbeing, boost economic efficiency and foster sustainability for a better world.

Research and Innovation Office

As a forward-looking department in the University, Research and Innovation Office 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 PolyU community, and foster partnerships among universities, industries, governments, supranational bodies, and the public.

Our roles:

- Exert all-rounded support to facilitate research endeavors, including the application for funding, both internally and externally
- Impel translational research across disciplines to provide joint responses to global challenges
- Engage PolyU experts with industry players to spur high-impact research partnership
- Build strategic platforms to foster University, Industry, and Government collaboration

65th

QS World University
Rankings 2023

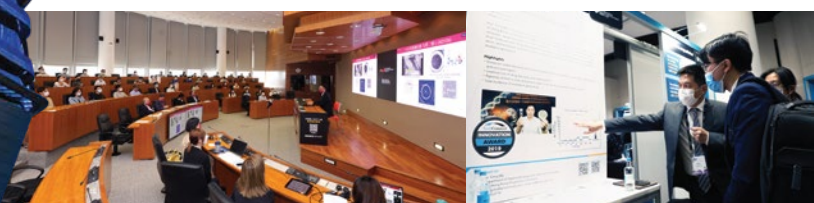
79th

Times Higher Education
World University Rankings 2023



Over 200 PolyU scholars
ranked among
World's Top 2%
most-cited scientists

by Stanford University



Supporting Hong Kong as a global hub for research collaboration

In support of the Hong Kong government's new initiative, InnoHK Clusters, which aims to develop Hong Kong as a hub for global research collaboration, PolyU has partnered with world-leading institutions to bring together world-leading researchers for impactful collaborative research in Hong Kong. Under two newly established research clusters – **AIR@InnoHK** (focusing on artificial intelligence and robotics technologies) and **Health@InnoHK** (focusing on healthcare related technologies), PolyU has launched three research centres:

- Laboratory for Artificial Intelligence in Design (with Royal College of Arts, UK)
- Centre for Advances in Reliability and Safety (with University of Maryland – College Park, USA)
- Centre for Eye and Vision Research (with University of Waterloo, Canada)

Interdisciplinary Research

The University has set up the PolyU Academy for Interdisciplinary Research (PAIR) as a platform to facilitate interdisciplinary research and innovation, technology transfer and collaboration with world-leading institutions. There are currently ten research institutes and five research centres operating under PAIR to create impactful solutions in areas including artificial intelligence, carbon neutrality, deep space exploration, smart cities and smart energy.

- Mental Health Research Centre
- Otto Poon Charitable Foundation Research Institute for Smart Energy
- Otto Poon Charitable Foundation Smart Cities Research Institute
- Photonics Research Institute
- Research Centre for Chinese Medicine Innovation
- Research Centre for Deep Space Explorations
- Research Centre for Resources Engineering towards Carbon Neutrality
- Research Centre for SHARP Vision
- Research Institute for Advanced Manufacturing
- Research Institute for Artificial Intelligence of Things
- Research Institute for Future Food
- Research Institute for Intelligent Wearable Systems
- Research Institute for Land and Space
- Research Institute for Smart Ageing
- Research Institute for Sports Science and Technology
- Research Institute for Sustainable Urban Development

In addition, the University recently approved a total grant of HKD 50.75m to support eight Research Centres, including five new and three existing centres, to develop new research niche areas and further enhance some focused research areas. PolyU will continue to spare no effort in supporting interdisciplinary research and expanding our talent pool.

- Colour, Imaging, and Metaverse Research Centre
- Research Centre for Blockchain Technology
- Research Centre for Carbon-Strategic Catalysis
- Research Centre for Future (Caring) Mobility
- Research Centre for Quantitative Finance
- Peking University – The Hong Kong Polytechnic University China Social Work Research Centre
- Research Centre for Data Science and Artificial Intelligence
- Research Centre for Gerontology and Family Studies



COLLABORATIVE PLATFORMS

PolyU actively joins hands with industry, government and other stakeholders to create synergy in translating our innovations and technology into applicable deliverables. We are keen to foster partnerships in Life Sciences and Healthcare through various strategic platforms and technology exchanges.

Joint Center for Immunotherapy with Axis Therapeutics

The Joint Center established by PolyU and Axis Therapeutics aims to foster the research and development of translational medicine. It is set to conduct collaborative research on cancer immunotherapy, with an aim to develop new cancer treatments. PolyU supports 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.



Joint Research Laboratory for New Drug Development

Research Centre for Chinese Medicine Innovation and Increasepharm (HK) Limited established the PolyU-Increasepharm Joint Research Laboratory for New Drug Development, aiming to develop CM-based new drug to treat osteoporosis, sarcopenia, dementia, and ocular diseases.

This collaboration hopes to seize the strategic opportunities to integrate with the country's overall development, further advanced drug discovery and development in view of the surging demand in healthcare and pharmaceutical industry.



Life Sciences and Engineering R&D Platform

PolyU joins forces with the Fraunhofer-Gesellschaft and the Karlsruhe Institute of Technology, two leading research organisations in Germany, to drive collaborative applied research and technology development in life sciences and engineering for the benefits of the global community. This collaboration hopes to bring in significant innovations in chronic diseases, immunomodulation, traditional Chinese medicines, and translational medicine.

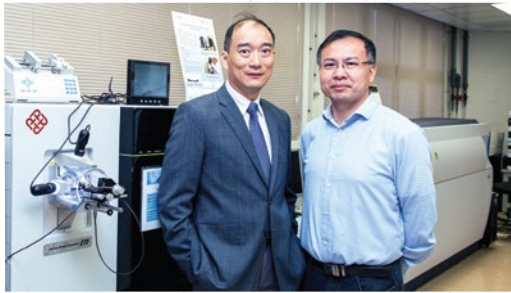


Collaboration to Advance Drug Development

PolyU has actively collaborated with the industry to contribute new anti-cancer drugs development over the years. Pegtomarginase, which was initially developed by PolyU is further developed and exploited by Avalon Polytom and Athenex for the treatment of patients with advanced malignancies. It received U.S. FDA allowance of Investigational New Drug (IND) Application in 2019, and this second-generation human arginase (PT01 – Pegtomarginase) is further granted to enter into clinical trial phase 1, a significant milestone for this anti-cancer drug development with researchers' innovation and strong execution capabilities at the companies commitment to commercialising novel technologies for the treatment of a wide range of cancers.



Space Biology Research Projects to Support National Space Missions



PolyU has a strong research track record in space technology since 1990s. 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. From participating in space biology experiment to the nation's plan for space exploration to Mars, PolyU looks forward to further collaborate with various research partners to develop other forward-looking research projects for future space missions.

Joint Research Laboratory for Probiotics and Prebiotics in Human Health

With the generous donation from Hong Kong Yakult Co. Ltd., PolyU-Yakult Joint Research Laboratory for Probiotics and Prebiotics in Human Health was established in 2021. It promotes interdisciplinary research in the fields of food science and human health, and focus on the cutting-edge research of probiotics and prebiotics for the prevention and treatment of intestinal, brain diseases, eczema and women's health.



Technology Showcase

COMBAT COVID-19



Since the beginning of the COVID-19 pandemic, researchers at PolyU have applied themselves to using their knowledge to help combat the virus. Anti-pandemic contributions from the PolyU community range from devices to detect the virus, to antivirus 3D printing material, to modelling platforms to predict how the pandemic will develop, to help for patients recovering from infection.



Ultrasensitive and Portable Detection Sensor for COVID-19 Antibody Detection

The portable SARS-CoV-2 immunoglobulin G detection platform uses organic electrochemical transistors (OECTs) which can convert biological signals into electrical signals. By optimising the test conditions, including ion concentrations, pH values and voltage signals, the test is able to identify COVID-19 antibodies within minutes and controlled by mobile. The antibody detection sensor can test the concentration of antibodies from lower than 10fM to higher than 100nM. The detection limit satisfies the needs of exquisite analytical sensitivity for saliva. It is anticipated that the platform could also be used to detect other disease antibodies.



Portable COVID-19 Testing Device for Fast and Accurate Results

Weighing only 2kg and equipped with a built-in power source, the newly-invented handheld device can be operated outside the laboratory in efficient manner, without sacrificing reliability. It is designed to provide highly sensitive SARS-CoV-2 viral RNA detection based on the combination of reverse transcription–loop-mediated isothermal amplification (RT-LAMP) and gold nanoparticles as the amplification result readout reagent, with full agreement with the reverse transcription–polymerase chain reaction (RT-PCR) standard.



Antiviral 3D Printing Materials and Technology for Public Infection Control

An interdisciplinary research team has developed the world's first anti-virus 3D printing material that can eliminate over 90% of the COVID-19 viruses on a surface within 10 minutes, and terminate almost all viruses and bacteria in 20 minutes. The main component of the material is resin, added with anti-viral agents such as cationic compounds, to pierce the cell membrane of the virus and destroy its structure to kill the virus and bacteria.

The material can be produced in different forms using 3D printing technology, and could be used extensively in public facilities to provide epidemic prevention support to the community.



Development of a Recombinant RBD Vaccine Against SARS-CoV-2

Since the early days of the outbreak, PolyU and Macau University of Science and Technology have been devoted in the development of a COVID-19 vaccine in collaboration with other Chinese institutions.

The study evaluated a candidate vaccine based on the RBD domain of SARS-CoV-2. It demonstrated that recombinant vaccines against spike protein in the RBD region can effectively induce a potent immune response in the body with a good safety profile, providing a potential solution in the fight against COVID-19.

AI-assisted System to Advance Diagnosis of COVID-19 Pneumonia

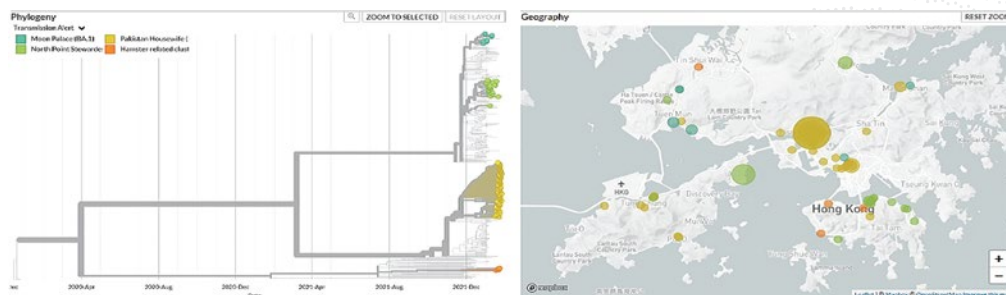


Many COVID-19 patients develop novel coronavirus pneumonia (NCP) and rapidly progress to respiratory failure. PolyU has been collaborating with the Macau University of Science and Technology to use a large computed tomography database from 3,777 patients and develop an AI system that can diagnose NCP and differentiate it from other common pneumonia and normal controls. The AI system assists radiologists and physicians in performing a quick diagnosis. This system identifies important clinical markers that correlated with the NCP lesion properties thus providing accurate clinical prognosis for early clinical management and better resources allocation.

Whole-genome Sequencing Uncovers COVID-19 Transmission Chains

Whole genome sequencing is the gold standard method to characterize the mutation patterns, yet takes at least one week to complete which is inefficient to halt the viral transmission.

The revised library preparation protocol coupled with nanopore sequencing technology is able to characterize the entire viral genome and identified mutations within 8 hours. It also integrates the genome data with geographic information system and epidemiological information of the patients to develop a phylogeographic database of COVID-19 in Hong Kong. The work by the research team has provided scientific support for the Government's anti-pandemic measures and helped to close loopholes.



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

PolyU research team is 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 2020 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.

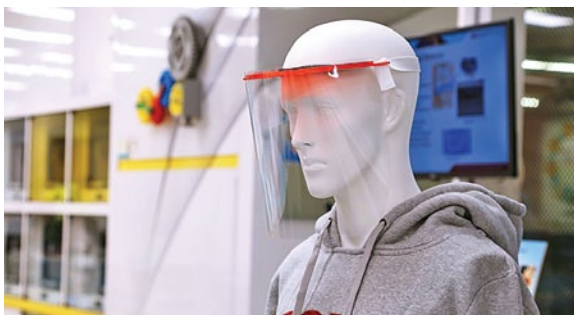
Most Comprehensive Rapid, Automated Multiplex Diagnostic System for Detecting Infectious Respiratory Pathogens

The automated multiplex diagnostic system 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. It 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 and simultaneous differentiation of various pathogens with extremely high specificity.



3D-printed Face Shield for Frontline Medical Staff

To help meet the pressing need for personal protective equipment (PPE) during the early outbreak of COVID-19, PolyU has quickly pooled together its expertise and resources to produce eye shields and face shields for frontline medical staff. Design, mould-making and production took just a fortnight.



General Use Face Shield for the Public

Two new reusable face shields, namely “General Use Face Shield” and “Extra Protection Face Shield” were 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.



Visit PolyU website for more research and studies:
www.polyu.edu.hk/combatcovid19



DRUG RESEARCH AND DEVELOPMENT



2019

- **Pegtomarginase**, Hong Kong's fifth IND granted by USFDA

2018

- **Eribulin ORA** Oral form of **Eribulin**, Hong Kong's fourth IND granted by USFDA

2017

- **Oratopo** Oral form of topotecan, Hong Kong's third IND granted by USFDA
- **Quinoline-type Compounds as Novel Anti-cancer Agents** Licensed
- **Prodrugs of Epigallocatechin Gallate (EGCG)** Licensed

2016

- **Oradoxel** Oral form of docetaxel, Hong Kong's second IND granted by USFDA
- **HAI-PEG20** Second generation of BCT-100, licensed

2015

- **Apigenin Flavonoid Dimer** Licensed

2014

- **Oratecan** Oral form of irinotecan, with HM30181, a P-glycoprotein inhibitor of the GI tract; Phase 1 results announced

2012

- **BCT-100** Hong Kong's first IND granted by USFDA

2001

- **BCT-100** Feasibility studies initiated

Anti-Cancer Drug Discovery

Cancer is a leading cause of death worldwide and there is no true cure currently. Cancer treatment usually includes surgery, radiotherapy and systemic therapy (e.g. chemotherapy/ targeted therapy), but the options are often limited and may not always be effective. Thus, the discovery and development of a new cancer drug with better efficacy and safety is essential.

Our researchers have played a significant role in cancer research over the years and have led to the development of new anti-cancer drugs. 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.

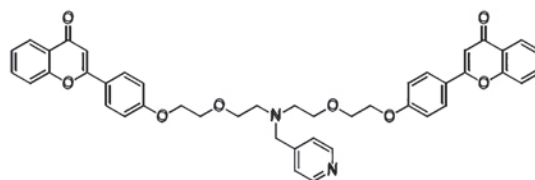


Novel Flavonoid Dimers for Reversing Cancer Drug Resistance

A novel class of effective, safe and specific flavonoid dimers is designed, synthesized and characterized through inhibition of ATP-binding cassette transporters with a candidate compound identified for preclinical studies. This apigenin flavonoid dimer can prevent drug efflux by drug-resistant cancer cells and reverse multidrug resistance in tumor. It also allows anticancer drugs to be absorbed orally, reducing the risks, time, inconvenience and discomfort for patients enduring chemotherapy.

Novel Flavonoid Dimers against Cutaneous and Visceral Leishmaniasis

Leishmaniasis is a serious parasitic disease that threatens about 350 million people in the world. Treatment of leishmaniasis by chemotherapy remains a challenge because of limited efficacy, toxic side effects and drug resistance. Plant-derived natural products such as flavonoids have been a good source for discovering antiparasitic compounds. Previously, we demonstrated that synthetic flavonoid dimers can inhibit the pumping activity of ATP-binding Cassette (ABC) transporters, resulting in an increase in intracellular drug accumulation and thereby reversing drug resistance in both cancer and Leishmania. In this study, some of the flavonoid dimers were found to have potent anti-promastigote and anti-amastigote activity towards cutaneous strain and visceral strain of Leishmania in vitro and in vivo.



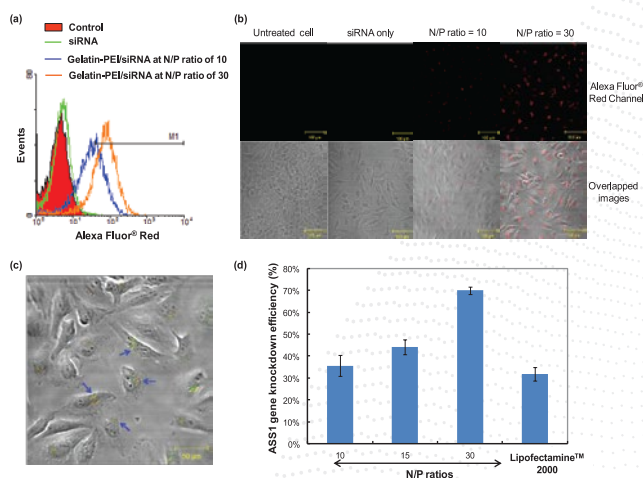
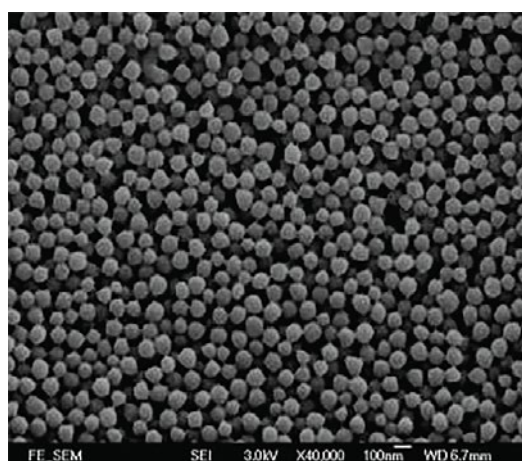
New Class of Antibiotic Candidates for Fighting Against Superbugs

The new class of antibiotic drug candidates, Nusbiarylins, which has high potential to be developed into a new generation of antibiotics fighting against multi-drug resistant superbugs including methicillin-resistant *Staphylococcus aureus* (MRSA). It demonstrates much effective abilities of inhibiting bacterial growth than commonly used antibiotics, yet with no toxicity to human cells. Further pre-clinical studies on the in vitro pharmacological properties of Nusbiarylins on human cells indicated the compounds lead to nearly no hemolysis and excellent result in intestine absorption, implying being safe for injection and effective for oral taking respectively.



Amphiphilic Core-Shell Nanoparticles for Biomedical Applications

Polyethyleneimine (PEI) is considered to be an effective non-viral gene carrier because of its high complexing ability and excellent transfection efficiency. However, the use of PEI for gene delivery has only achieved limited success owing to its cytotoxicity and broad size distribution of its resultant polyplexes. This novel class of PEI-based core-shell nanoparticles contains a dense PEI layer and a biocompatible core, making it a unique nano-structural design for safe and efficient gene delivery and would have important applications in the delivery of diverse biomolecules into cells.



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 antitumour and antiangiogenic activity in several important tumour cell pathways, without significant perturbation of normal cells.

Tiger Milk Mushroom Extract Inhibits Breast Cancer

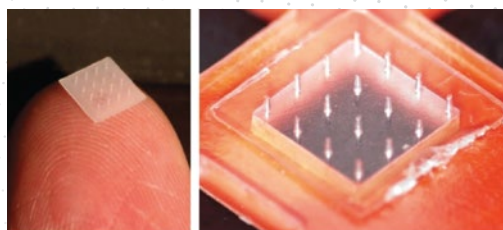
Highly stable selenium nanoparticles synthesized using mushroom polysaccharide-protein complexes isolated from the sclerotia of *Pleurotus tuber-regium*, found to remarkably inhibit growth of human breast carcinoma by apoptosis induction while possessing cancer-specific cytotoxicity.

DRUG DELIVERY AND THERAPEUTICS



Plastic Injectable Transdermal Drug Delivery Microneedles

Transdermal drug delivery using microneedle is a novel and promising method of drug delivery. PolyU has been conducting research on plastic hollow and sharp tipped microneedles by micro injection molding. Since the successful application of plastic micro injection molding is frequently determined by goodness and accuracy in the design and manufacture of microneedle mould cavity, non-conventional micro fabrication methods such as photolithography, micro-electroforming and pico-second laser machining have been developed for the fabrication of precise hollow microneedle mould structures. The latest developments of micro injection moulding technology and micro mould fabrication technique enabled the plastic injectable microneedles fabrication an innovative, reliable and cost-effective production method.

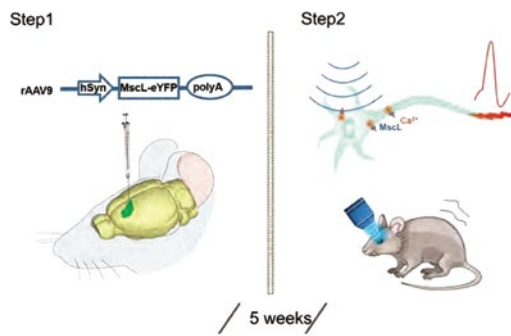


A Functional Textile-based Thermal-stimuli Drug Delivery Apparel System

This research focuses on how "second-skin" apparel and skin interact with each other to serve therapy functions. The relation between the thermo-stimulated drug-delivery system and the textile will be studied for the development of healthcare apparel for patients whose disease are typically realised by applying ointment or dressing to the skin. This study provides a functional textile system that delivers lowcost, rapid, and efficient patient care. The development is expected to bring great benefits to both patients who seek long-term daily medical treatment and the apparel industry.

The application of the system will potentially apply to the following areas: textiles in healthcare development, functional fashion innovation, and care possibilities for patients.

Non-invasive Selective Neural or Cellular Stimulation by Ultrasound



Transcranial Magnetic Stimulation is non-invasive yet lack of spatial resolution and cell type selectivity. The newly developed non-invasive stimulation has significant impact on both fundamental brain function research and treating brain dysfunction. Using ultrasound in specific spatio-temporal regions, one is able to collect selectively manipulation of neuronal activity. The success translation of this technology would result in huge breakthrough in brain initiative projects and clinical needs.

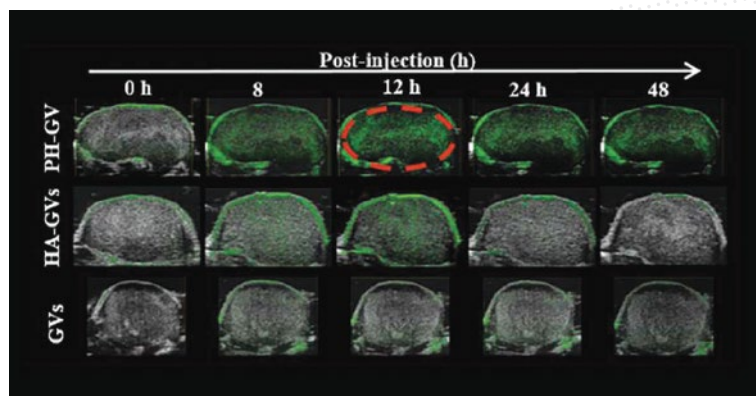
Wearable Closed-loop Neural Control 'Remind-to-Move' (RTM) Treatment

The RTM treatment uses a sensory-cueing wristwatch, which is strapped to the patient's affected arm and emits vibration signals at fixed intervals, to remind the patient to do exercises as instructed by therapists. The device is in its third-generation which plans to harness kinematics, neuroscience and artificial intelligence to develop a closed-loop wearable device. It will stimulate the hemiparetic arm based on a machine learning algorithm developed by capturing the affected arm's actual activities and comparing them with those of the non-affected arm. The new closed-loop treatment will facilitate motor control in a more natural way and improve the brain's ability to adapt to the environment and adjust based on experience, enabling patients to make a better recovery.



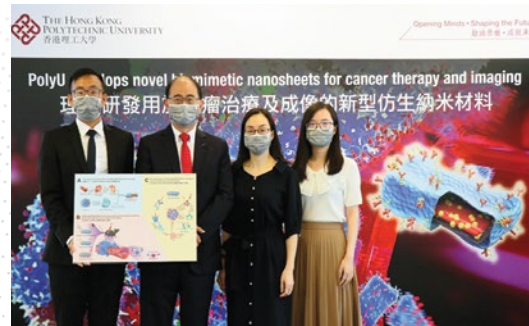
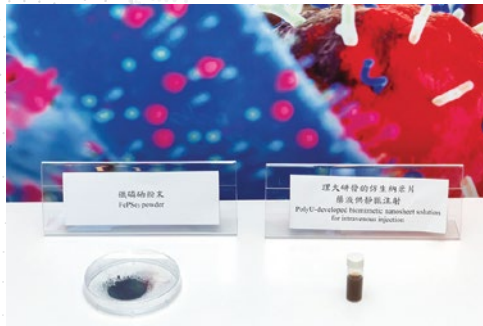
Multi-functional Gas Vesicles for Enhanced Cancer Therapy

Recently reported gas vesicles (GVs) have been demonstrated as the first biomolecular acoustic reporters with gene editability and inherent stability. In this innovation, multi-functional GVs are developed for enhanced cancer therapy through the surface modification, endowing it with various properties. Notably, the PEGylated HA-GVs have high tumour-targeting efficacy, enabling it to serve as a molecular ultrasound probe for in vivo tumour detection; whereas lipid-GVs could function as an oxygen carrier that could deliver large quantity of oxygen to the tumour site to alleviate tumour hypoxia. Besides, GVs themselves could facilitate the occurrence of cavitation which can potentially enhance the efficacy of sonodynamic therapy. As such, modified GVs could function as a potent theranostic tool in the future of cancer treatment.

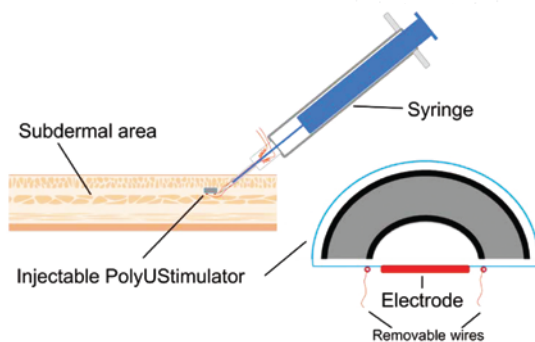


Biomimetic Nanosheet for Cancer Therapy and Imaging

The innovation integrates two emerging cancer therapies (immunotherapy and photothermal therapy) with three imaging modalities (magnetic resonance imaging, photoacoustic imaging and photothermal imaging) and is able to track tumour development and treatment processes in real-time. The novel two-dimensional nanosheet, made with iron phosphorus triselenide (FePSe₃), enables doctors to choose the best imaging modality and treatment for patients. It also facilitates the development of a new generation of cancer theranostic agents which are safe and have a high targeting ability and efficacy. It can significantly improve the therapeutic outcome, reduce side effects and increase patients' survival rates.



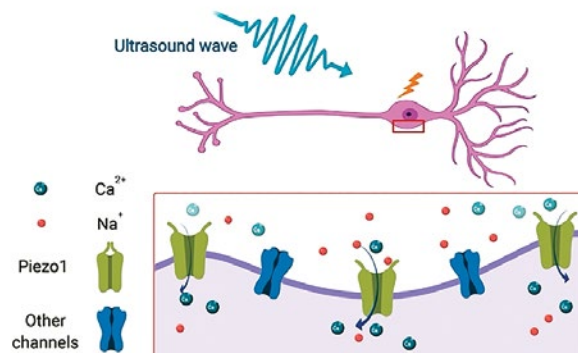
PolyUStimulator – Ultrasound Driven Piezoelectric Stimulator for Neuromusculoskeletal Rehabilitation



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. The PolyUStimulator presents a battery-free, ultrasonically-powered, piezoelectric stimulator for functional muscles, nerves and bones.

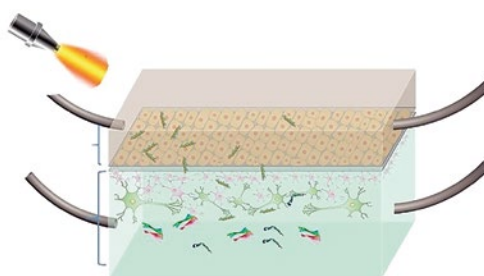
Ultrasound Theranostics

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.



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 nanoprobe 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.

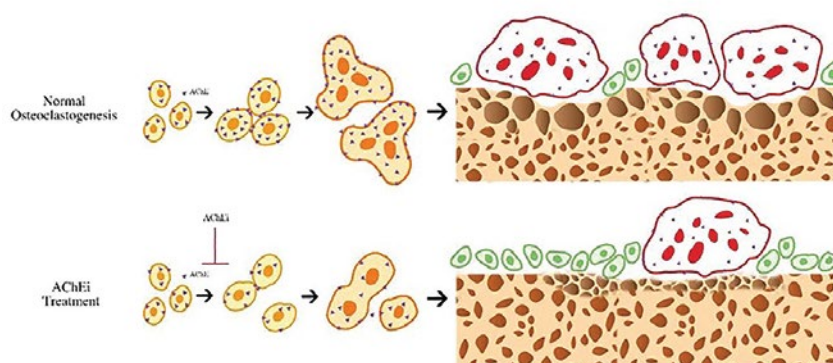


Acetylcholinesterase as a Novel Therapeutic Target for Osteoporosis

Osteoporosis represents a major global public health problem with increasing grey population. Its most worrying complication is the life-threatening hip fracture. However, current anti-osteoporosis treatment fails to lower the incidence of hip fracture in very older adults, which prompts researchers to discover new drugs to address this unmet need.

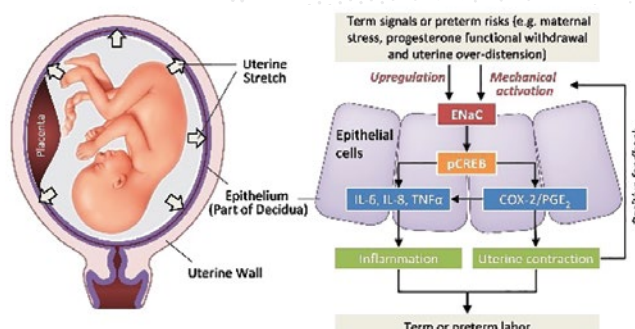
In recent years, there has been a growing interest in repositioning the FDA-approved anti-Alzheimer's acetylcholinesterase (AChE) inhibitors for osteoporosis treatment. Use of AChE inhibitors was associated with the reduced risk of hip fracture, enhanced osteoporotic fracture healing and decreased overall mortality in the elderly Alzheimer's patients. Yet the exact role of AChE in bone homeostasis and diseases remains equivocal until very recently.

Under the auspices of Jockey Club Smart Ageing Hub and University Research Facility on Behavioral and Systemic Neuroscience, we will liaise with Jockey Club Centre for Osteoporosis Care and Control to longitudinally monitor the effects of donepezil on bone mineral density as well as cerebral blood flow in MCI or demented patients.



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.



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 tumour cells. Softening/stiffening cells enhances/suppresses nanoparticle uptake through activating/inhibiting endocytosis. Drug-loaded N-GQDs inhibit tumour but not animal body growth and specifically eliminate breast CSCs in vitro and in vivo, which reduces the tumourigenicity of xenograft cells. This research unveils a new mechanism by which cell mechanics can be harnessed in nanoparticle-based mechanotargeting for specific CSC elimination.

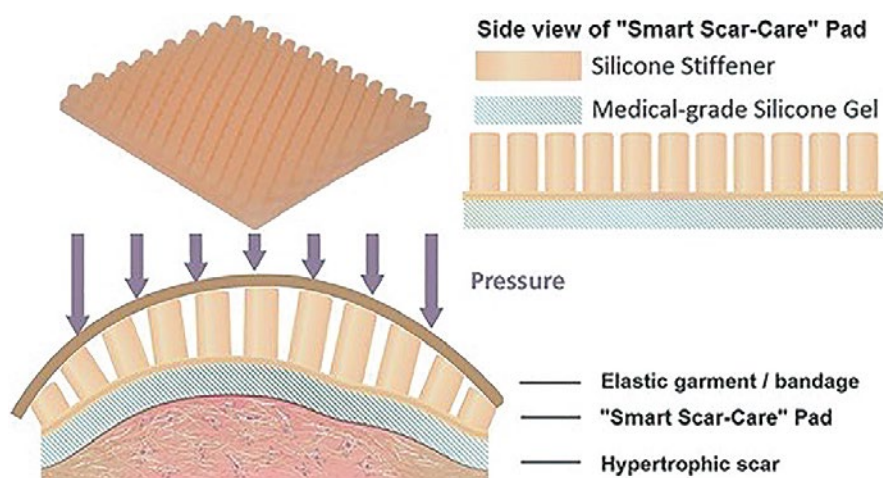
Epigenetic Regulation and Glaucoma – the Effect of DNA Methylation Inhibition of Thrombospondin 1 on Aqueous Humor Dynamics

Primary Open Angel Glaucoma is a leading cause of blindness worldwide. In early stage of the disease, it is often undiagnosed as the symptoms of peripheral vision is difficult to notice.

DNA methylation is an epigenetic process considered to play an important role in the pathophysiology of many diseases and potentially in glaucoma. We hypothesize that hypomethylation of the TSP1 gene, which upregulated in glaucoma patients, is a key mechanism of glaucoma. Because DNA methylation has been implicated in the transcriptional inactivation of selected genes in diseases. Findings from the present study may lead to the development of novel targeted and specific glaucoma therapies.

Combine Pressure and Silicone Gel Therapy to Control Hypertrophic Scar

Hypertrophic scar is a common complication following burns, surgeries and trauma. It will cause aesthetic problems, and induce severe deformities, thus causing dysfunctions, particularly among the Asian population. "Smart Scar-Care" pad is a newly invented padding material for the better control of hypertrophic scar. It is composed of a specially designed silicone stiffener and the medical-grade silicone gel lining underneath was synthesised with unique formula. Together with pressure treatment modalities, "Smart Scar-Care" pad helps to distribute pressure evenly over the hypertrophic scar, thus reducing skin tension and at the same time creating occlusion effect. "Smart Scar-Care" pad is a highly conformable, durable, and comfortable padding material to be applied underneath the pressure garment.

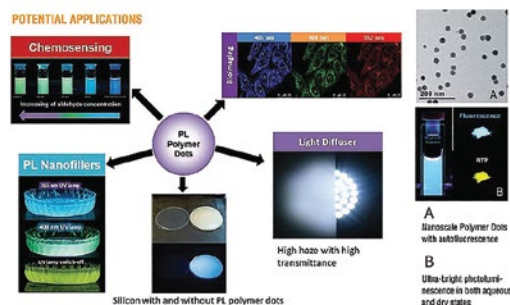


MEDICAL DEVICES AND DIAGNOSTICS



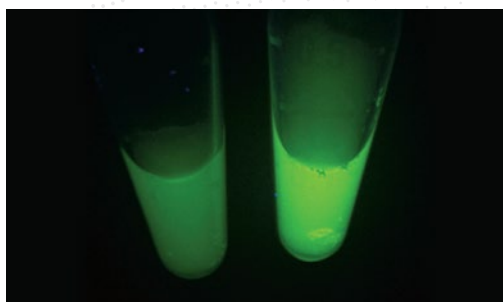
Water Dispersible Auto-fluorescent Polymer Dots Comprising of Non-Conjugated Polymers

This new type of photoluminescent nanoparticles uses inexpensive nonconjugated polymers as building blocks, and has the ability to display ultra-bright and multi-colour fluorescence upon excitations in both water and dry states. It also has excellent water dispersibility, low toxicity, high absorptivity, good photostability, and high quantum yield. It has various potential applications, including serving as: bioimaging markers for in vitro cell imaging; autofluorescent nano-carriers for image-guided therapy; nanofillers in plastics for LED diffuser applications; fluorescent ink in anti-counterfeiting applications; chemosensors for heavy metal detection and structural health monitoring.



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.



Palm-sized 3D Ultrasound Imaging System for Scoliosis Mass Screening and Frequent Monitoring Scolioscan

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.

The invention is a further advanced system, Scolioscan, that can facilitate mass screening and frequent follow-up monitoring. Clinical trials have proven the novel technology is very reliable, with accuracy of curve measurement comparable to X-ray assessment. Moreover, it can obtain image in any postures, provide vertebra rotation and muscle-related information, and form a 3D spinal model for the three-dimensional analysis of deformity of spine. All these cannot be achieved by X-ray imaging systems commonly used at present. Scolioscan can also be applied to conducting prognosis and monitoring treatment outcomes for each scoliosis patient so as to establish personalised treatment plan.



A High-throughput Microfluidic Platform for CTCs In-situ Analysis

CTC are cells that shed from tumours and enter the circulatory system, which can travel along blood vessels to any part of the body, causing tumours transfer. CTC can be used as biomarkers for cancer and can be detected by blood for ultra-early cancers. This low-cost microfluidic detection system integrates CTC isolation unit and single CTC cell characterisation unit for multiple miRNAs identification to realise high-throughput detection of CTC in clinical samples. This is of great significance for the early diagnosis of cancer, precise treatment and prognosis evaluation of patients with metastatic tumours.



AI-Empowered Quantitative Chest Radiography Technology

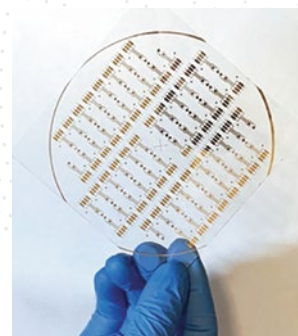
The proposed AI-empowered quantitative chest radiography technology will combine several deep learning techniques and radiomics analysis for enhanced its clinical performance. The technology will contain AI-based image quality enhancement, AI-assisted segmentation, and multi-omics quantitative analysis framework. The benefits of the technology are manifold in healthcare, technology, and economy by improving clinical efficiency, providing new diagnosis techniques, and optimizing allocation of healthcare resources.

Multi-level Point-of-Care Optical Biosensor for Virus Diagnosis

The pioneering diagnostics platform was designed and fabricated based on upconversion nanoparticle (UCNP) luminescence biosensing probes. UCNPs are novel nanoprobe for biodetection not only because of their excellent biocompatibility, also, their fluorescence mechanism permits them to be well suited for sensitive, reliable and rapid detection at the point-of-care. Moreover, the capability of simultaneously screening multi-level biomarkers, including viral RNA sequences, IgG/IgM antibodies, spike and nucleocapsid proteins bestowed them with advantages over other conventional point-of-care single-analyte tests. With the advancement of cheap, compact, and reliable microelectronic modules, a low-cost upconversion luminescence-based portable device was devised to realise a high-throughput, convenient on-site diagnostics.

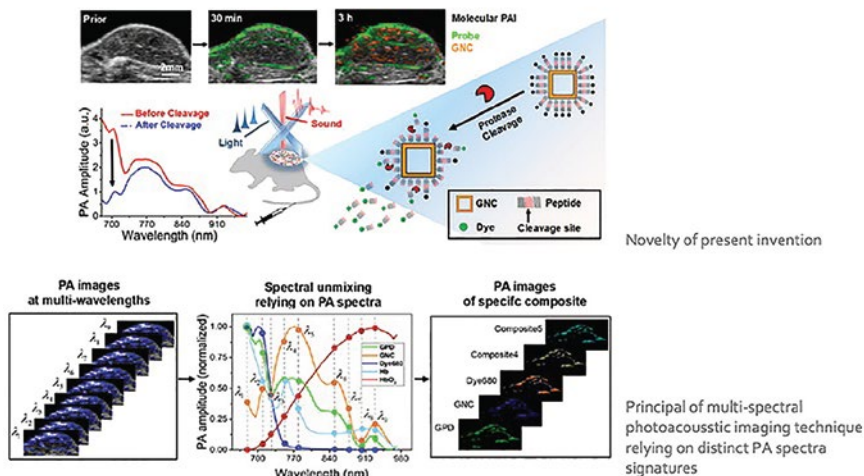
Biosensors for Non-invasive Glucose Tests

This new ultra-sensitive transistor-based biosensor can measure the level of glucose in saliva. Fabricated by using a glucose oxidase enzyme layer, the biosensor is sensitive only to glucose. It simply measures the glucose level by detecting the electric current in saliva, which reflects glucose level in human body. Comparing to conventional blood-glucose measuring device, this biosensor can detect glucose level as low as 10-5mmol/L. That is a thousand times more sensitive than conventional measurement. Apart from being inexpensive to manufacture, the biosensor can be fabricated with flexible substrates to apply on curved and moving surfaces, including human skin and such wearable electronics as smart textiles and medical bandages. This technology will be a revolution towards traditional blood glucose meter and can be expanded to different healthcare monitoring systems.



Activatable Multispectral Photoacoustic Probes, Methods of Making Probes, and Methods of Use

Tumor proteases have been recognised as significant regulators in the tumor microenvironment, but the current strategies for in vivo protease imaging have tended to focus on the development of probe design rather than the investigation of novel imaging strategy by leveraging the imaging technique and probe. Herein, it is the first invention to investigate the ability of multispectral photoacoustic imaging (PAI) to estimate the distribution of protease cleavage sites inside living tumor tissue by using an activatable photoacoustic (PA) probe. This novel strategy is a potential to be translated into clinical applications in the future (e.g., non-invasive precise assessment of various types of cancer to increase prognosis, reduce medicine cost).



High Frequency Ultrasound for Medical Diagnoses

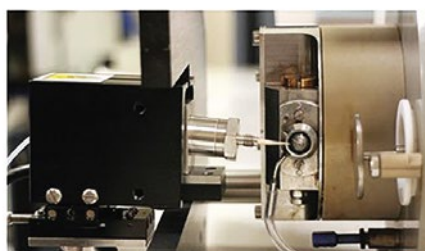
With increased frequency, bandwidth and sensitivity, the resolution of ultrasound imaging can be increased significantly making it possible for eye imaging and small animal imaging.

Our invention developed a fabrication proven technology process involving ultrasound wire bonding, photolithography, laser cutting etc, to fabricate piezoelectric single crystal based 20 MHz phase-array transducer. The current invention has very large impact to industry and markets, it will provide more solutions for clinical diagnoses of eyes and also in micro-surgery monitoring.

Rapid Detection of Drug-abuse by Mass Spectrometry

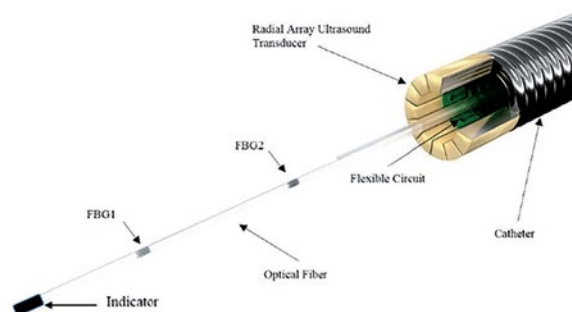
Conventional drug analysis typically involves preliminary screening, followed by confirmatory analysis. However, the preliminary screening has the problem of producing false positive or false negative results, while the confirmatory analysis is time-consuming and laborious. Two techniques have been developed, i.e., wooden-tip electrospray ionization mass spectrometry (WT-ESI-MS) and solid phase microextraction coupled with electrospray ionization mass spectrometry (SPME-ESI-MS), for rapid and reliable detection of drugs-of-abuse.

WT-ESI-MS allowed detection of common drugs-of-abuse in urine and oral fluid with analysis of one sample within minutes, while SPME-ESI-MS allowed detection of drugs-of-abuse in urine and oral fluid with higher sensitivity within reasonable time.



Ultrasound Imaging & Fiber Optic Pressure Sensing Composite Catheter for Cardiovascular Disease Diagnostics

Integrating Intravascular Ultrasound Imaging (IVUS) diagnosis and Fiber Bragg Grating (FBG) optical pressure sensing techniques, this innovation provides a complementary cardiovascular diagnostic technology with simultaneous ultrasound imaging and Fractional-Flow-Reserve (FFR) functions. This integrated system can simultaneously "see" the narrow site of the cardiac blood vessel and gives the FFR value across this narrow site, and thereby supports doctors with the most accurate information to judge whether a heart stent surgery is required. This is a brand-new diagnostic technology with strong potential to be implemented in cardiac disease diagnostics.



Viewing Muscle Vibration with Ultrasound Imaging

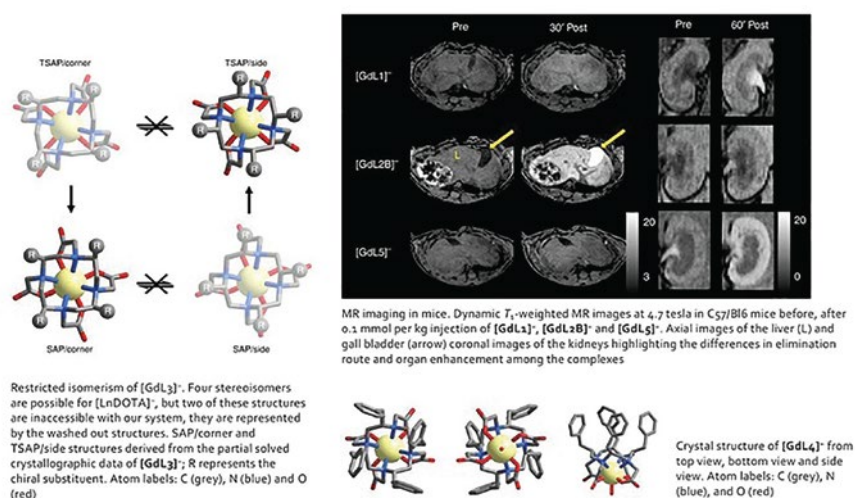
A novel method for imaging the dynamics of muscle contraction using ultrafast ultrasound. With ultrasound, muscle vibration can be observed at high time- and spatial-resolution, which is not possible with use of traditional methods such as MMG. This technology will be valuable for studies of neuromuscular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

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.

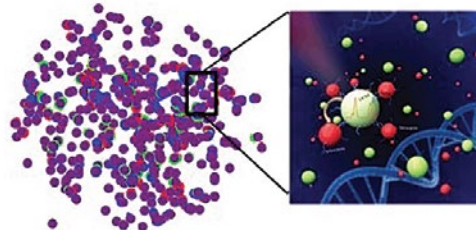
Chiral Cyclen Compounds and Their Uses

Despite established clinical utilization, there is an increasing need for safer, more inert gadolinium-based contrast agents, and for chelators that react rapidly with radiometals. Here we report the syntheses of a series of chiral DOTA chelators and their corresponding metal complexes, and reveal properties that transcend the parent DOTA compound. We incorporated symmetrical chiral substituents around the tetraaza ring, imparting enhanced rigidity to the DOTA cavity, enabling control over the range of stereoisomers of the lanthanide complexes. The Gd chiral DOTA complexes are shown to be orders of magnitude more inert to Gd release than [GdDOTA]⁻. These compounds also exhibit very fast water exchange rates in an optimal range for high field imaging. Radiolabeling studies with (Cu-64/ Lu-177) also demonstrate faster labelling properties. These chiral DOTA chelators are alternative general platforms for the development of stable, high relaxivity contrast agents, and for radiometal complexes used for imaging and/or therapy.



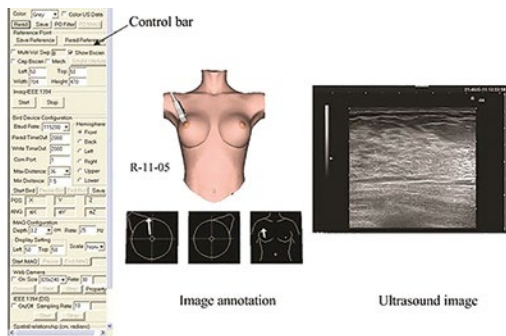
Nanoprobe Based Multi-scale Spatiotemporal Single-cell In-situ Analysis

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 multicolour fluorescence resonance energy transfer (FRET) probes for multi-scale spatiotemporal single-cell analysis.



AI System for Assessing the Risk of Dementia

Mini-Mental State Examination (MMSE) is a commonly used cognitive assessment tools. Early administration at the asymptomatic stage and repeated use of the MMSE would lead to a “practice effect” that degrades its effectiveness in later stages. PolyU’s AI assessment system uses the health data of the elderly, such as basic information and a health index like age, gender, blood pressure, teeth condition and nutritional assessment to screen the risk of dementia with accuracy of screening dementia reaching 88%.



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.

Multi-functional Optical Coherence Tomography (OCT) System for 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.

Wireless Ultrasound Scar Scanner

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.

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.

Elasticity Evaluation for Diabetic Foot


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.

Palm-sized Real-time B-mode Ultrasound Imaging Guided System for Liver



Liver fibrosis is a very common disease which may lead to cirrhosis and ultimately loss of liver function or cancer. It is often caused by alcoholism, hepatitis B and C, and fatty liver disease. Currently, liver biopsy is a gold standard for liver fibrosis diagnosis, but it is invasive and may cause bleeding and serious complications.

To provide a safer, more effective and comprehensive diagnostic solution, the team has developed a Palm-sized Real-time B-mode Ultrasound Imaging Guided System for liver fibrosis assessment, which performs fibrosis evaluation through non-invasive measurement of liver stiffness. The innovative system features real-time image guiding that enhances the accuracy of measurement. Moreover, its portable and wireless design allows convenient operation.



BIOMEDICAL ENGINEERING



AI-based Risk Assessment System for Knee Osteoarthritis

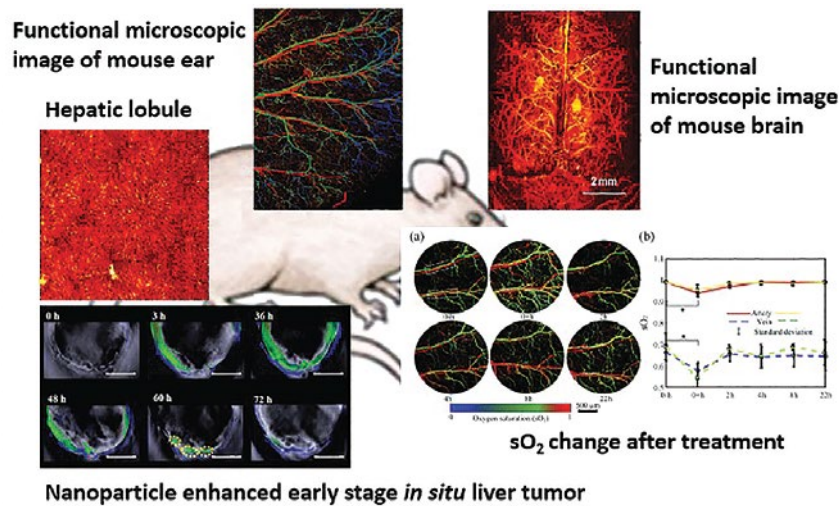
Early detection of knee osteoarthritis (KOA) is critical for preventing disease progression and reducing the need for joint replacement surgery. With a view to facilitating the treatment, this project aims to develop a novel KOA progression prediction system with artificial intelligence and a big data analytic approach to facilitate short, mid, and long-term KOA treatment planning.

AI-Based Image Hyper-Resolution for Clearer CT and MRI Images

Advanced medical machines can generate medical images with higher resolution, yet they are still imperfect when helping doctors with disease diagnoses. This project proposes a novel diffusion model-based unsupervised learning algorithm for image hyper-resolution. Based on our knowledge, this is the first application of image super-resolution to improve the quality & visualisation of medical images among the world. It has potential to create great economic and social impact by improving the images generated by existing medical equipment.

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.



Supramolecular Soft Robotics

Using a concept in the chemistry of non-covalent intermolecular interaction, PolyU researchers are able to fabricate novel supramolecular soft robotic materials with the smallest machine in the world, "artificial molecular machinery".

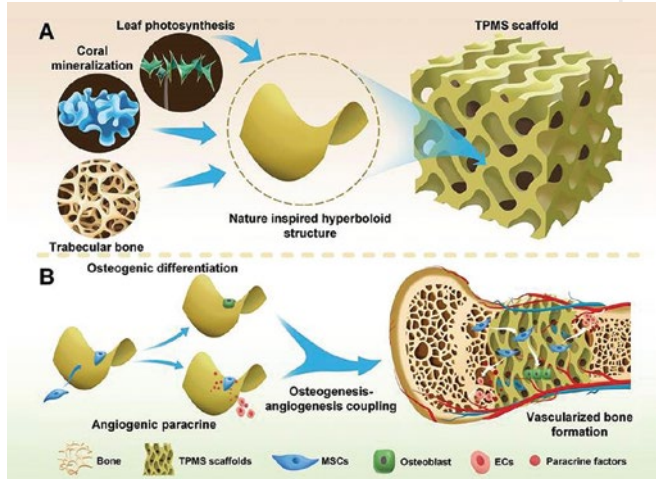
The photoresponsive molecular amphiphiles are composed of photoresponsive molecular switching units, oil soluble, and water-soluble motifs, providing intrinsic structural and functional properties in its nanostructures. The nanostructures are forming the supramolecular soft robotic material through supramolecular interaction. Upon UV light irradiation, the supramolecular soft robotic material provides muscle-like motion. The supramolecular soft robotic material can serve as a growth scaffold for stem cells without losing photoresponsive properties.



It is hoping to develop these highly dynamic, reversible and biocompatible supramolecular soft actuators into future soft robotics materials. Further improvement on the biocompatibility by using less harmful visible-light to substitute bio-damaging UV-light would speed up the progress in applying as tissue regenerative materials.

Gaussian Curvature-driven Direction of Cell Fate Towards Osteogenesis with Triply Periodic Minimal Surface Scaffolds

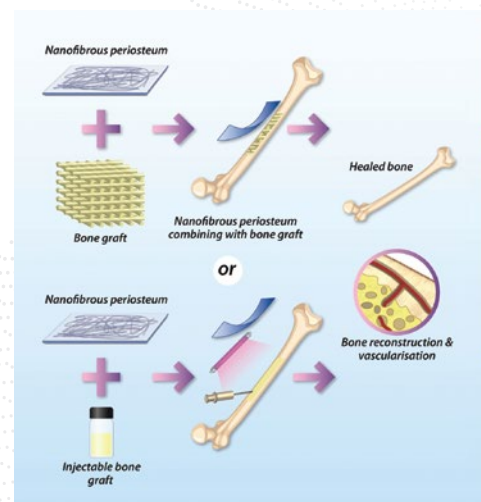
Surface topology has demonstrated significant influence on regulating stem cell behaviours, functions and regenerating bone tissues. Notably, the hyperboloid structure is one that many species around the globe have adopted due to evolutionary advantages related to their amplified surface area, curvature, and energy dissipation.



To utilise the advantage of the architectural marvel of the hyperboloid structure, a novel three-dimensional (3D) Triply Periodic Minimal Surface (TPMS) scaffolds with varying Gaussian curvatures is developed to embody a trabecular bone mimicking hyperboloidal topography. The wavy TPMS scaffolds direct the osteogenic differentiation and angiogenic paracrine of mesenchymal stem cells through the hyperboloidal topography-induced cytoskeleton reorganization and nuclear deformation, accelerating the bone regeneration. The TPMS bone scaffolds can get a head start towards a simple, safe, efficient and personalised bone graft with notable clinical translation potential.

Biomimicking Photocrosslinkable Nanocomposite Bone Graft

A novel photocrosslinkable nanocomposite bone graft is developed by mimicking the natural bone structure. With this technology, surgeons can premade, trim and directly apply the nanocomposites during bone graft operations according to patients' needs, thereby greatly reduce the bedridden time. This innovation can serve a huge number of patients receiving orthopedic surgeries, such as for craniomaxillofacial, dental, foot & ankle, as well as joint reconstruction, long bone and spinal fusion.



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.

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 analysed using a specifically designed evaluation platform.

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.

Mobile Exo-neuro-musculo-skeleton

Mobile exo-neuro-musculo-skeleton robot was designed for multi-joint upper limb rehabilitation after stroke. Combining neuromuscular electrical stimulation (NMES), soft pneumatic muscle and exoskeleton, it is able to sense the electromyogram (EMG) signals of paretic muscles and provides voluntary motor intention control. The exo-neuro-musculo-skeleton can provide multi-joint mechanical assistance and NMES to paralysed joints in elbow, wrist and fingers, and improve motor functions in the whole upper limb.



Functional Electrical Stimulator for Stroke Patients

A programmable multi-channel functional electrical stimulator system for stroke rehabilitation through stimulation of paralysed 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.

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.

A Novel Robotic Arm for Self-Help Upper Limb Rehabilitation After Stroke

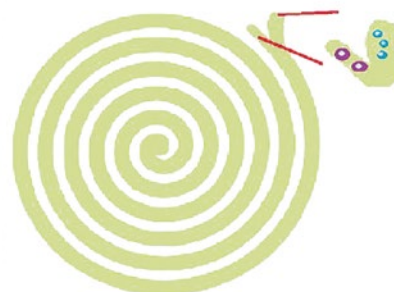
A novel multi-integrated robotic system that incorporates the advantages of soft pneumatic robot, rigid exoskeleton and neuromuscular electrical stimulation (NMES) with textile engineering to support effective, affordable and self-help mobile rehabilitation after stroke.

Highly Sensitive, Microscopic Optical Fibre Sensors with Pioneering Biomedical Monitoring Capability

A critical breakthrough by basing the novel fibre optic sensors on an advanced plastic material, ZEONEX, that solves the problems of glass and traditional plastic. In addition, the new sensor is made more sensitive by adding a side hole running in parallel with the light transmission path inside the optical fibre. They are biocompatible, supple and extremely sensitive to very small pressure changes, enabling whole new applications for medical monitoring inside the human body not available before. Examples include smart cochlear implantation, bone fracture recovery monitoring, or navigation monitoring in cardiac catheterisation.

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

Senescent cells that stop 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.



Data Storage Using Peptide Sequences

In response to the huge amount of digital generated today, a novel method is developed by using peptide sequences to store data and retrieving it via tandem mass spectrometry. Compared with existing commercial data storage devices and other developing technologies such as DNA data storage, peptides offer a much higher storage density and longer storage duration. Combining proteomics and data storage technology, this innovation has the potential to transform the data storage industry, including to be deployed in space mission.

Removal of Endotoxin Using Amphiphilic Coreshell Nanosorbents

The technology provides a fast and simple solution for selective removal of endotoxin from protein solutions in physiological buffers. It adopts a type of magnetic core-shell (MCS) composite particle, which can selectively bind endotoxin in protein mixtures and are easily removed by a magnetic separation. The endotoxin level of the treated protein solution is low enough (<10 EU/mL) to allow for further processing, analysis or even administration to mammals. The method has the following advantages:

- High selectivity for endotoxin adsorption in both basic and acidic protein mixtures, e.g. bovine serum albumin
- Effective in broad working conditions (different pHs, electrolyte concentrations and buffer types)
- Simple process which does not require multiple extraction steps (unlike Triton X-114 extraction method)
- Low cost, avoiding the use of expensive reagent, e.g. polylysine
- Fast purification process without common problems such as filter blocking in microfiltration and time-consuming process when using porous adsorbents

Exoskeleton Robots for Rehabilitation Training

Traditionally, rehabilitation tasks are implemented with assistance from physical therapists. Training quality and intensity is thus affected when therapists are handling a large number of patients. The therapist can only assess the patient's status based on own knowledge and observation without any data. In addition, the limb training trajectory is non-reproducible during a long training time. The application of exoskeleton robots can deal with the aforementioned problems by taking the advantage of robot-aided rehabilitation. A series of exoskeleton robots are introduced to help the disabled or people with neuromuscular dysfunctions in their activities of daily living (ADL).



COMMUNITY HEALTH AND WELLNESS



Novel Optical Method for Retarding Myopia Progression

The revolutionary “myopic defocus” method, based on the natural homeostatic mechanism of the eye, aims to produce a clear image on the retina and a defocused or blurred image in front of the retina simultaneously. The 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.

To cater to people who find contact lenses uncomfortable to wear, or those who are prone to eye infections, PolyU and HOYA Corporation jointly developed the Defocus Incorporated Multiple Segments (DIMS) Spectacle Lens. The DIMS Spectacle Lens comprises a central optical zone for correcting refractive error and multi-segments of constant myopic defocus surrounding the central zone and extending to mid-periphery of the lens. DIMS has been clinically proven to be effective at slowing down myopic progression by 59% in children in Hong Kong.



Proteomics in Eye Research

Proteomics has been regarded as the core research technology in the post-genomic era. Central to the life sciences in health discipline is the aim of identifying potential and small molecule biomarkers that may correlate to diseases, drug toxicity, genetic and environmental variations. Recent revolution in mass spectrometric (MS) platforms paves the way for rapid evaluation of potential biomarkers qualitatively and quantitatively for various diseases or physiological conditions. Cutting edge Next Generation MS platform can routinely allow thousands of unknown biological compounds be resolved and analyzed in an accurate and fully automated fashion. Ultimately, these measurements will provide novel insight into the biological regulation of signalling compounds in disease-causing alterations.

Using comprehensive proteomic line-up including discovery based and targeted based proteomics coupled with bioinformatics tools, we are interested in exploring the expressions / regulations of proteins in various ocular disorders and diseases (dry eyes, myopia, glaucoma and others).

AkkMore™: a Fungus and Plant Based Supplement Against Obesity or Prediabetes

AkkMore™ is a nutritional supplements formula drink that aims to improve users' body conditions by building a healthy microbiome. AkkMore™ formula precisely targets on promoting the abundance of Akkermansia muciniphila (Akk) in human guts. It is designed to reduce metabolic disorders and lose body weight. The research team has recently completed animal studies as well as the phase 1 clinical trial in humans.

Omni-Cool-Dry™: A Desert Beetle Inspired Skin-like Fabric for Dynamic Thermal and Moisture Management

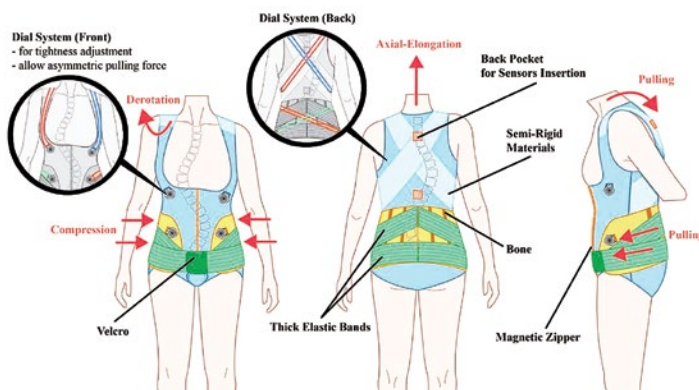
The desert beetle inspired skin-like fabric promises all-day cool, dry, breathable, and comfortable feelings under dynamic thermal conditions. This unique fabric quickly dissipates excessive sweat as water droplets to avoid sensation of wetness and saturation. It also reflects solar radiation and emits body heat to the cold universe for cooling. Compared to conventional fabrics, Omni-Cool-Dry™ weighs 75% less, dissipates sweat 3 times faster, and is 50% less clingy during heavy perspiration. The human skin can be cooled by 5°C lower than with a commercial cotton fabric. This fabric will help the outdoor enthusiasts and athletes to perform the best. It will also be desirable to professionals such as medical personnel, construction workers, and firefighters for more endurance.

Anti-viral and Anti-microbial Durable Disinfectant Coatings for Facemask

The novel discovery of the application of poly (3-hydroxybutyrate) (PHB) oligomer is an outstanding wide-spectrum anti-pathogenic agent against viruses, fungi, disease causing agents like mice, bacteria and drug-resistant bacteria. They can effectively kill influenza viruses, such as H1N1 and H3N2, with an anti-viral activity rate of 99.99%. Moreover, these disinfectants are non-toxic and biodegradable, and can be applied as aqueous coating solutions over facemasks and other personal protection equipment for enhanced disinfection efficacy.



Active Bodysuit for Adult Degenerative Scoliosis



In response to the drawbacks of bracing and special needs of older Adult Degenerative Scoliosis (ADS) patients, an active training bodywear that incorporates both passive and active corrective forces with a more age-friendly design is proposed. The design would be very helpful for maintaining the level of bodily function of patients while minimizing the symptom progression of ADS, as well as improving the current problems of brace-wearing experiences through the design and development of the posture training bodywear. It is anticipated that this project will contribute as a new breakthrough in brace development especially for older ADS patients and provide a healthier lifestyle.

Body Mapping Tank-top with Biofeedback Posture Training System

With a personalised training protocol, this innovative body mapping tank-top provides tailored pain-free posture training for adolescents with early scoliosis. The tank-top is equipped with inertial measurement units (IMUs) that are synchronised with pre-recorded surface electromyography (sEMG) signals. The tank-top works alongside an app that monitors body posture information in real-time. This technology encourages scoliosis patients to take a more active role in improving their control and coordination of movement and daily posture, while reducing the future likelihood of bracing or surgical treatment.



Ergonomic Design of Footwear

The primary means of managing diabetic foot problems is by using custom-fabricated footwear and insoles for reducing plantar pressures, foot pain, and risk of foot ulcers. This project has integrated anthropometry, biomechanical analysis, artificial intelligence algorithms and material sciences that provides new insights into design of functional footwear.

Intelligent Textiles for Rehabilitation

Utilising computer vision and illuminating optical fibres, intelligent textiles are designed to recognise hand and body gestures to customise its colour illuminations instantly. The patented design and technology transforms conventionally passive fabrics into interactive textiles, making possible dynamic customisation of products and environments. It can be applied to rehabilitative environments to facilitate multi-sensory therapy.

eNightLog - Multi-function Monitoring System for Fall Prevention and Dementia Elderly

"eNightLog" is a bed-leaving monitoring system designed for dementia elderly with the design philosophy of "non-contact" and "non-restraint". The system can track the locations and postures (lying in bed, sitting on bed/ side of bed, standing near the bed and bed-leaving) of the elderly without any wearable devices. Signals will be sent to caregivers to alert them about elderly's needs, thus, to prevent fall and wandering.

Smart Interactive Doll - Doll Therapeutic Tool

This doll therapeutic tool has a patented design and aims to improve emotional state, reduce challenging behaviours and facilitate social interaction of users. The skeleton can sense the actions taken by users and provide programmable feedbacks for training and therapy. It can be used individually or in groups of elderly, elderly with dementia, people with mental disabilities.



Social Companion Robot, a Cantonese-speaking Accompany Doll for People with Mild Cognised Impairments

The localised social companion robot allows customisation in both appearance and content. Features including customised daily schedule and task reminders, personalised memory preset dialogue and report of useful information such as date & time, weather or festivals are equipped. It can provide companionship to mild cognised impairments users and motivate them to engage in social interaction.



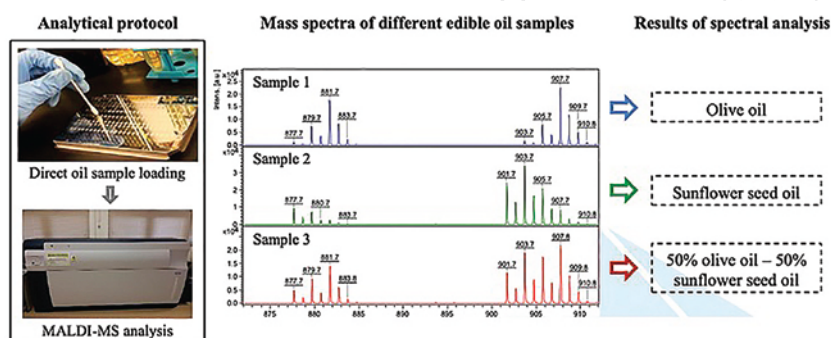
Smart Footwear System for Balance Improvement and Fall Prevention

The smart footwear system, iBalanz, can provide instant postural stability analysis and monitoring through wearable motion sensors. It collects relevant data to prompt users for postural correction. The system supports cloud-based data storage for remote monitoring and big data analytics. The postural reminder feature can provide additional scientific references to doctors/therapists and facilitate telerehabilitation in different clinical settings.

Rapid Qualitative and Quantitative Analysis of Edible Oils by MALDI-MS Technology

A direct analysis of edible oils using matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS) have been developed and a database containing spectra of more than 30 different types of pure edible oils have been established. Since different types of pure edible oils have different MALDI-MS spectral patterns, the authenticity of an edible oil sample can be determined by comparing its MALDI-MS spectrum with those of its labeled oil in the established database with a high correct classification rate. The MALDI-MS spectral patterns of blended edible oils are related to its compositional edible oils, hence the proportions of edible oils in blended edible oils can be measured with good accuracy by using chemometric methods to establish quantitative models based on the MALDI-MS spectra.

Compared to conventional techniques for analysis of edible oils, using MALDI-MS is much faster which allows direct analysis of edible oils, without the need of sample extraction, derivatization, sample cleanup and separation. It takes only several minutes for the technique to analyze one edible oil sample which can greatly reduce cost. The technique can be used by the industry to authenticate edible oils and screen out mixed edible oils and recycled edible oils.



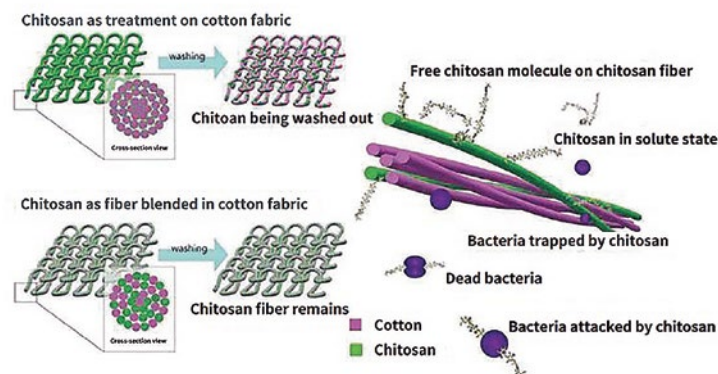
Microbial Solution for Microplastic Pollution

Most microplastics are toxic and they endanger aquatic ecosystems and the pollutants eventually make their way into human bodies via the food chain. This innovative approach has genetically modified *Pseudomonas aeruginosa*, a bacterium known to produce robust biofilms, to help remove microplastics from water. The “trap and release mechanism” immobilises the microplastics floating around in the water and traps the particles by forming biofilms on them. The microplastics would gradually sink to the bottom of the bioreactor tank. This could potentially be used in wastewater treatment plants, which play an important role in blocking microplastics from escaping into the sea.



Chitosan Medical & Healthcare Textile

Chitosan fibers consist of numerous advantageous characteristics such as being biodegradable, is considered as nontoxic in nature, and as a natural and effective anti-microbial agent with wound healing and cell regenerating abilities. Unlike the conventional practice of coating chitosan onto the textile material surfaces, the research team invented an innovative anti-static spinning system for providing a solution for spinning chitosan and its blends. Chitosan yarns with sufficient physical properties such as length, strength and evenness can be produced. This innovation can help to realise the possibility of producing highly flexible chitosan textiles while preserving the biological features for medical and healthcare applications. The chitosan textiles can be applied in various aspects which include daily and protective clothing, interiors and furniture, filtration and purification, sanitary products and cosmetics. The new system is believed to be a promising solution for securing the market of chitosan-based textile products in the future.



Effects of Soy Exposure in Early Life on Bone Development and Gut Microbiota

The project aims to investigate the effects of soy consumption at early life on gut microbiota development and bone growth. It will identify which timing of exposure (before birth, during nursing and after weaning) and soy components that offer better effects on bone growth in the animal studies. It will examine the association between maternal soy intake with infant gut microbiota and child's bone development from 120 mother-child pairs for the human studies. Findings will provide evidence for the use of soy preparation in early life as a preventive measure for optimising bone growth.

Research Labs, Institutes and Centres

Chinese Academy of Sciences – PolyU Joint Laboratories

- Joint Laboratory for Aerosol and Environment
- CAS AMSS-PolyU Joint Laboratory of Applied Mathematics
- CAS GIG-PolyU Joint Laboratory of the Guangdong-Hong Kong-Macao Greater Bay Area for the Environment

Hong Kong Branches of Chinese National Engineering Research Centres

- Hong Kong Branch of National Engineering Research Centre for Steel Construction
- Hong Kong Branch of National Rail Transit Electrification and Automation Engineering Technology Research Centre

State Key Laboratories

- State Key Laboratory of Chemical Biology and Drug Discovery
- State Key Laboratory of Ultra-precision Machining Technology

PAIR Research Institutes and Centres

- Mental Health Research Centre
- Otto Poon Charitable Foundation Research Institute for Smart Energy
- Otto Poon Charitable Foundation Smart Cities Research Institute
- Photonics Research Institute
- Research Centre for Chinese Medicine Innovation
- Research Centre for Deep Space Explorations
- Research Centre for Resources Engineering towards Carbon Neutrality
- Research Centre for SHARP Vision
- Research Institute for Advanced Manufacturing
- Research Institute for Artificial Intelligence of Things
- Research Institute for Future Food
- Research Institute for Intelligent Wearable Systems
- Research Institute for Land and Space
- Research Institute for Smart Ageing
- Research Institute for Sports Science and Technology
- Research Institute for Sustainable Urban Development

InnoHK Research Centres

- Centre for Advances in Reliability and Safety (CAiRS)
- Centre for Eye and Vision Research (CEVR)
- Laboratory for Artificial Intelligence in Design (AiDLab)

University Research Facilities

- Centralised Animal Facilities
- University Research Facility in 3D Printing
- University Research Facility in Behavioral and Systems Neuroscience
- University Research Facility in Big Data Analytics
- University Research Facility in Chemical and Environmental Analysis
- University Research Facility in Life Sciences
- University Research Facility in Materials Characterization and Device Fabrication

Research Centres at University, Faculty, School or Department Level

University-level

- Policy Research Centre for Innovation and Technology (PReCIT)

Faculty of Science

- Food Safety and Technology Research Centre
- Lo Ka Chung Research Centre for Natural Anti-Cancer Drug Development
- The PolyU-SDU Joint Research Center on Financial Mathematics
- Research Centre for Carbon-Strategic Catalysis
- Research Centre for Quantitative Finance

Faculty of Business

- Logistics Research Centre
- Shipping Research Centre

Faculty of Construction and Environment

- PolyU-NAMI 3D Concrete Robotic Printing Research Centre
- Research Centre for Environmental Technology and Management
- Research Centre for Fire Safety Engineering
- Research Centre for Sustainable Infrastructure Development
- The Hong Kong Polytechnic University – Wuhan University Partner GNSS Research Centre
- Colour, Imaging, and Metaverse Research Centre

Faculty of Engineering

- Behaviour and Knowledge Engineering Research Centre
- Biometrics Research and Innovation Centre
- Power Electronics Research Centre
- Research Centre for Fluid-Structure Interactions
- Research Centre for Data Science and Artificial Intelligence
- Research Centre for Unmanned Autonomous Systems
- Research Centre for Blockchain Technology

Faculty of Health and Social Sciences

- Centre for Myopia Research
- Peking University-The Hong Kong Polytechnic University China Social Work Research Centre
- Research Centre for Gerontology and Family Studies

Faculty of Humanities

- International Research Centre for the Advancement of Health Communication
- Research Centre for Language, Cognition, and Neuroscience
- Research Centre for Professional Communication in English
- The Hong Kong PolyU-PKU Research Centre on Chinese Linguistics

School of Design

- Research Centre for Future (Caring) Mobility

School of Hotel and Tourism Management

- Hospitality and Tourism Research Centre

Others

- Aviation Services Research Centre
- Industrial Centre



Faculties and Schools – Life Sciences and Healthcare Related

Faculty of Science

Department of Applied Biology and Chemical Technology

- Drug Discovery and Cancer
- Medicinal Chemistry and Chemical Biology
- Food Safety and Technology
- Materials and Sustainable Chemistry

Department of Applied Physics

- Energy Materials and Devices
- Nanomaterials and Microelectronic Devices
- Photonics, Plasmonics and Optoelectronics – Materials and Devices
- Smart Materials and Devices
- Theoretical and Computational Physics

Department of Applied Mathematics

- Applied Optimization and Operations Research
- Applied Statistics and Financial mathematics
- Engineering and Computational Mathematics

Faculty of Engineering

Department of Computing

- Artificial Intelligence and Robotics
- Cyber Security and Privacy
- Data Science, Information Retrieval and Human Computer Interaction
- Fundamentals and Software
- Network and Mobile Computing
- Vision, Language and Graphics

Department of Industrial and Systems Engineering

- Advanced Materials Processing Technologies
- Precision Engineering
- Products Design and Miniaturization
- Smart Manufacturing and Robotics
- Operations and Supply Chain Management
- Aviation and Transportation Logistics

Department of Mechanical Engineering

- Fluid-structure Interactions
- Advanced Materials Research
- Aerospace Engineering
- Combustion and Pollution Control
- Sound and Vibration Research

Department of Biomedical Engineering

- Medical Imaging and Biosensing
- Molecular and Cellular Engineering
- Neuromusculoskeletal Science and Engineering
- Prosthetics, Orthotics, and Rehabilitation Engineering

Department of Electrical Engineering

- Power & Energy Systems
- Power Electronics & EV
- Photonics & Smart Materials and Devices Technologies
- Intelligent Transportation

Department of Electronic and Information Engineering

- Artificial Intelligence and Robotics
- Future Wireless Networks and IoT
- Photonic Systems and Devices Focus Area

Department of Aeronautical and Aviation Engineering

- Aviation Engineering
- Satellite Communication and Navigation
- Aerodynamics

Faculty of Health and Social Sciences

Department of Health Technology and Informatics

- Cancer
- Haemodynamic and Vascular Disorders
- Immunity and Infection
- Metabolic and Ocular Disorders
- Neuroimaging and Neuropathology

Department of Rehabilitation Sciences

- Complementary and Integration Health in the East-West Context
- Translational Neuroscience and Rehabilitation
- Musculoskeletal and Sport Rehabilitation
- Healthy Ageing

School of Nursing

- Ageing and Health
- Family and Community Health
- Mental Health Care
- Transitional, Supportive & Palliative Care

School of Optometry

- Myopia Research
- Healthy Lifelong Vision

Faculty of Humanities

Department of Chinese and Bilingual Studies

- Computational and Corpus Linguistics
- Neurocognitive Studies of Language and Clinical Linguistics

School of Fashion and Textiles

- Smart wearable technology
- Color management and textile processing
- Human factor & functional clothing technologies
- Advanced fibrous materials & technology
- Machinery/instrument development of modification




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