College of Biomedical Engineering
Taipei Medical University, Taiwan

Scientific Report 2023-2024

臺北醫學大學 TAIPEI MEDICAL UNIVERSITY

臺北醫學大學 醫學工程學院 TMU BIOMEDICAL ENGINEERING

College of Biomedical Engineering
Taipei Medical University, Taiwan
Scientific Report

Taipei Medical University (TMU)

Taipei Medical University (TMU) is a distinguished academic institution with a rich and illustrious history in Taiwan.

Established in 1960, TMU has steadfastly grown and thrived over the past half-century, overcoming formidable challenges without the consistent financial backing of the government or support from foundations. It has not only weathered these challenges but has harnessed them to lay the foundation for its success, fostering growth, expansion, and transformation through a spirit of innovation.

In the present day, TMU has blossomed into a world-class university encompassing 11 colleges and annually welcoming over 6,000 students. The university is also renowned for its six prominent hospitals, including TMU Hospital, Taipei Municipal Wan Fang Hospital, Shuang Ho Hospital, Taipei Cancer Center, Taipei Neuroscience Institute, and Hsin Kuo Min Hospital. With a global network of more than 50,000 alumni, TMU is dedicated to serving society and humanity, while simultaneously nurturing the talents of tomorrow for the benefit of the nation. These accomplishments epitomize TMU's most tangible contributions and underscore its paramount responsibilities and mission.

In 2023, TMU secured its place as the 324th institution in the esteemed Times Higher Education (THE) World University Rankings, claiming the third spot among Taiwanese universities. Across Asia, TMU achieved a commendable 43rd position in the THE Asia University Rankings. Furthermore, TMU made significant strides in the Essential Science Indicators (ESI) for 2023, excelling in 11 categories, each ranked among the top 1%. Notably, a new addition to this remarkable list is Ecology/Environment, complementing our consistent excellence in the existing ten areas, including Clinical Medicine, Pharmacology & Toxicology, Neuroscience & Behavior, Biology & Biochemistry, Immunology, Chemistry, Psychology/Psychiatry, General Social Sciences, Molecular Biology & Genetics, and Agricultural Sciences.

In Taiwan, TMU has held the prestigious title of the number one institution among medical universities and private universities for five consecutive years in the 2022 university rankings published by Global Vision Magazine. This remarkable achievement underscores TMU's steadfast dedication to its aspiration of becoming a world-renowned university.

Education, research, and healthcare represent the core pillars of TMU, with continuous innovation serving as a vital driver to bolster our competitiveness. Moreover, TMU remains ardently committed to promoting sustainable development, fulfilling its social responsibilities, and collaboratively shaping a brighter future.

In line with its mission and social responsibility, TMU has formulated the "TMU 2030 White Paper: A Ten-year Vision," which outlines six key strategies. These encompass cultivating the next generation of interdisciplinary biomedical talents, pioneering world-leading research domains, broadening international influence, nurturing an innovative and entrepreneurial ecosystem, enhancing administrative efficiency and capacity, and optimizing the medical-industry supply chain. With practical planning, deliberate steps, and unwavering teamwork, TMU and its six affiliated hospitals are poised to continue advancing, fostering perpetual innovation, and delivering positive impacts on a global scale.

Dean's Message

Biomedical engineering (BME) is a rapidly evolving field in applied science. It involves the application of engineering and advanced technologies to address specific challenges within the biomedical sector. BME researchers also play a crucial role in developing new biomedical devices and technologies. Taiwan is currently grappling with the effects of an aging society and low birth rates, leading to a significant increase in social and healthcare demands. These are challenges that many developed countries are facing as well. The rapid advancement of science and technology has created a heightened demand for individuals who can bridge the gap between biomedicine and engineering.

In the future, successful collaboration among a broader range of talents will be essential to integrate academia and industries that can compete on a global scale. BME expertise is required at every stage of development, from academia and research to industry and the clinical domain. Taipei Medical University's College of Biomedical Engineering has achieved remarkable success in various areas, including biomedical electronics, nanotechnology, biomedical materials, optoelectronics, biomedical imaging and informatics, as well as medical materials and assistive devices. Our long-term objective is to foster innovative biomedical industries under the TMU brand.

In the coming years, we will continue to establish partnerships with other organizations to enhance CBME's influence. We eagerly anticipate your support and welcome your valuable suggestions.

Sincerely

Jiunn-Horng Kang
Professor and Dean
College of Biomedical Engineering
Taipei Medical University

Vice Dean's Message

Our College is an “international hub” in the field of Biomedical Engineering research and teaching in the Asia-Pacific area, with multiple connections to the rest of the world. We achieve world-class research and have established multiple exchanges with Foreign universities.

Our Graduate Institutes and the International Ph.D. Program in Biomedical Engineering offer all classes in English. Our undergraduate program is continuously expanding, with students actively engaged in international internships and exchange programs. Additionally, our graduate students have opportunities to pursue dual Master's or Ph.D. degrees. Our three graduate institutes have become full partners in the highly competitive Erasmus Mundus 'Euro-Asian Joint Master Program in Medical Technology and Healthcare Business', collaborating with three European engineering schools (in France, Germany, and Portugal) and supported by the European Commission.

We have established robust and meaningful working relationships in various research domains with sister universities in the USA, France, Japan, Australia, and Sweden. We also maintain research contracts with both local and international industries to develop new biomedical technologies. The number of foreign students from Asia, Europe, Africa, and Central America applying to and joining CBME) is steadily increasing—with over 50% for the Ph.D. program and nearly 25% for the Graduate program annually.

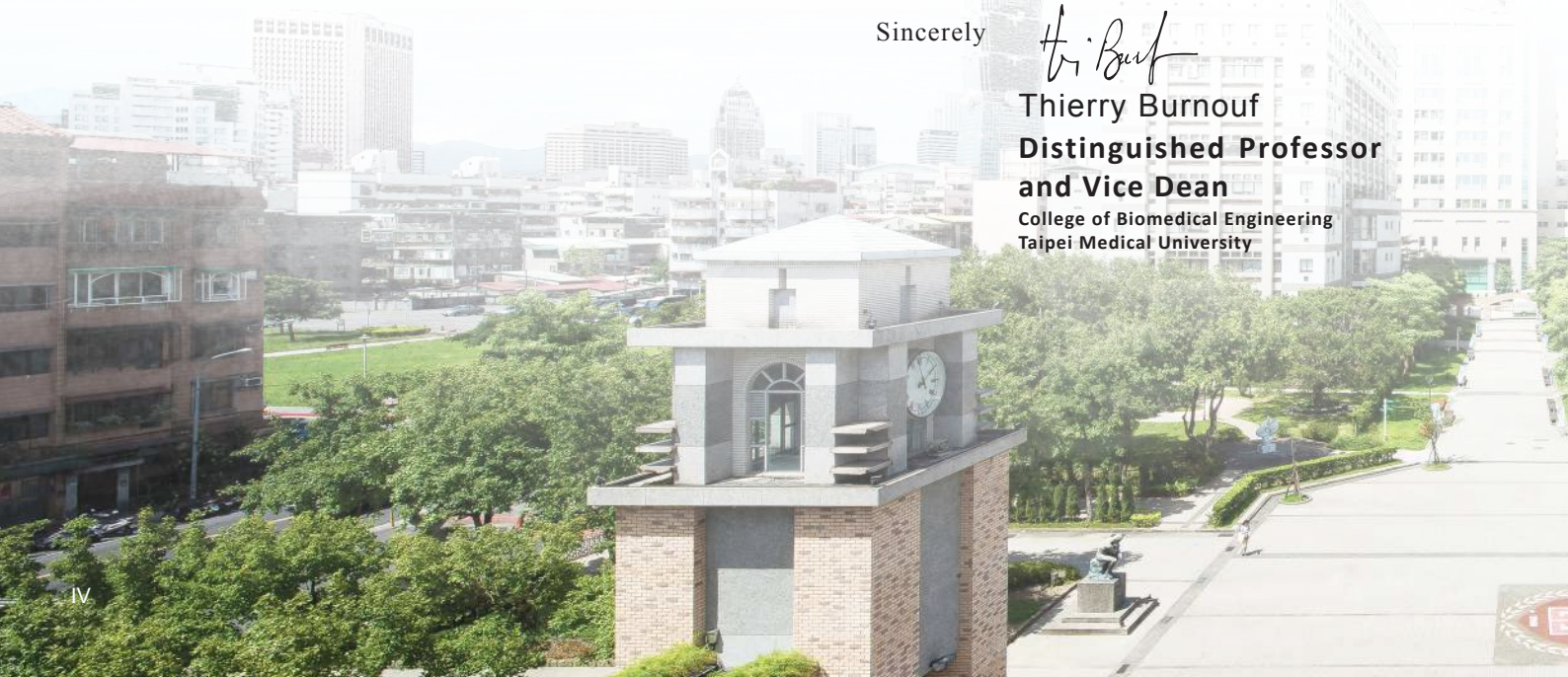
The proportion of our scientific publications produced in collaboration with international laboratories is consistently on the rise, indicating our active global collaborations. This upward trend is likely to continue, as evidenced by the enhanced quality of CBME's scientific publications in top-tier journals within the biomedical engineering and life sciences sectors, and by our college's improving international academic ranking.

Our international faculty members extend our global reach, amplify our research and teaching prowess, and promote our international endeavors.

Through persistent efforts and by leveraging the unique connections our university has with its affiliated hospitals, and through its location in the dynamic and friendly environment of Taiwan, our College has become a leading hub for biomedical engineering. We are committed to providing our students with a promising career trajectory.

Sincerely

Thierry Burnouf
Distinguished Professor and Vice Dean
College of Biomedical Engineering
Taipei Medical University



Vice Dean's Message

The College of Biomedical Engineering (CBME) draws from core disciplines such as clinical engineering, basic sciences, biodesign, nanotechnology, biomaterials, and tissue engineering, emphasizing an interdisciplinary approach to research and education.

The goal of CBME is dedicated to solving clinical needs through advanced biomedical engineering technology, with a focus on translational commercialization. CBME actively promotes opportunities in the field of biomedical engineering, encompassing areas like bioengineering, biotechnology, medical AI, biomaterials, assistive devices, wearable technology, drug delivery, and medical devices. We have established research laboratories and clinical trial centers in the affiliated TMU teaching hospitals to streamline clinical applications in areas such as diagnosis, therapeutics, medicine, nanotechnology, and public health. By collaborating with the industry-university-research platform for pre-clinical studies in the development of medical devices and providing cooperative development services, CBME cultivates a dynamic interdisciplinary innovative ecosystem and enables the faculty to achieve multiple effects based on their research achievements. Moreover, we educate students to be contributors to medical science and nanotechnology with a global vision.

Sincerely

Jen-Chang Yang

Professor and Vice Dean

College of Biomedical Engineering
Taipei Medical University

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11 **Hua-Shan Liu** : Magnetic Resonance Imaging Technique
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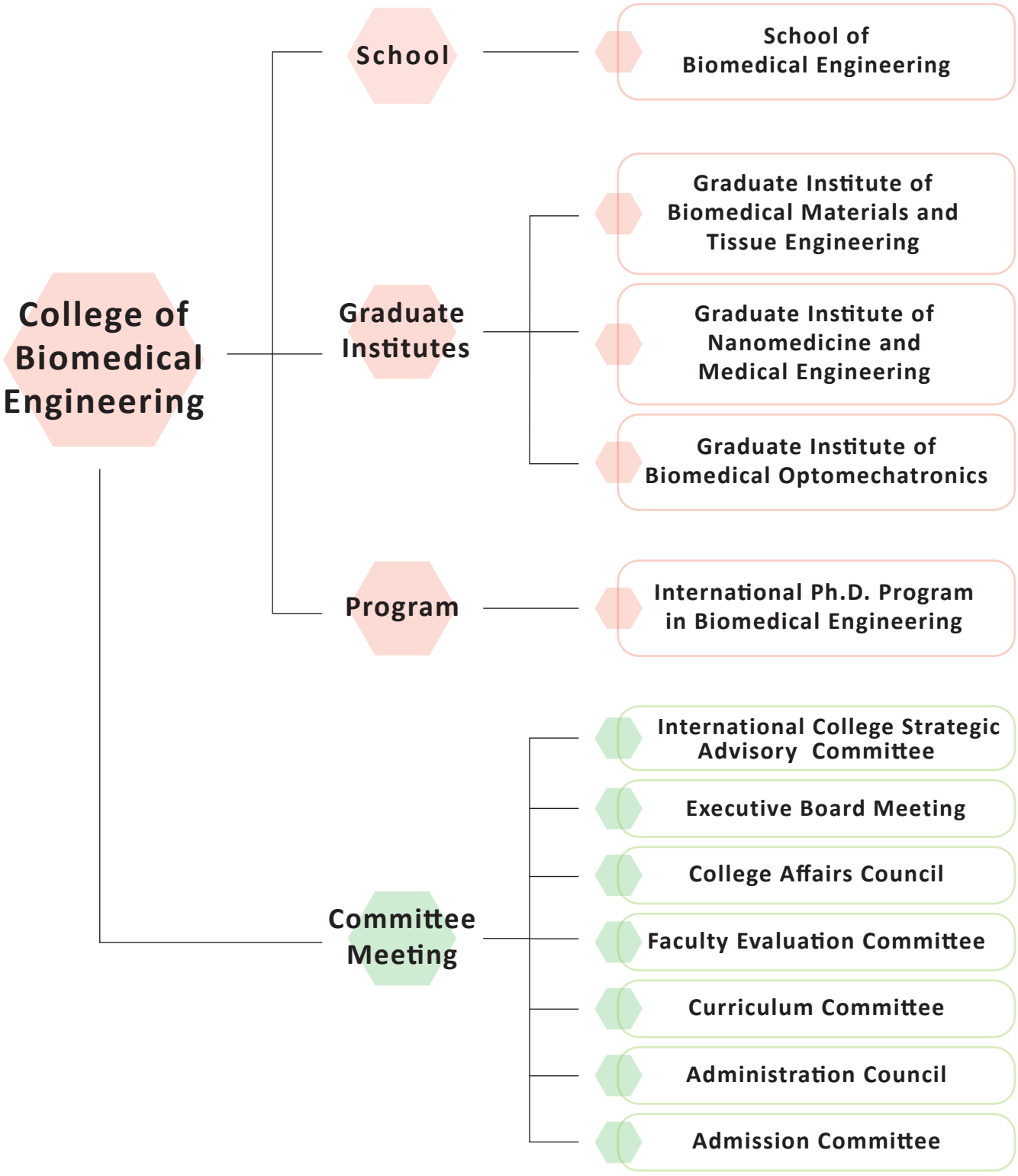
ORGANIZATION CHART



SCHOOL, GRADUATE INSTITUTES, AND PROGRAM

School of Biomedical Engineering

Graduate Institute of Biomedical Materials and Tissue Engineering

Graduate Institute of Nanomedicine and Medical Engineering

Graduate Institute of Biomedical Optomechatronics

International PhD Program in Biomedical Engineering

SCHOOL OF BIOMEDICAL ENGINEERING

About

The School of Biomedical Engineering (SBME) was established in August 2016. SBME aspires to become a top-rated and leading school of biomedical engineering worldwide. SBME provides students with a high-quality, medical-driven learning environment and excels in undergraduate education. Students will acquire the basic ability to apply mathematics, chemistry, engineering, biology, physics, and medical knowledge. We encourage students to explore medical issues and unmet clinical needs. We emphasize the importance of students developing their ability to design and conduct experiments, analyze and interpret data, and solve these problems. Students have a unique opportunity to understand and become familiar with the application of advanced technology to the complex problems of clinical medicine. We prioritize a clinically-oriented education to prepare students to excel as professionals in biomedical engineering. We expect our students to contribute to the academic and industrial development of biomedical engineering.

Chih-Wei Peng, Ph.D.
Chairman

Eligibility

1. Admissions
   - General Category
   - Foreign Category
   - Special Talents (e.g. Design, Protyping, etc.)
2. Entrance Test

Missions

1. Enhance students' foundational knowledge and professional skills in biomedical engineering, equipping them with the competence to integrate multidisciplinary technologies.
2. Educate students to specialize comprehensively in the field of biomedical engineering through hands-on, clinic problem-based teaching approaches.
3. Foster students with a sense of humanities and noble character to promote social care and well-being.
4. Nurture students to become innovative biomedical engineers with a prospective and international vision.

Requirement for B.S. Degree

The BS degree in biomedical engineering requires 130 credits.

- Required (70 credits)
- Selective (32 credits)
  - A. Track of Medical Mechanics & Materials
  - B. Track of Bio-optomechatronics
- Humanities and Social Sciences (28 credits)

Staff and Contact Information
Chih-Wei Peng, Professor and Chairman
Louise Kao, Secretary

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Major Publications

1. Chen SC, Chu PY, Hsieh TH, Li YT, Peng CW. Feasibility of Deep Brain Stimulation for Controlling the Lower Urinary Tract Functions: An Animal Study. Clinical Neurophysiology, 2017 ; 128:2438-2449.
2. Liou JC, Chang YT .Inves tigated of the Reproducibility of Upper-Limb Motor Function in Stroke Patients. Journal of Nanoelectronics and Optoelectronics .2017 ;12: 862-867.
3. Chen YJ, Kuo KK, Ting LL, Lu LS, Lu YC, Cheng AJ, Lin YT, Chen CH, Tsai JT, Chiou JF. Piperlongumine inhibits cancer stem cell properties and regulates multiple malignant phenotypes in oral cancer. Oncology Letters 2018 ;15:1789-1789.
4. Chung PS, Fan YJ, et al., Real-time dual-loop electric current measurement for label-free nanofluidic preconcentration chip .Lab on a Chip. 2015 ;15: 319-330
5. Liu HS, Shen H, Luo Y, Hoffer BJ, Wang Y, Yang Y. Post-treatment with Cocaine- and Amphetamine-regulated Transcript Enhances Infarct Resolution, Reinnervation and Angiogenesis in Stroke Rats - A Magnetic Resonance Imaging Study. NMR Biomed. 2016; 29: 361–370.

GRADUATE INSTITUTE OF BIOMEDICAL MATERIALS AND TISSUE ENGINEERING

Ching-Li Tseng, Ph.D.
Director

About

The Graduate Institute of Biomedical Materials and Tissue Engineering (GIBMTE) was established in 2006 under the College of Oral Medicine. This institute was later moved to the newly-established College of Biomedical Engineering in 2015, reflecting the broad scope of BMTE in biomedical and therapeutic fields. We offer both Master's and Ph.D. degrees in Sciences, as well as dual diplomas with universities in Europe, Japan, the USA, and other countries. GIBMTE provides international, multidisciplinary teaching courses and is equipped with various instruments to create a conducive research environment for educating students with basic and advanced knowledge in the field of biomedical materials, tissue engineering, and cell-based regenerative medicine. Our connections with the TMU system of hospitals provide students with the opportunity to work in clinical settings, inspiring critical thinking and novel discoveries. We also offer a special fellowship program to support foreign students in becoming excellent researchers and leaders in the field of BMTE.
Furthermore, we are the first university or college in Taiwan to participate in the Erasmus Programme international program. Graduates are awarded a joint diploma co-signed by the EU partners, the MSc from TMU, and digital graduation certificates.

Eligibility

1. Open to Taiwanese and non-Taiwanese nationals
2. MS applicants: Hold a Bachelor's degree in science or engineering related to biomedical engineering
3. PhD applicants: Hold (a) an MS in science/engineering, related to biomedical engineering or (b) a MD degree and at least two years of documented clinical training with publication(s) equivalent to an MS thesis

Missions

1. Broaden the vision and experience of MS students in the field of biomedical engineering, meeting the expectations of global research. Establishing the knowledge, skills, and confidence of students to serve in biomedical/biotech companies, hospitals, or to pursue further study in a PhD program.
2. Train doctoral candidates with critical thinking, creativity, and wisdom to become independent researchers, conduct post-doctoral fellow studies, and subsequently become faculty members in universities, principal investigators in academic institutes, or managers in biomedical and biotech companies.

Master Degree Requirements (2 Years)

- 26 credits in required courses (including 6 credits for MS Thesis), 4 credits in elective courses and Research Ethics (no credit)
- Thesis and pass the oral dissertation defense

PhD Degree Requirements (3-4 years ideally)

- 26 credits in required courses (including 12 credits for PhD dissertation), 4 credits in elective courses and Research Ethics (no credit)
- Present an oral PhD progress report each year, one being considered as Qualification Examination, making the candidate eligible for PhD thesis presentation
- (a) Single first author of 1 SCI original paper in the top 30%, or (b) Single first author or co-first author of several SCI papers and the sum of their impact factors is 5 or above
- PhD dissertation and pass the oral dissertation defense

Staff and Contact Information

Agnes Chu, Secretary

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Achievements

- 2023 Industry-Academia Collaboration Excellence Award.
- 2023 Research Excellence Department Award.
- 2023 Academic Research-Outstanding Thesis Research Award (Prof. Thierry Burnouf)
- 2023 University-Level Outstanding Mentor (Asso. Prof. David J. Lundy)
- 2023 Major Research Project Award (Prof. Chien-Chung Chen)
- 2023 International Collaborative Project for "Presidents' Forum of Southeast and South Asia and Taiwan Universities, SATU" (Prof. Ching Li Tseng)
- 2022 International Collaborative Project for "Presidents' Forum of Southeast and South Asia and Taiwan Universities, SATU" (Prof. Er-Yuan Chuang)
- 2022 19th National Innovation Award-Academic Research Innovation Award Recipients (Prof. Thierry Burnouf, and Asso. Prof. Long-Sheng Lu)
- 2022 U.S./European patent for "A lutein-containing ophthalmic composition." (Prof. Ching Li Tseng)

2023 Graduation Photo

2023 Student Tzu-Hsin Chang studies dual-degree at Tokyo University of Science

GRADUATE INSTITUTE OF NANOMEDICINE AND MEDICAL ENGINEERING

Tsung-Rong Kuo, Ph.D.
Director

About

The Graduate Institute of Nanomedicine and Medical Engineering (GINME) has been established with a focus on translational research to address clinical needs through innovations and advances in nanotechnologies. Two major areas of focus for GINME are nanomaterials for medical devices and drug delivery, as well as nanotechnology-based diagnostics. The implementation of nanomaterials in medical device applications and long-term translational research toward clinical trials are our primary objectives.

In our course design, we emphasize the connection between nanomaterials and clinical applications. Each student is assigned two advisors, including one specializing in basic research and one who is a clinical doctor. GINME is also an internationally-oriented institute, offering dual degree programs, scholar exchange programs, and research collaborations in partnership with leading institutes. Our goal is to establish a program with international visibility, recognized for research excellence and a proven track record in the incubation of nano-products.

Major Achievements

In GINME, students will learn how to apply electrical, electronics, and systems engineering in medicine and biology. They will also gain experience in developing and using new technologies, including medical instrumentation and prosthetic devices. Additionally, they will explore the properties of materials used in the fabrication of medical devices, such as caries prevention and ENT hemostasis.

The missions of GINME

1. Advance and disseminate knowledge for students in the fields of health, medicine, and nanotechnology.
2. Offer students opportunities to serve as visitors and interns in affiliated hospitals.
3. Educate students to become contributors to the fields of medical science and nanotechnology.
4. Integrate research resources and lectures to enhance students' skills, performance, and global perspective."

GINME Highlights:

1. Dual degree program with Tokyo University of Science (TUS)
2. Two tracks: (1) Innovations in Nano/Biomedical Materials and (2) Nanotechnology Applied in Medical Diagnosis and Therapy
3. Dual advisors: (1) one basic research professor and (2) one clinical doctor

Career Opportunities After Graduation

Our graduates will be eligible to take board certification examinations for biomedical engineers, and they may pursue careers in biotechnology, pharmaceuticals, cosmetics, material science, healthcare, public service, and research faculty positions at universities.

GINME Has Ten Core Research Fields Including:

1. Medical devices toward preventive and the minimally invasive applications.
2. Electrospun silk polymers for biomimetic researches.
3. Biological applications of porous silica nano-platform.
4. Catcher in the Rel protein: Nanoparticles-antibody conjugate as NF-κB nuclear translocation blocker.
5. Impacts of protein corona on biological effects of mesoporous silica nanoparticles.
6. Peptide-mediated delivery of pH-sensing mesoporous silica nanoparticles into lysosome in living cells.
7. Screening and harnessing stem cell behavior.
8. Gold nanoclusters as a fluorescent probe for assessment of cancer progression.
9. SERS substrate for detection of disease biomarkers.
10. Flexible and wearable devices for point-of-care tests (POCT)

Staff and Contact Information
Tsung-Rong Kuo Professor and Director

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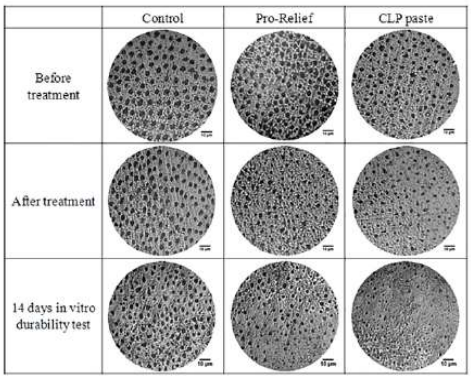
URL: https://tmu.pure.elsevier.com/en/persons/david-jon-lundy

Representative Figures

1.



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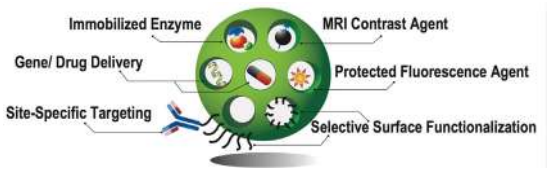

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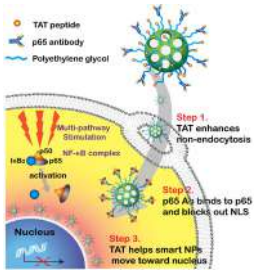

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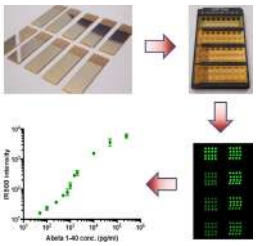

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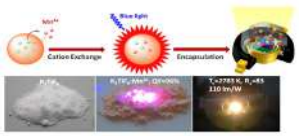


1. The optical micrographs of occlusal dentin disk surface pre-treatment, immediately post-treatment, and 14-day post-treatment of various desensitizing pastes.
2. Biological applications of porous silica nano-platform.
3. Catcher in the Rel: Nanoparticles-antibody conjugate as NF-κB nuclear translocation blocker.
4. SERS platform for biomarker detection
5. Flexible and stretchable bioelectronic devices integrated with nanomaterials.
6. Synthesis, analysis and device package of the luminescent materials.

GRADUATE INSTITUTE OF BIOMEDICAL OPTOMECHATRONICS

About

The aims of GIBOM are to integrate the fields of optics, electronics, mechanics, and materials in order to develop biomedical instruments for use in life sciences and clinical medicine. We offer a Master's degree in Sciences, as well as dual diplomas with universities in Europe, Japan, the USA, and other countries. Students in GIBOM will receive training in a broad, flexible, interdisciplinary, and international education rooted in engineering, biological sciences, and medicine. GIBOM has two main training components. One focuses on medical optoelectronic and mechatronic engineering, which emphasizes innovative and impactful research on diagnostic sensors. The second component focuses on the biological response to physical stimulation, with the aim of developing medical devices for precision medicine. The course arrangement at GIBOM is suitable for biology and medical students, as well as for engineering students who wish to specialize in biomedicine.

Tzu-Sen Yang, Ph.D.
Director

Eligibility

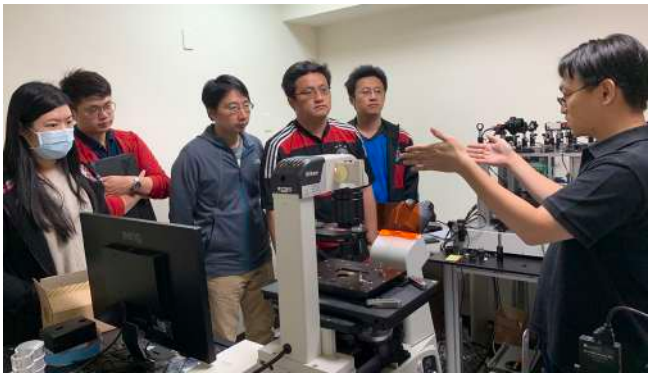
1. Open to Taiwanese and non-Taiwanese nationals
2. MS applicants: Hold a Bachelor degree in science, related to biomedicine or engineering (biology, pharmacy, medicine, mechanical engineering, electronic engineering, chemical engineering, material science etc.)

Missions

1. GIBOM will connect with mature local electronics and optoelectronic industries to quickly leverage collaboration with companies that develop and manufacture products with advanced biomedical-optomechatronics-related technologies.
2. GIBOM aims to incubate interdisciplinary experts who can integrate various scientific and engineering techniques and develop novel instrumentation necessary for modern medical treatment and disease prevention.

Master Degree Requirements (2 Years)

- 26 and 4 credits in Required (including 6 credits for MS Thesis) and Elective courses, respectively.
- Research Ethics (no credit)
- Thesis
- Pass oral thesis defense



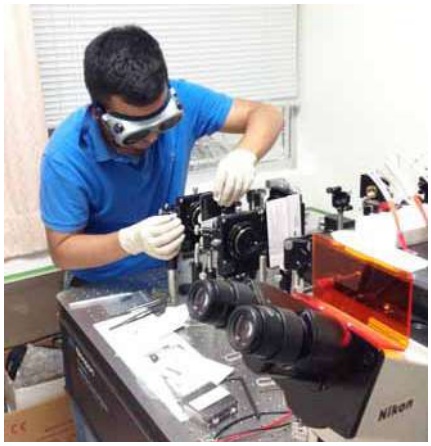
Major Publications

1. Yen HC, Kuo TR, Wang CT, Lin JD, Chen CC, Hsiao YC. Optical Properties of Electrically Active Gold Nanoisland Films Enabled with Interfaced Liquid Crystals. Nanomaterials 2020: 10, 290-297.

2. Huang, CF, Colley MMS,;Lu LS, Chang CY, Peng PW, Yang TS. Performance characterization of continuous-wave laser-induced forward transfer of liquid bioink. Appl. Phys. Express. 2019; 12: 116504-116508.

3. Manga YB, Ko FS, Yang YS, Hung JY, Yang WL, Huang HM, Wu CC. Ultra-fast and sensitive silicon nanobelt field-effect transistor for high-throughput screening of alpha-fetoprotein. Sensors & Actuators: B. Chemical 2018;256:1114-1121

4. Lew WZ, Huang YC, Huang KY, Lin CT, Tsai MT, Huang HM. Static magnetic fields enhance dental pulp stem cell proliferation by activating the p38 mitogen-activated protein kinase pathway as its putative mechanism. Journal of Tissue Engineering and Regenerative Medicine. 2018;12:19-29.



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https://www.facebook.com/TMUGIBOM/

INTERNATIONAL PhD PROGRAM IN BIOMEDICAL ENGINEERING

About

The International PhD Program in Biomedical Engineering (IPBME) was established in 2016 under the newly established College of Biomedical Engineering at TMU. All professors in the College of Biomedical Engineering are affiliated with IPBME, offering foreign PhD students a unique opportunity to develop and apply their skills in the multidisciplinary field of biomedical engineering. Students can pursue dual diploma PhD degrees with universities in Europe, Japan, the USA, and other countries. Our mentoring system is also unique, allowing students to have an overseas collaborating professor and providing strong support for international research collaborations. Our teaching and research environment is truly stimulating for students interested in biomedical materials, tissue engineering, nanotechnologies, nanomedicine, and bio-optomechatronics. The close links with the TMU group of hospitals provide a strong incentive for students to test, evaluate, and apply their research ideas for successful translational medicine applications. International students enrolled in this program are eligible for fellowships to support their professional or academic aspirations. Pursuing a PhD degree within IPBME represents an excellent opportunity for career development in safe and hospitable Taiwan while gaining insight into how biomedical engineering is changing the quality and accuracy of patient treatment worldwide.

Tsung-Rong Kuo, Ph.D.
Director

Eligibility

1. Open exclusively to non-Taiwanese nationals
2. Degree: Hold (a) an MS degree in science related to biology, medicine, pharmacy, biomedicine engineering or materials-related fields, or (b) an MD degree and at least two years of clinical training with publications equivalent to an MS thesis.

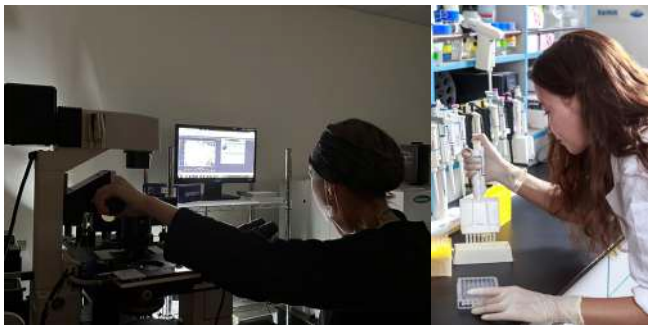
PhD Degree Requirements

- 26 credits in required courses (including 12 credits for PhD dissertation), 4 credits in elective courses and Research Ethics (no credit)
- Present an oral PhD progress report each year, one being considered as Qualification Examination, making the candidate eligible for PhD thesis presentation
- (a) Single first author of 1 SCI original paper in the top 30%, or (b) Single first author or co-first author of several SCI papers and the sum of their impact factors is 5 or above
- PhD dissertation
- Pass the oral dissertation defense

Timeline (3-4 Years)

A student progressing well and on schedule can expect to follow this timeline:

1. First Year – Take courses, select a thesis advisor, and start to conduct research.
2. Second / Third Year – Pass the progress report, take courses, and continue research.
3. Fourth Year – Pass the Qualifying Exam, defend the dissertation and graduate.



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TMU BIOMEDICAL ENGINEERING RESEARCH

Chih-Wei Peng : Neural Engineering Assistive Technology (NEAT)

Chih-Hwa Chen : Bone & Joint

Jian-Chiun Liou : Nano Bioengineering and Bio-ASIC Chip

Hua-Shan Liu : Magnetic Resonance Imaging Technique

Yu-Jui (Ray) Fan : Total Analysis System on Tissue and Cell (FanTASTiC)

Kuang-Hsuan (Sherry) Chen : Intracranial Electroencephalography Analysis

Ching-Li Tseng : Biomaterial Design For Drug Delivery, Tissue Regeneration-Ophthalmology

Thierry Burnouf : Platelet Biomaterials and Drug Delivery Systems

Der-Zen Liu : Liposomal Vaccine

Chien-Chung Chen : Microtube Array Membrane (MTAM)

Er-Yuan Chuang : Drug Delivery

Long-Sheng Lu : Translational Radiation Biology

David J. Lundy : Cell Therapy and Extracellular Vesicles

Jen-Chang Yang : Dental Materials & Medical Devices

Jiunn-Horng Kang : Artificial Intelligence in Medicine, Assistive Technology and Neuromodulation

Yi-Ping Chen : Nano Theranostic

Tsung-Rong Kuo : Nanomaterials & Nanotechnology

Si-Han Wu : Hybrid Silica

Chih-Hsin (Melody) Lin : Tissue Engineering

Tzu-Sen Yang : Molecular Dynamics

Li-Chern Pan : Microfluidic Biochips

Yu-Cheng Hsiao : Photonics & Soft Matters

Zhao-Chi Chen : Advanced Laser Process and Functional Biomedical Device

Pei-Chun Wong : Integrated BioFabrication

Yen-Ling Sung : Cardiovascular Diseases and Optical Mapping

Anup Pandith : Chemical-Biology and Bioanalytical Chemistry

Lucas A. Lane : Cancer Imaging and Spectroscopic Detection

CHIH-WEI PENG RESEARCH TEAM :
NEURAL ENGINEERING ASSISTIVE TECHNOLOGY (NEAT)

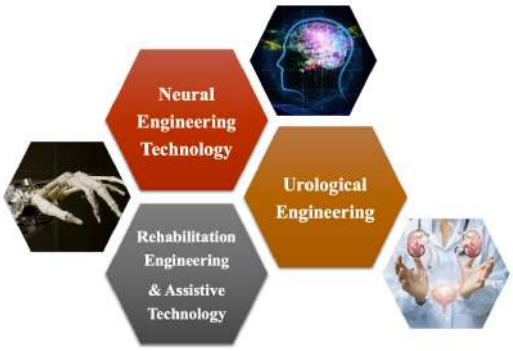
Chih-Wei Peng, Ph.D., Professor

Major Research Aims

My research employs neuroscience and engineering approaches to develop new therapeutic technologies for restoring motor or sensory functions in patients with neurodegenerative diseases. We have successfully achieved several neuromodulation technologies and applied these treatment approaches to restore physical functions in animal models and clinical patients with various neurological impairments. My current projects include:

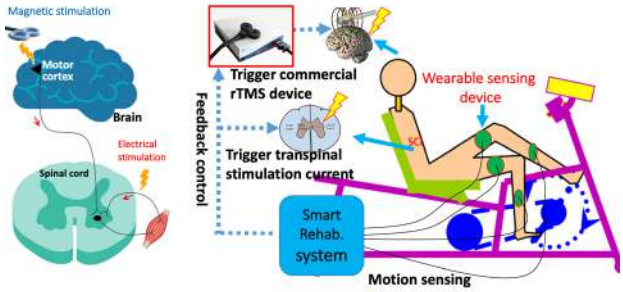
- Developing a novel brain stimulation system for neural rehabilitation.
- Developing advanced neural engineering approaches to treat bladder functions.
- Creating an intelligent drop foot stimulator with real-time adaptive feedback control to adaptively adjust stimulation intensity and enhance walking ability in Parkinson's disease patients.
- Developing paired associative nerve stimulation to restore motor function in spinal cord injured (SCI) patients.

Major fields



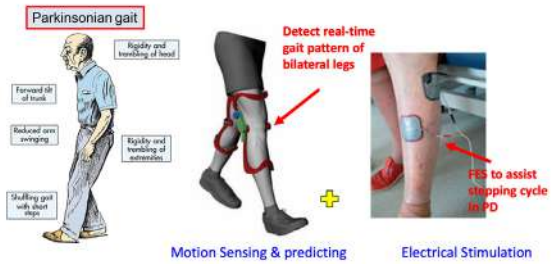
Representative Figures

1. Rehabilitation Effects on Lower Extremity Functions via Paired Associative Nerve Stimulation in Subjects with SCI.



2. Our Prototype Novel Transcranial Direct Current Stimulator.

3. Prototype Intelligent Drop Foot Stimulator with Real-Time Feedback for Parkinsonian Gait.



1. **Neural engineering for restoring motor function via paired associative nerve stimulation in patient with SCI**
   We are developing an intelligent neural rehabilitation system that includes evaluation and paired associative nerve stimulation for patients with SCI. The system is expected to improve the efficiency of SCI subjects' rehabilitation in the future and has the potential of commercialization.
2. **Novel transcranial direct current stimulator**
   We are developing a novel transcranial direct current stimulator (t-DCS) system for rehabilitation therapy and other applications. Our developed system has passed safety certification and is currently being used in animal and clinical studies to verify its therapeutic effects and the underlying mechanisms.
3. **Intelligent drop foot stimulator with real-time feedback control**
   We are developing and testing an intelligent drop foot stimulator with real-time adaptive feedback control to enhance the walking ability in Parkinson's disease patients with freezing gait.

Major Publications

1. Y.T. Li, S.C. Chen, L.Y. Yang, T.H. Hsieh, C.W. Peng* (2019, May). Designing and implementing a novel transcranial electrostimulation system for neuroplastic applications: a preliminary study, IEEE Trans Neural Syst Rehabil Eng, 27(5):805-813. (IF=3.478, SCI, REHABILITATION, 5/65=7.7%)
2. S.D. Yeh, B.S. Lin, S.C. Chen, C.H. Chen, KJ. Gustafson, DJ. Bourbeau, CP. Rajneesh, C.W. Peng* (2019, Jun). Effects of Genital Nerve Stimulation Amplitude on Bladder Capacity in Spinal Cord Injured Subjects, Evid Based Complement Alternat Med, 2019:1248342. (IF=1.984, SCI, INTEGRATIVE & COMPLEMENTARY MEDICINE, 10/27=37.0%)
3. S.C. Chen, P.Y. Chu, T.H. Hsieh, Y.T. Li, C.W. Peng* (2017, Dec). Feasibility of Deep Brain Stimulation for Controlling the Lower Urinary Tract Functions: An Animal Study, Clinical Neurophysiology, 128(12):2438-49 (IF= 3.675, CLINICAL NEUROLOGY, SCI, 51/199=25.6%).
4. T.H. Hsieh, Y.T. Lin, S.C. Chen, C.W. Peng* (2016, April). Chronic Pudendal Neuromodulation by Using an Implantable Microstimulator Improves Voiding Function in Diabetic Rats, Journal of Neural Engineering, 13(4):046001. (IF=3.493, SCI, ENGINEERING, BIOMEDICAL, 14/76=13.2%)
5. S.C. Chen, T.H. Hsieh, W.J. Fan, C.H. Lai, W.F. Wei, C.W. Peng* (2015, May). Design and Evaluation of Potentiometric Principles for Bladder Volume Monitoring: A Preliminary Study, Sensors, 15(6), 12802-12815 (IF=2.245, SCI, 10/56=17.8%, INSTRUMENTS & INSTRUMENTATION).

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CHIH-HWA CHEN : BONE AND JOINT RESEARCH TEAM

Chih-Hwa Chen, M.D., MBA
Professor

Major Research Aims

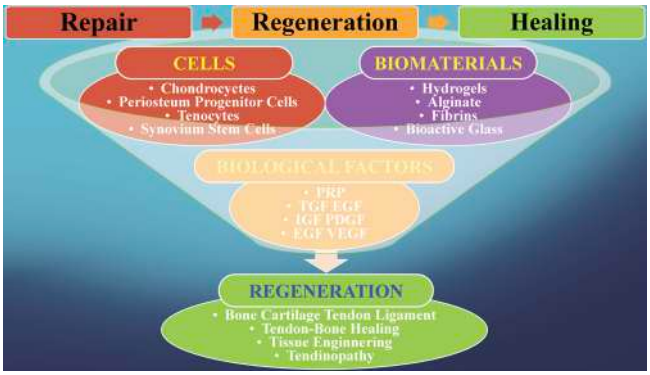
Chih-Hwa Chen, M.D., MBA, an Orthopedic professor at the Department of Orthopedics at Shuang Ho Hospital, also serves as a Professor at the College of Biomedical Engineering and the College of Medicine at Taipei Medical University. Dr. Chen has held several positions and directorships in the past and currently, such as the Committee of the International Symposiums of Ligament and Tendon since 2002, and a committee member of the Knee Sports & Preservation Committee of the International Society of Arthroscopy, Knee Surgery, and Orthopedic Sports Medicine (ISAKOS). He is an Emeritus President of the Asia-Pacific Knee, Arthroscopy, and Sports Medicine Society (APKASS), the Taiwan Arthroscopy and Knee Society, and the Taiwan Shoulder and Elbow Society. He also holds memberships in several international and national orthopedic and related research organizations and serves on the editorial boards of several journals.

Under his leadership, the Bone and Joint Research Team is making tremendous progress and focusing on improving biomedical research conditions and results, leading in tissue engineering, knee, shoulder, sports medicine, and degenerative joint diseases. Research on tendon-to-bone healing, cartilage tissue regeneration, bioengineering using different biomaterials (hydrogel, cell sheet, cell types, bioglass), and exploring novel strategies for rapid healing and regeneration are core values and innovative approaches for the research team.

Major Achievements

1. Graphene oxide hydrogel crosslinking for reconstructive surgery by Nonthermal Microplasma.
2. Periosteum bone enhancement and fibrocartilage in-growth into interface zone of tendon-bone.
3. Successful fabrication of PPC-BMP-2 hydrogel to enhance tendon-bone healing through fibrocartilage.
4. Bioengineered PPC sheets through tissue engineering.
5. Periosteum-enveloping hamstring tendon grafting in single-bundle ACL reconstruction with minimal tunnel widening.

Representative Figures



1. Integrating research through repair, regeneration, and healing, with a focus on reconstruction targeting cell groups from a clinical application perspective, supporting tendon-bone healing.
2. Evaluating biomaterials in terms of fibrocartilage formation at the interface between tendon and bone to enhance anchorage strength and improve tendon-bone healing.
3. Exploring biological factors, including growth factors, cytokines, extracellular matrix molecules, cell surface molecules, and nucleic acids, which are of significant innovative importance for tendon-bone healing.
4. Conducting regeneration studies to support overall innovation in biomaterials, orthopedics, tissue engineering, and bioengineering for bone, cartilage, and tendon-bone healing after sports injuries. Additionally, developing novel biomedical materials and devices for orthopedic applications.

1. The research team is encouraged to study and evaluate relevant sources for excellent research findings.
2. Biofabrication – nonthermal microplasma, platelet-rich fibrin (PRF) patch preparation, and extracellular matrix (ECM) preparation.
3. *In vitro* – successful cell seedings and analyzed by ImageJ for cells sizes, cell-sheets characterization, SEM bio-glass evaluation.
4. *In vivo* – femur tendon-bone interference fixation, PRF augmented tendon-bone healing, ACL partial tear healing.

Major Publications

1. Satapathy MK, Manga YB, Ostrikov KK, Chiang WH, Pandey A, Lekha R, Nyambat B, Chuang EY, CHEN CH. Microplasma cross-linked graphene oxide-gelatin hydrogel for cartilage reconstructive surgery. ACS Appl Mater Interfaces, 12(1):86-95, 2020
2. Wong PC, Song SM, Tsai PH, Nien YY, Jang JSC, Cheng CK, CHEN CH. Relationship between the surface roughness of biodegradable Mg-based bulk metallic glass and the osteogenetic ability of MG63 osteoblast-like cells. Materials, 13(5): 1188, 2020
3. Wong CC, Yeh YY, Yang TL, Tsuang YH, CHEN CH. Augmentation of tendon-graft bone tunnel interfacial healing by using bioactive platelet-rich fibrin scaffolds. Am J Sport Med, 48(6): 1379-1388, 2020
4. Nyambat B, Manga YB, CHEN CH, Gankhuyag U, Pratomo AWP, Satapathy MK, Chuang EY. New insight into natural extracellular matrix: genipin cross-linked adipose-derived stem cells extracellular matrix gel for tissue engineering. Int J Mol Sci, 21:4864, 2020 (SCI, Corresponding author)
5. Rethi L, Lu L, Huynh VT, Manga YB, Rethi L, Mutalik C, CHEN CH, Chuang ER. Bioactive glass fiber-reinforced plastic composites prompt a crystallographic lophelia atoll-like skeletal microarchitecture actuating periosteal cambium. ACS Appl Mater Interfaces, 13(27):32226-32241, 2021

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JIAN-CHIUN LIOU : NANO BIOENGINEERING AND BIO-ASIC CHIP

Jian-Chiun Liou Ph.D.
Professor

Major Research Aims

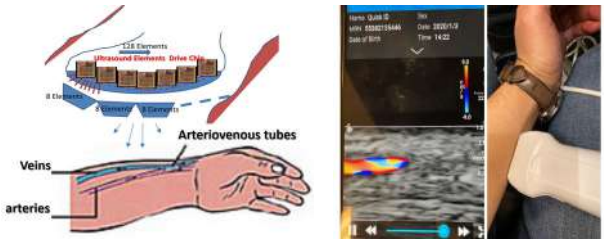
The Nanomedical Chip and Wisdom Medical Electromechanical System Research Team focuses on DNA, cDNA, RNA, and other materials placed on a glass slide. They employ an Application-Specific Integrated Circuit (ASIC) designed for the precise application of liquid containing medical wisdom DNA gene sequencing system technology onto the fabric placed on the glass slide. The design includes an Integrated High Voltage Pulse Generator for Medical Ultrasound Transmitters, which is achieved by converting high voltage drive array technology into low-voltage CMOS logic technology. This technology provides complete control over logic signal processing at the circuit level, ensuring precise liquid jetting on the chip. The Wisdom Medical Electromechanical System research project also proposes the integration of a real-time heart rate monitoring platform and a Multi-Channel Physiological Monitoring Integrated Artificial Intelligence Prosthetic Arm Assistive Learning System.

Major Achievements

1. Ultrasonic detection of blood flow rate in clinical patients. Ultrasonic mode low noise interference biological treatment and imaging common system and method.
2. Next-generation Intelligence an application-specific integrated circuit(ASIC) design for medical DNA sequence genes addressing system
3. Medical electronic ultrasonic photoelectric imaging system chip technology.
4. The research focuses are medical minimally invasive surgery technology for optical electromechanical systems.
5. This study pertains to ultrasonic probe chip imaging technology.

Representative Figures

1.



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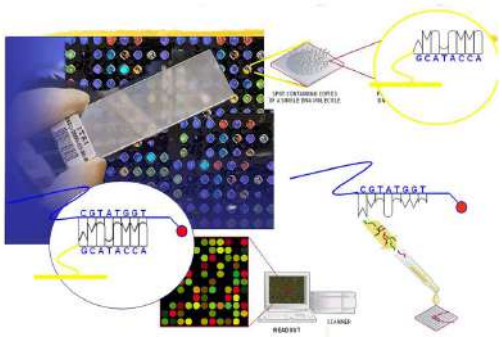

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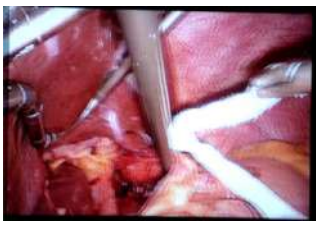

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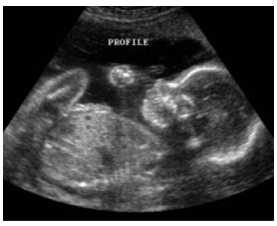

1. This study involves the examination of DNA, cDNA, RNA, and other materials placed on a glass slide. It employs an Application-Specific Integrated Circuit (ASIC) designed for the precise application of liquid containing medical wisdom DNA gene sequencing system technology onto the fabric placed on the glass slide.
2. It incorporates a high-frequency, high-density microfluidic structure design.
3. This study involves electrical stimulation therapy for stroke patients.
4. The research focuses on medical minimally invasive surgery technology for optical electromechanical systems.
5. This study pertains to ultrasonic probe chip imaging technology.

Major Publications

1. Jian-Chiun Liou, Cihun-Siyong Alex Gong, and Lung-Chien Chen,"Multi-Channel Physiological Monitoring Integrated Artificial Intelligence Prosthetic Arm Assistive Learning System",Journal of Nanoelectronics and Optoelectronics, Vol. 14, pp. 1–11 (2019).
2. Deng-Fong Lu, Chin Hsia, Jian-Chiun Liou, and Yen-Chung Huang,"Design of Integrated High Voltage Pulse Generator for Medical Ultrasound Transmitters", IEICE Transactions on Communications, Vol.E102-B, No.6, pp.1121-1127(2019).
3. Jian-Chiun Liou, "Circuitry of multiplexer-on-chip system within the micro-LED array manufacturing CMOS substrate", 2018nal: Optical and Quantum Electronics, DOI: 10.1007/s11082-018-1625-7(2018).
4. Jian-Chiun Liou, Cheng-Fu Yang,"Investigation of DNA sequencing droplet trajectory observation and analysis", Microelectronics Reliability, 91(2018) 243-250 (2018).
5. Jian-Chiun Liou, Yi-Tsung Chang,"Investigated of the Reproducibility of Upper-Limb Motor Function in Stroke Patients", Journal of Nanoelectronics and Optoelectronics, Volume 12, Number 8, August 2017, pp. 862-867(2017)SCI.
6. Jian-Chiun Liou, Te-Jen Su, Wen-Chieh Lin, and Wei-Jie Wen,"A novel printhead multiplexer data registration chip system with injection cavity design", Microsystem Technologies, DOI 10.1007/s00542-016-3147-1, pp.1-8.(2017)SCI.
7. Jian-Chiun Liou ,"Investigations of adhesion between waveguide and InP-laser with finger structure bonding" Computational Materials Science, Volume 122, Pages 30–37(2016)SCI.
8. Jian-Chiun Liou, Cheng-Fu Yang, and Cihun-Siyong Gong,"Design and Fabrication of Identification Inkjet Print Head Chip Fuse Sensors", Sensors and Materials, Volume 28, Number 5, pp. 493–501 (2016) SCI.
9. Jian-Chiun Liou, Chia-Ching Wu, Design and Fabrication of Microfluidic inkjet Chip with High Voltage ESD protection system for DNA droplets arrangement and detection, Microsystem Technologies-Springer Publishing Corporation, 12/2015;DOI:10.1007/s00542-015-2729-7,pp.1-15(2015) SCI.

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HUA-SHAN LIU :
MAGNETIC RESONANCE IMAGIING TECHNIQUES

Hua-Shan Liu, Ph.D.,
Associate Professor

Major Research Aims

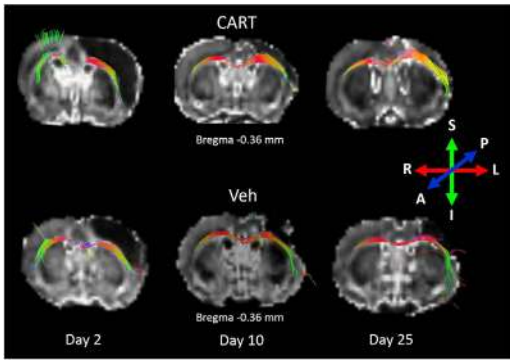
My research interests encompass the development of multimodal in vivo magnetic resonance (MR) imaging techniques in the fields of clinical and translational research, with a primary focus on the central nervous system, its related physiology and functions, as well as its pathophysiology. I achieve this through the utilization of advanced MR imaging and spectroscopic techniques. Drawing from my extensive research experience and interests, I continue to make advancements in MR perfusion-weighted imaging, quantitative susceptibility mapping, and spectroscopy, applying these techniques to clinical and translational research in the field. My aim is to use these approaches to study brain diseases and their functioning in neuroscience, as well as to develop expertise related to the investigation of mental and neurobiological disorders, and psychological/psychiatric studies.

Major Achievements

1. Utilized MR diffusion-tensor imaging (DTI) and susceptibility-weighted imaging (SWI) to detect changes in white matter plasticity and angiogenesis in an animal model of stroke.
2. Employed MR SWI to demonstrate iron depletion in the dentate nuclei of individuals with ataxia-telangiectasia.
3. Investigated the pathophysiological effects of chronic kidney disease (CKD) on brain function in children with CKD using ASL-MRI. This was accomplished by correlating cerebral blood flow (CBF) with clinical and behavioral indices.
4. Assessed the therapeutic efficacy of superparamagnetic erlotinib nanoparticles in treating lung cancer through the application of quantitative magnetic resonance imaging.
5. Utilized the first-pass pharmacokinetic model of permeability imaging in MR perfusion-weighted imaging to effectively grade tumors in patients with gliomas.

Representative Figures

1.



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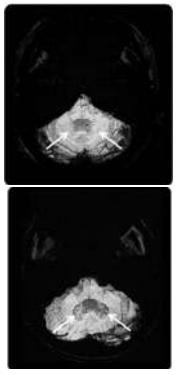

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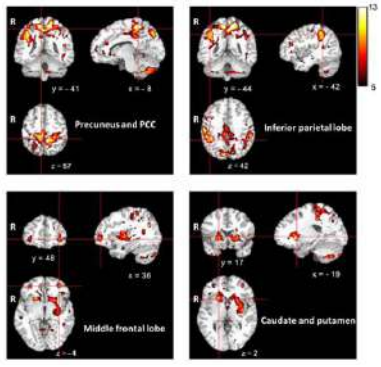

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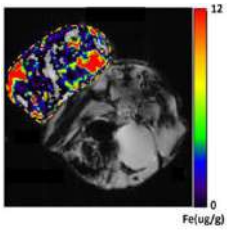

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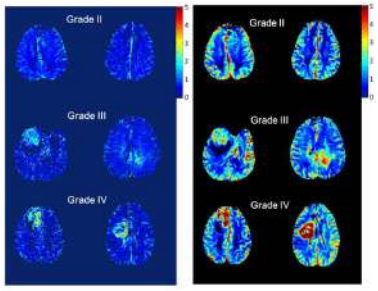

(1.) Post-stroke treatment with CART increased fiber growth in the ipsilateral cortex as revealed in diffusion-tensor imaging. (2.) Susceptibility-weighted images reveal an absence of hypointensity of the iron signal in the dentate nuclei of the patient with ataxia-telangiectasia (left). (3.) Overlapped clusters from all individual CKD subjects with positive extrema in CBF in the subject-specific voxel-wise analysis. (4.) Voxelwise estimates of the intratumoral iron concentration derived from changes in the ΔR2* signal, which correlates to the amount of intratumoral erlotinib content. (5.) Representative histograms of K^{trans} and vp from patients with high- and low-grade gliomas.

Major Publications

1. Liu HS, Shen H, Luo Y, Hoffer BJ, Wang Y, Yang Y. Post-treatment with Cocaine- and Amphetamine-regulated Transcript Enhances Infarct Resolution, Reinnervation and Angiogenesis in Stroke Rats - A Magnetic Resonance Imaging Study. NMR Biomed. 2016; 29: 361–370.
2. Liu HS, Hartung EA, Jawad AF, Ware JB, Laney N, Port AM, Gur RC, Hooper SR, Radcliffe J, Furth SL, Detre JA. Regional Cerebral Blood Flow in Children and Young Adults with Chronic Kidney Disease. Radiology. 2018; In Press.
3. Liu HS, et al. Regional Cerebral Blood Flow in Children and Young Adults with Chronic Kidney Disease. Radiology. 2018; In Press.
4. Liu HS, Jawad AF, Laney N, Hartung EA, Furth SL, Detre JA. Effect of Blood T1 Estimation Strategy on Arterial Spin Labeled Cerebral Blood Flow Quantification in Children and Young Adults with Kidney Disease. J Neuroradiol. 2018. S0150-9861(17)30402-9.
5. Liu HS, Chiang SW, Chung HW, Tsai PH, Hsu FT, Cho NY, Wang CY, Chou MC, Chen CY. Histogram Analysis of T2-Based Pharmacokinetic Imaging in Cerebral Glioma Grading. Comput Methods Programs Biomed. 2018. 155:19-27.
6. Hsu FT, Liu HS, Ali AAA, Tsai PH, Kao YC, Lu CF, Huang HS, Chen CY. Assessing the Selective Therapeutic Efficacy of Superparamagnetic Erlotinib Nanoparticles in Lung Cancer by Using Quantitative Magnetic Resonance Imaging and a Nuclear Factor Kappa-B Reporter Gene System. Nanomedicine. 2018. S1549-9634(18)30021-2.

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YU-JUI (RAY) FAN :
TOTAL ANALYSIS SYSTEM ON TISSUE AND CELL (FAN TASTiC)

Yu-Jui (Ray) Fan, Ph.D.,
Professor

Major Research Aims

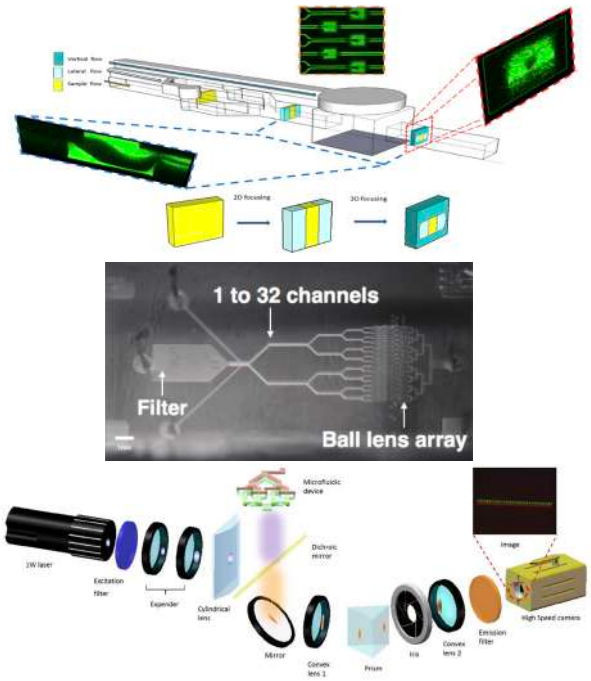
We are exploring multi-coupled physics to achieve precise micro-environmental control and demonstrate the potential for automation in miniaturized systems for various biomedical applications, including basic biology, medical diagnostics, and cellular engineering. Our current studies are primarily focused on three areas: (1) a vessel-mimicking microfluidic system to investigate cellular responses to cyclic stretch force coupled with programmable sheath force, (2) a lattice light-sheet illuminated cell and tissue analyzer, and (3) portable biosensors.

Major Achievements

1. High throughput and parallel micro-flow cytometer.
2. Vessel mimic microfluidic platform.
3. Smartphone-based biosensors integrated with Nanofluidic preconcentrator.

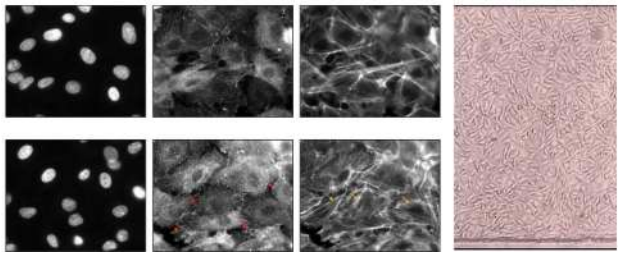
Representative Figures

1.



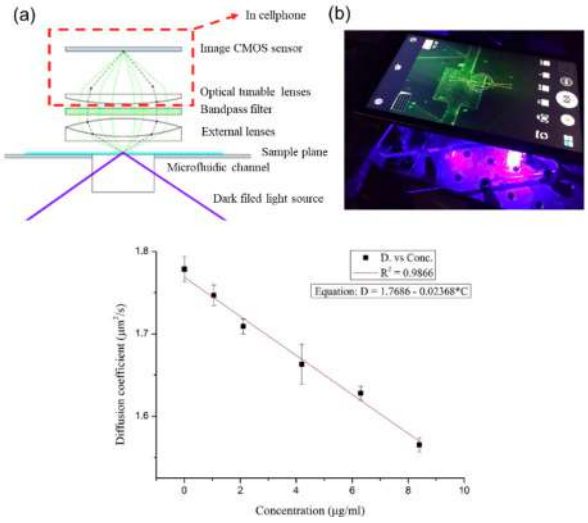
High throughput flow cytometer integrating parallel 3D microfluidic device with microball lens array.The optical system includes epi-fluorescence detection and employs a 4F optical system to transport fluorescent signals to a high-speed camera. A prism is used to separate different colors of fluorescent signals. This system has achieved a throughput of up to 1,000,000 cells per second.

2.



Vessel mimic flicrofluidic device for cell mechanics study.

3.



Smartphone based biosensors.

Major Publications

1. Chung PS, Fan YJ, Sheen HJ, Tian WC. Real-time dual-loop electric current measurement for label-free nanofluidic preconcentration chip. Lab on a Chip 2015;15:319-330.
2. Fan Y, Wu Y, Chen Y, Kung Y C, Wu T, Huang K, Sheen HJ, Chiou PY. Three dimensional microfluidics with embedded microball lenses for parallel and high throughput multicolor fluorescence detection. Biomicrofluidics 2013;7:44121.
3. Fan YJ, Deng CZ, Chung PS, Tian WC, Sheen H J.A high sensitivity bead-based immunoassay with nanofluidic preconcentration for biomarker detection. Sensors and Actuators B: Chemical 2018 ;272:502-509.
4. Fan YJ, Sheen HJ, Liu YH, Tsai JF, Wu TH, Wu KC, Lin S. Detection of C-reactive protein in evanescent wave field using microparticle-tracking velocimetry.Langmuir.2010;26: 13751-13754.
5. Chung PS, Fan YJ, Sheen HJ, Tian WC. Real-time dual-loop electric current measurement for label-free nanofluidic preconcentration chip. Lab on a Chip 2015, 15 (1), 319-330.

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URL: https://sites.google.com/view/
URL: fantastic-lab/fans-lab?authuser=0

KUANG-HSUAN (SHERRY) CHEN :
INTRACRANIAL ELECTROENCEPHALOGRAPHY ANALYSIS

Kuang-Hsuan (Sherry) Chen, Ph.D.,
Assistant Professor

Major Research Aims

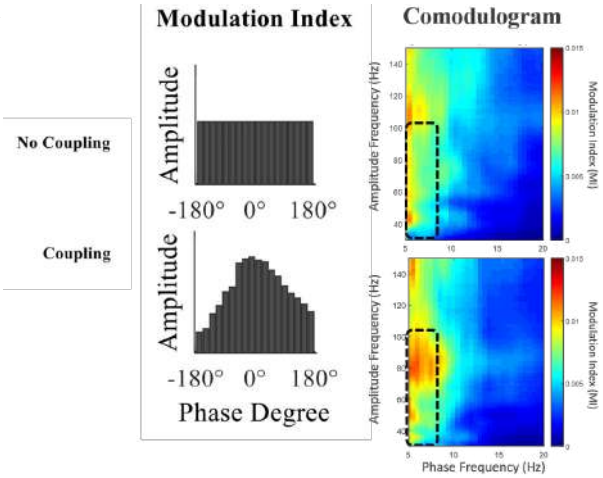
Intracranial electroencephalography (iEEG) offers outstanding temporal and spatial resolutions for recording neural activities compared to scalp electroencephalography (EEG). iEEG is primarily used to localize seizure onset zones and investigate the propagation of epileptic activities by implanting depth electrodes in areas of interest. This provides valuable information for neurosurgeons in determining final resection areas. Our clinical research has two main objectives: (a) Constructing epileptogenic networks for pre-ictal, ictal, and post-ictal phases, including source and direction information of seizure activities. (b) Investigating the possibility and mechanisms of secondary epileptogenic zones. In our scientific research, we focus on exploring neural patterns involved in cognitive behaviors, such as conflict processing. These behavior-related patterns can serve as neurophysiological biomarkers for closed-loop Deep Brain Stimulation (DBS) in patients with Parkinson's disease or epilepsy, as well as for Brain-Computer Interfaces (BCI).

Major Achievements

1. Established a signal pre-processing flow and a statistical testing process dedicated to iEEG recordings.
2. Based on our analysis of iEEG recordings during participants' performance of the Stroop Task, we identified two neural patterns related to conflict processing: (a) decreased theta coherence between the human orbitofrontal cortex and hippocampus, and (b) increased theta-LG phase-amplitude coupling (PAC) within the orbitofrontal cortex.
3. We also investigated neural activities during movement tasks, such as the reaching task and Go or No-Go task, and found that the human hippocampus and amygdala are involved, exhibiting increased beta-band power and gamma-band power, respectively.

Representative Figures

1.



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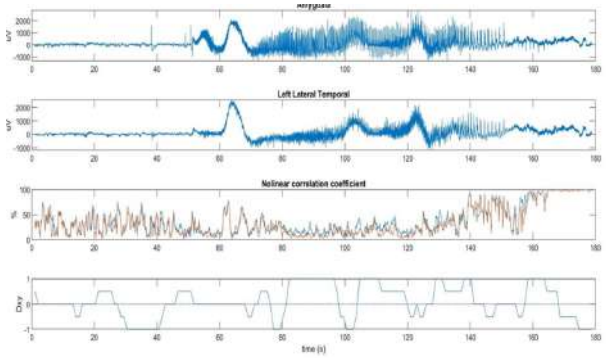

Figure 1 illustrates the increased theta-LG PAC (Phase-Amplitude Coupling) in the color-word conflict scenario (bottom plots) compared to no significant change in PAC in the color-word consistent scenario (top plots). Figure 2 displays the iEEG recordings of the pre-ictal, ictal, and post-ictal phases in the amygdala and left lateral temporal cortex (first 2 subplots). It also presents the calculated nonlinear correlation coefficient and directional information between these two brain areas (lower 2 subplots). The analysis results show that the correlation between these two areas increases sharply in the pre-ictal phase, decreases at the beginning of the ictal phase, and slowly increases as seizure activity ends. The directional information indicates that the amygdala plays a leading role during the ictal phase, suggesting that the amygdala may be a seizure onset zone.

Major Publications

1. Chen KH, Tang A, Gilbert ZD, Martin del Campo-Vera R, Sebastian R, Gogia AS, Sundaram S, Tabarsi E, Nune G, Liu CY, Kellis S, Lee B. Theta low-gamma phase amplitude coupling in the human orbitofrontal cortex increases during a conflict-processing task, Journal of Neural Engineering. (Under revised). [SCI]

2. Tang A, Chen KH, Gogia AS, Martin del Campo-Vera R, Sebastian R, Gilbert ZD, Nune G, Liu CY, Kellis S, Lee B. Amygdaloid Theta-Band Power Increases During Conflict Processing in Human. Journal of Clinical Neuroscience. (Accepted). [SCI]

3. Martin del Campo-Vera R, Tang A, Gogia AS, Chen KH, Sebastian R, Gilbert ZD, Nune G, Liu CY, Kellis S, Lee B. Neuromodulation in Beta-Band Power between Movement Execution and Inhibition in the Human Hippocampus. Neuromodulation: Technology at the Neural Interface. (Accepted). [SCI]

4. Tang A, Chen KH, Martin del Campo-Vera R, Sebastian R, Gogia AS, Lee MB, Nune G, Liu CY, Kellis S, Lee B. Hippocampal and orbitofrontal theta band coherence diminishes during conflict resolution. World Neurosurgery. 2021 Apr 16 (In press). [SCI]

5. Chen KH, Gogia AS, Tang A, Martin del Campo-Vera R, Sebastian R, Lee MB, Kramer DR, Peng T, Tafreshi A, Barbaro MF, Liu CY, Kellis S, Lee B. Beta-band modulation in the human hippocampus during a conflict response task. Journal of Neural Engineering. 2020 Nov 15 (In press). [SCI]

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CHING-LI TSENG : BIOMATERIAL DESIGN FOR DRUG DELIVERY, TISSUE REGENERATION- OPHTHALMOLOGY

Ching-Li Tseng, Ph.D., Professor

Major Research Aims

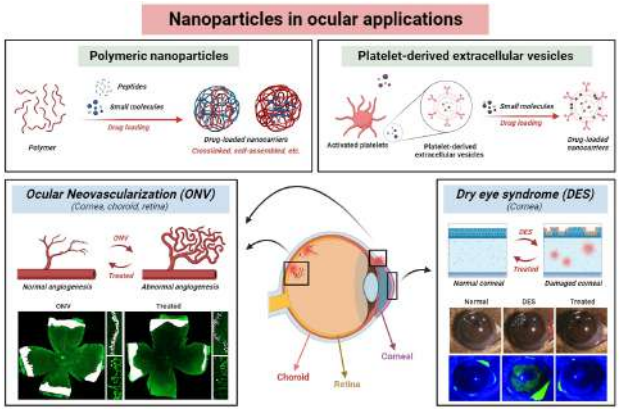
Biomaterials have broad applications in medical devices, tissue regeneration, and drug delivery. The same material can have a completely different impact on cell function depending on whether it is fabricated at the micro- or nano-scale. In our lab, we utilize biological polymers such as gelatin, collagen, chitosan, and hyaluronic acid as carriers for drugs and cell scaffolds for disease treatment. Our focus is on the development of novel formulations for non-invasive drug delivery, particularly in ophthalmology and lung cancer. We have been working on the development of new formulations to enhance patient compliance and targeting efficiency, which can improve therapeutic outcomes in clinical settings. In recent years, we have designed and developed gelatin nanoparticles for the treatment of conditions like dry eye syndrome and corneal neovascularization in the form of an eye drop formulation. It has been demonstrated that nanoparticles can increase the bioavailability of drugs on the ocular surface, effectively treating these diseases with just one daily dose. We are currently testing the therapeutic effects of these nanoformulations in the treatment of retinal diseases. Additionally, our research has shown that the inhalation delivery of nanomedicine is effective in treating lung cancer in situ, as it significantly increases the concentration of chemodrugs in the lungs while maintaining targetability for cancer tissue.

Major Achievements

1. Design of targetable drug carriers for disease treatment.
2. Synthesis of degradable scaffolds for tissue regeneration.
3. Control of stem cell differentiation using nanotechnology for retina regeneration.
4. Development of disease models for therapeutic evaluation, including dry eye syndrome, corneal neovascularization (NV), glaucoma, age-related macular degeneration (AMD), and blue light damage, among others.
5. Inhalation delivery of nanomedicine for diagnosing and treating lung cancer and fibrosis.
6. Preclinical testing for the treatment of eye, bone, cartilage, skin, and lung diseases.

Representative Figures

1.



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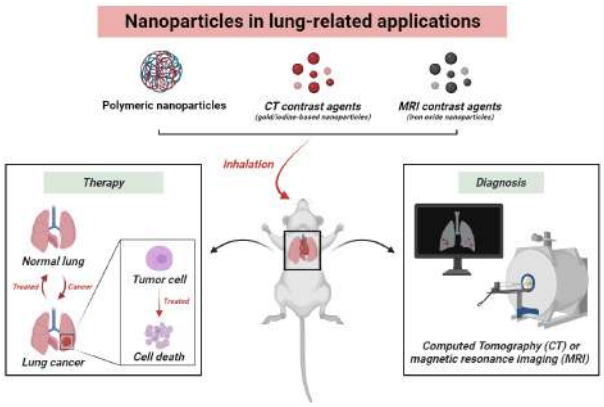

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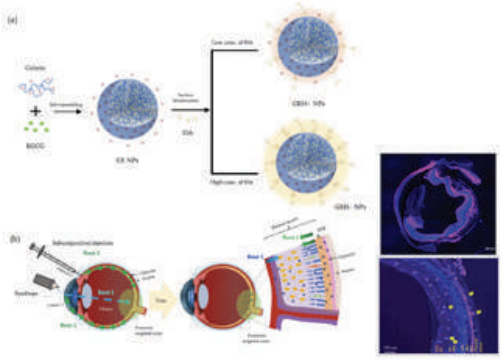

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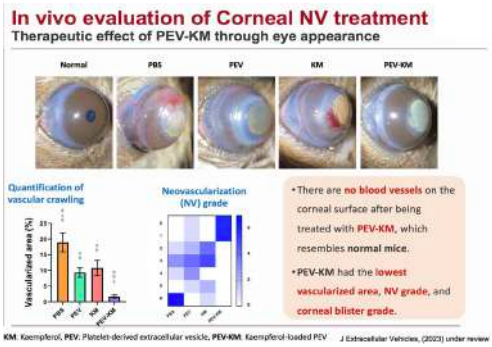

1. Utilization of nature/synthetic nanoparticles with anti-inflammation/ anti-angiogenic agents (e.g., tea polyphenol, gp91 peptide, TAK1 inhibitor) encapsulation for the treatment of conditions like blue light-damaged retina, dry eye syndrome, corneal neovascularization (NV), and age-related macular degeneration (AMD).
2. Development of novel nanomedicines using fabrication methods such as self-assembly, microemulsion, and desolvation.
3. Bioconjugation and surface modification of targetable ligands (e.g., RGD, EGF, folic acid) for targeted therapy in vascular and cancer-related applications.
4. Development of theranostic agents for MRI (using materials like iron oxide or platinum) and CT contrast agents (based on gold or iodine nanoparticles) for the treatment of lung cancer.

Major Publications

1. YC Chu, HW Fang, YY Wu, YJ Chen,..... GS Liu, CL Tseng*. Functional peptide-loaded gelatin nanoparticles as eyedrops for cornea neovascularization treatment. International journal of nanomedicine, 2023; 1413-1431.
2. A Khalil, A Barras, R Boukherrou, CL Tseng, ...T Burnouf, .., Sabine Szunerits*. Enhancing paracellular and transcellular permeability using nanotechnological approaches for the treatment of brain and retinal diseases, Nanoscale Horizons, 2023, 09. DOI: 10.1039/D3NH00306
3. JJH Wang†, CL Tseng†, FL Lin, ... J Hernandez, LL Tu, PY Wang, GS Liu. Topical application of TAK1 inhibitor encapsulated by gelatin particle alleviates corneal neovascularization. Theranostics. 2022; 12(2):657-674.)
4. YZ Chen, ZY Chen, YJ Tang, ..., L Tucker, IC Lin, CL Tseng*. Development of Lutein-Containing Eye Drops for the Treatment of Dry Eye Syndrome. Pharmaceutics, 2021, 13, 1801. 1-18. https://doi.org/10.3390/p

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THIERRY BURNOUF : PLATELET BIOMATERIALS AND DRUG DELIVERY SYSTEMS

Thierry Burnouf, Ph.D.,
Distinguished Professor

Major Research Aims

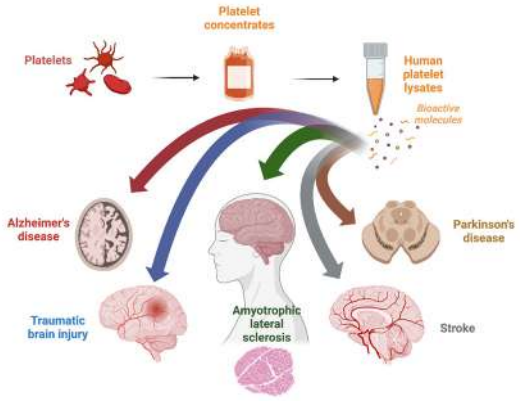
Human blood is a source of essential cellular and protein therapeutics to treat diseases resulting from accidents, aging, and congenital or acquired protein deficiencies. Our research aims at improving the quality of blood products, and expanding the range of blood-based therapies serving human health. With translational medicine applications in mind, our research focuses on exploring (a) applications of tailor-made platelet lysates and platelet extracellular vesicles (p-EVs) rich in multiple trophic factors in regenerative medicine (such as neurological disorders and ocular diseases) and cell therapy (mesenchymal stromal cell expansion), (b) use of blood cells and cell-derived EVs as drug delivery systems and therapies, and (c) novel bioprocessing technologies for the chromatographic purification and virus inactivation of blood proteins, in particular immunoglobulins. Our research has a strong international focus with close collaborations with foreign universities and research centers (Universities of Lille, Bourgogne Franche-Comté, France; Queensland Brain Institute, Australia; Uppsala University, Sweden; University of Saskatchewan, Canada) as well as international and Taiwan industries. Our research has won the NSTC Outstanding Research Award in 2022.

Major Achievements

1. Tailor-made platelet lysates and p-EVs rich in neurotrophins to treat neurodegenerative diseases and truma of the CNS, (such as traumatic brain injury, Parkinson's disease, and cognitive loss associated with aging) and corneal endothelium damages.
2. Procedures to prepare and use platelets as drug delivery system.
3. Characterization of p-EVs as drug delivery vehicles and regenerative medicine adjunct.
4. Clinical grade, virally-inactivated human platelet lysates for human cell (e.g. mesenchymal stromal cells) propagation ex vivo.
5. Virus inactivation and removal procedures from platelet lysates for cell expansion and regenerative medicine.

Representative Figures

1.



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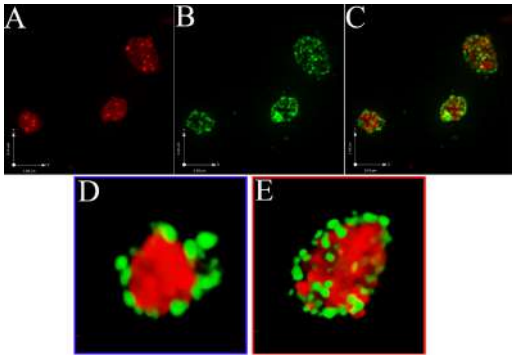

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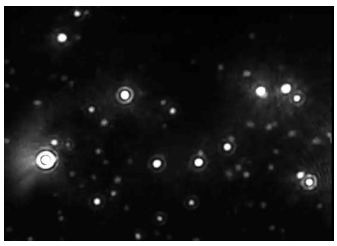

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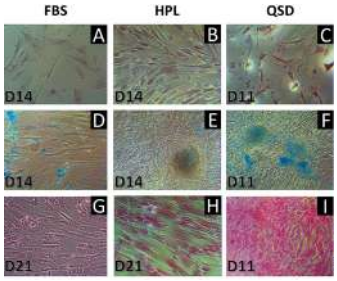

1. Use of platelet lysates for brain administration and treatment of neurological disorders
2. Loading of doxorubicin within a platelet microcarrier for targeted cancer treatment.
3. Observation of platelet-derived extracellular vesicles by Nanoparticle Tracking Analysis.
4. Differentiation capacity of Wharton Jelly MSC expanded in human platelet lysates treated for prion and virus removal.

Major Publications

1. Hao PC°, Burnouf T°, Chiang CW, Jheng PR, Szunerits S, Yang JC, Chuang EY. Enhanced Diabetic Wound Healing Using Platelet-Derived Extracellular Vesicles and Reduced Graphene Oxide in Polysaccharide-Coordinated Hydrogels. Journal of Nanotechnology, 21, 318 (2023). https://doi.org/10.1186/s12951-023-02068-x
2. Burnouf T, Walker T. The multifaceted role of platelets in mediating brain function. Blood, 2022; https://doi.org/10.1182/blood.2022015970
3. Delila L, Nebie O, Le NTN, Barro L, Chou ML, Wu YW, Watanabe N, Takahara M, Buée L, Blum D, Devos D, Burnouf T. Neuroprotective activity of a virus-safe nanofiltered human platelet lysate depleted of extracellular vesicles in Parkinson's disease and traumatic brain injury models. Bioeng Transl Med. https://doi.org/10.1002/btm2.10360
4. Nebie O, Buée L, Blum D, Burnouf T*. Can the administration of platelet lysates to the brain help treat neurological disorders? Cell Mol Life Sci, 2022; 10.1007/s00018-022-04397-w
5. Nebie O, Carvalho K, Barro L, Delila L, Faivre E, Renn TY, Chou ML, Wu YW, Niem-Redene A, Chou SY, Buée L, Hu CH, Peng CW, Devos D, Blum D, Burnouf T*. Human platelet lysate biotherapy for traumatic brain injury: pre-clinical assessment, Brain, 2021;144:3142-3158.
6. Johnson J, Wu Y-W, Blyth C, Lichtfuss G, Goubran H, Burnouf, T. Prospective Therapeutic Applications of Platelet Extracellular Vesicles. Trends in Biotechnology, 2021; 39: 598-612.
7. Wu YW, Huang CC, Changou CA, Lu LS, Goubran H,Burnouf T. Clinical-grade cryopreserved doxorubicin-loaded platelets: role of cancer cells and platelet extracellular vesicles activation loop. Journal of Biomedical Science, 2020;27:45

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DER-ZEN LIU : LIPOSOMAL VACCINE

Der-Zen Liu, Ph.D., Professor

Major Research Aims

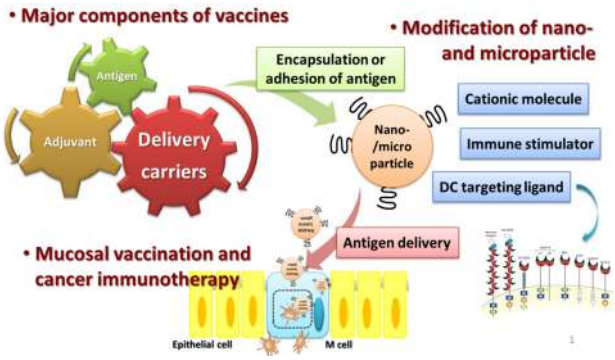
Mucosal surfaces, such as the gastrointestinal and respiratory tracts, serve as the primary entry points for many infectious agents. As a result, mucosal immunity represents the first line of defense against harmful microorganisms. Specialized dendritic cells (DCs) are abundant in mucosal surfaces, playing a critical role in recognizing environmental pathogens and initiating and regulating adaptive immune responses. Hence, it is essential to develop effective vaccines that target mucosal DCs to induce protective immunity against cancer and viral infections. To achieve this goal, we have developed a novel targeted liposomal delivery platform designed to transport antigens across mucosal membranes and directly target dendritic cells. This targeted liposomal approach has the potential to enhance protective effects significantly, making it a valuable tool in the prevention of infectious diseases and the treatment of mucosal tumors.

Major Achievements

1. Incorporation of the Galactose-DLPE targeting ligand, formed by covalently conjugating galactose to DLPE, into the liposomal bilayer to create a targeted galactosylated liposome carrier.
2. Effective facilitation of antigen uptake by dendritic cells (DCs) both in vitro and in vivo using galactosylated liposomes.
3. Successful induction of an efficient anti-OVA immune response against EG7 tumor challenge through intranasal administration of the galactosylated liposomal vaccine.

Representative Figures

1.



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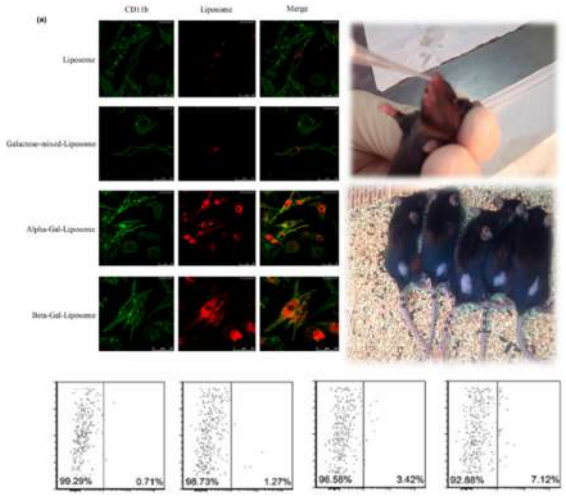

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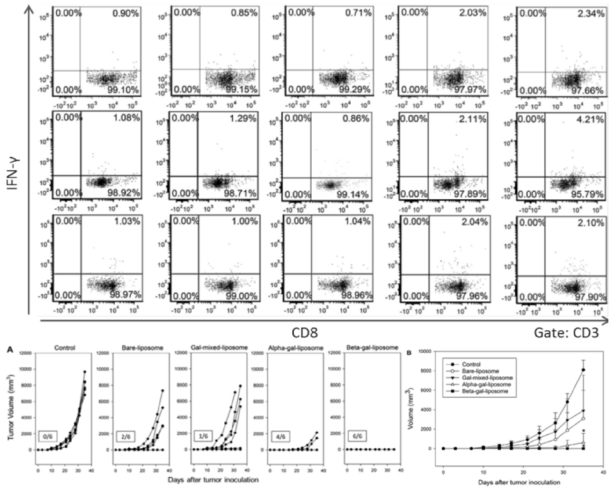

1. Design concept for functionalized targeted liposomes in mucosal vaccines.
2. Galactosylated liposomes effectively facilitated antigen uptake by dendritic cells (DCs) both in vitro and in vivo through intranasal administration.
3. The number of IFN-γ-producing CD8+ T cells increased in mice immunized with alpha-gal-liposomes and significantly increased in galactosylated liposomes. Five out of six mice receiving alpha-gal-liposomes and all six mice receiving beta-gal-liposomes completely rejected the EG7 tumor challenge.

Major Publications

1. Jiang PL, Lin HJ, Wang HW, Tsai WY, Lin SF, Chien MY, Liang PH, Huang YY, Liu DZ*. Galactosylated liposome as a dendritic cell-targeted mucosal vaccine for inducing protective anti-tumor immunity. Acta Biomaterialia. 2015; 11:356-67.
2. Wang HW, Jiang PL, Lin SF, Lin HJ, Ou KL, Deng WP, Lee LW, Huang YY, Liang PH, Liu DZ*. Application of galactose-modified liposomes as a potent antigen presenting cell targeted carrier for intranasal immunization. Acta Biomaterialia. 2013;9(3):5681-8
3. Cheng HC, Chang CY, Hsieh FI, Yeh JJ, Chien MY, Pan RN, Deng MC, Liu DZ*. Effects of tremella-alginate-liposome encapsulation on oral delivery of inactivated H5N3 vaccine. J Microencapsul. 2011;28(1):55-61.
4. Chiou CJ, Tseng LP, Deng MC, Jiang PR, Tasi SL, Chung TW, Huang YY, Liu DZ*. Mucoadhesive liposomes for intranasal immunization with an avian influenza virus vaccine in chickens. Biomaterials. 2009;30(29):5862-8.

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CHIEN-CHUNG CHEN, Ph.D.Professor : MICROTUBE ARRAY MEMBRANE (MTAM)

Chien-Chung, Chen, Ph.D., Professor

Major Research Aims

Our group's core research focus is the development of novel electrospun microtube array membranes (MTAMs), which can be tailored for various applications. Depending on the specific application, materials and microstructures can be modified to meet unique requirements and create distinct membrane properties. In our current research, we have successfully applied MTAMs in areas such as anti-cancer drug screening (personalized medicine and drug development). Our innovative platform offers highly translatable outcomes, rapid screening processes, and significant cost reductions in drug screening. Another key area of our research centers on tissue engineering, where MTAMs serve as a novel co-culture substrate. This work shows great promise in advancing tissue engineering approaches, including in vitro models for drug release studies that have the potential to replace animal testing, contributing to more ethical and efficient research. Additionally, our group is actively exploring projects related to hemodialysis and endotoxin removal. Here, MTAMs have proven exceptional in enhancing filtration efficiency while reducing the associated time and cost. In parallel with our current research endeavors, we are expanding our focus to include encapsulated cell therapy, a cutting-edge approach in treating neurodegenerative diseases like Alzheimer's. Our goal is to leverage the unique properties of MTAMs to encapsulate therapeutic cells, providing a controlled and protective environment. This innovative approach has the potential to significantly improve the efficacy of cell-based treatments for Alzheimer's and other neurodegenerative diseases.

Major Achievements

1. Inventor & holds upwards of 20+ international and local patents; including 2 PCTs
2. Published over 80+ peer reviewed SCI journals
3. Successfully established a technology spin-off company (MTAMTech Corporation) specializing in anti-cancer drug screening for personalized medicine and preclinical drug development.
4. Another spin-off is currently in progress, focusing on encapsulated cell therapy for neurodegenerative diseases through collaboration with a well-established and reputable cell therapy company.

Representative Figures

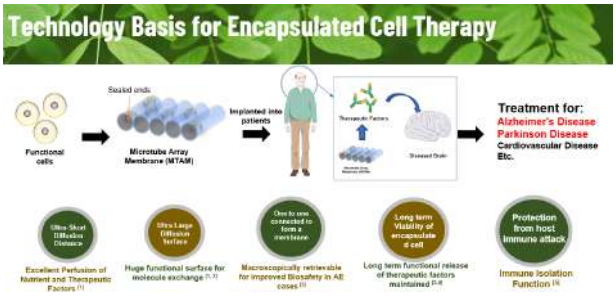
1.

The novel MTAM with its unique microstructures, patent coverage and applications

2.

Application of MTAMs in anticancer drug screening for personalized medicine and preclinical drug development

3.



Application of MTAMs Encapsulated Cell Therapy for neurodegenerative diseases

Major Publications

1. Tu SH, Huang WT, Chew CH, Chen AL, Chen ST, Chen JH, Hsieh YC, Chen CC. Unveiling the Power of Anticancer Drug Screening: A Clinical Case Study Comparing the Effectiveness of Hollow Fiber Assay Microtube Array Membrane (MTAM-HFA) in Breast Cancer Patients. Cancers. 2023 May 15;15(10):2764.

2. Chen SM, Hsu TC, Chew CH, Huang WT, Chen AL, Lin YF, Eddarkaoui S, Buee L, Chen CC. Microtube Array Membrane Encapsulated Cell Therapy: A Novel Platform Technology Solution for Treatment of Alzheimer's Disease. International journal of molecular sciences. 2022 Jun 20;23(12):6855.

3. Huang WT, Yun T, Chew CH, Chen A, Wei PL, Lee KY, Lee HL, Feng PH, Chiou JF, Chen CM, Chen CC. Microtube Array Membrane Hollow Fiber Assay (MTAM-HFA)—An Accurate and Rapid Potential Companion Diagnostic and Pharmacological Interrogation Solution for Cancer Immunotherapy (PD-1/PD-L1). Biomolecules. 2022 Mar 22;12(4):480.

4. Chew CH, Lee CW, Huang WT, Cheng LW, Chen A, Cheng TM, Liu YL, Chen CC. Microtube array membrane (MTAM)-based encapsulated cell therapy for cancer treatment. Membranes. 2020 Apr 26;10(5):80.

5. Tseng CH, Huang WT, Chew CH, Lai JK, Tu SH, Wei PL, Lee KY, Lai GM, Chen CC. Electrospun polylactic acid (PLLA) microtube array membrane (MTAM)—An advanced substrate for anticancer drug screening. Materials. 2019 Feb 14;12(4):569.

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ER-YUAN CHUANG : DRUG DELIVERY

Er-Yuan Chuang, Ph.D., Professor

Major Research Aims

We are deeply engaged in the fields of drug delivery and biomaterials, with a strong emphasis on collaborative teamwork. Our primary focus is on advancing cutting-edge nanobiomaterials to significantly enhance the effectiveness of treatments for various human diseases. Our research involves an in-depth examination of formulated material characteristics, physicochemical properties, their impact on cell viability, and the underlying biomolecular mechanisms. In pursuit of innovation, we continually strive to develop cost-effective processes for producing next-generation therapeutic materials.

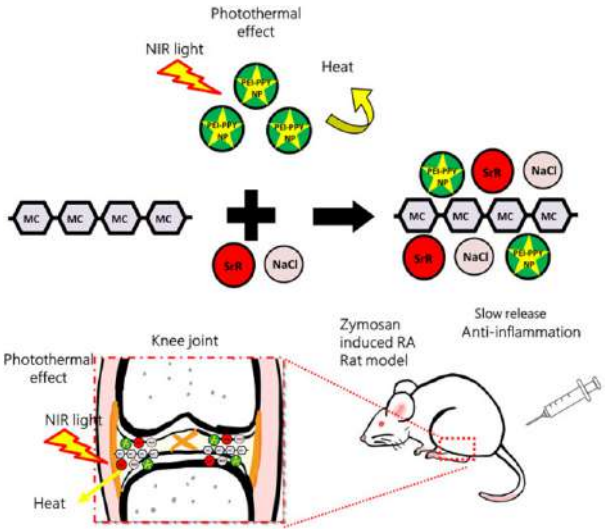
Our development efforts are guided by key principles, including biocompatibility, bioefficacy, clinical relevance, and addressing tangible industrial needs. To achieve our goals, we have forged valuable partnerships with clinicians and industry experts, working together to optimize our biomaterials, refine formulations, and conduct preclinical animal studies. Currently, our primary focus within this dynamic arena is on carbon-based nanomaterials.

Major Achievements

1. Carbon-based nanomaterials are the primary focus of our current research.
2. We have successfully developed a Genipin-crosslinked adipose stem cell-derived extracellular matrix-nano graphene oxide composite sponge for skin tissue engineering.
3. In addition to studying potential administration methods, the proposed nanocarrier systems have the potential to serve as a platform for the delivery of various therapeutic substances.

Representative Figures

1.



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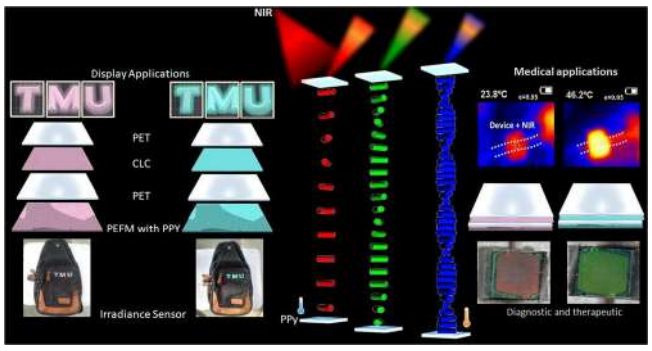

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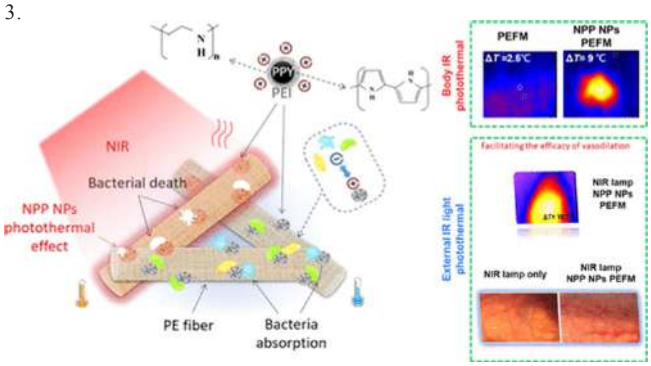

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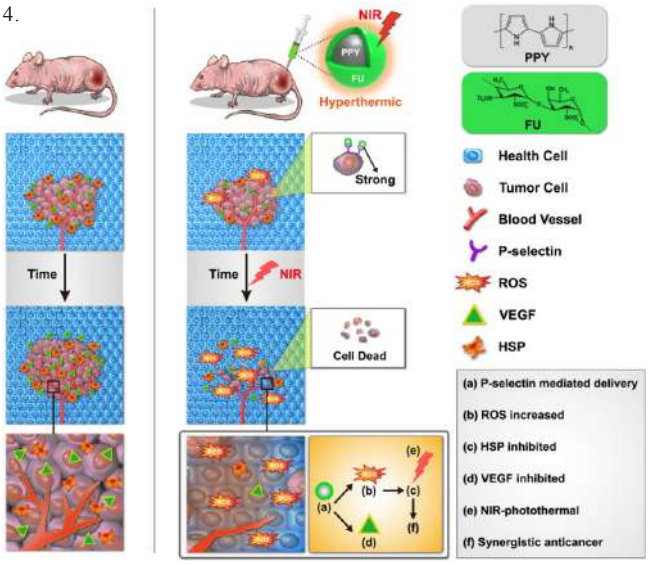

Major Publications

1. ACS Applied Materials & Interfaces 13 (32), 38074-38089
2. ACS Applied Materials & Interfaces 13 (27), 32226-32241
3. ACS Applied Materials & Interfaces 13 (8), 10287-10300
4. ACS Applied Materials & Interfaces 13 (2), 2483-2495
5. International Journal of Biological Macromolecules 166, 98-107
6. Materials Science and Engineering: C 123, 111980
7. Chemical Engineering Journal 429, 132213

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LONG-SHENG LU : TRANSLATIONAL RADIATION BIOLOGY

Major Research Aims

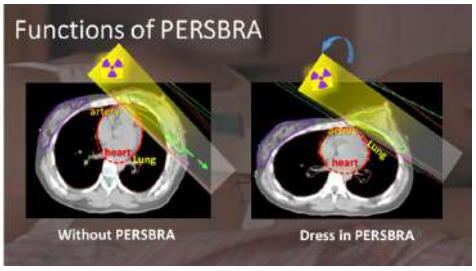
The Lu lab is interested in understanding how ionization radiation alters tumor-host interaction to achieve long-term control of cancers and minimize normal tissue side effects. We dedicate efforts to unmet clinical needs in radiation oncology, and solve these issues with an integrated BME approach. In the lab, we use live cell microscopy, image cytometry, molecular biology, explant culture, smart biomaterials, and murine models to explore the non-canonical effects of ionizing radiation. These bench findings are actively translated to new strategies for normal organ protection, personalized in vitro tests, targeted drug delivery, and anticancer immunity in the settings of metastatic breast and colorectal cancers. In the clinics, we are interested in radiation-assisted immunotherapy, personalized oncology, and cardiovascular protection for curative cancer treatment

Long-Sheng Lu, M.D, Ph.D.,
Associate Professor

Our Significant Contributions

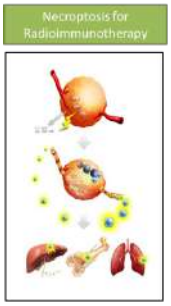
1. **Personalized breast holder (PERSBRA)**

   The unique value proposition of PERSBRA is that a customized unilateral breast holder is able to stably maintain a breast position that is compatible with cardiac sparing during whole breast irradiation. The breast position is derived from the torso contour when the patient is on a semi-prone position, in which breast stability is secured by gravity. Personalized manufacturing is made possible by introduction of polymer 3D printing technology. The concept has been tested in a cohort of 30 women with left breast cancer, and dosimetric analysis suggested that this simple workflow is as effective as DIBH to spare the heart by 30% dose reduction. Moreover, the turnaround efficiency with PERSBRA is at least 4 times higher comparing to DIBH. The implementation of PERSBRA requires no additional training on radiotherapy staffs, and the associated device is portable. Putting together, PERSBRA is a novel cardiac sparing solution for community radiation oncology units.



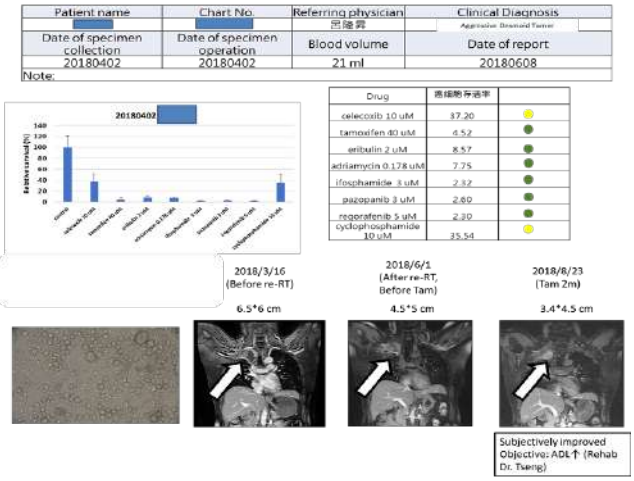
2. **Radiation assisted immunotherapy**

   Cancer immunotherapy not only controls the primary tumor but also work systemically to destroy distant metastatic lesions. Our lab is trying to develop novel in situ tumor vaccination strategy with precision radiation plus intratumoral drug delivery that collectively promote programmed necrosis of cancer cells and reprogramming of tumor microenvironment.



3. **Circulating sarcoma cells for personalized oncology**

   We developed a unique technology that can efficiently expand circulating sarcoma cells. These cells represent novel opportunities for personized oncology, especially when it is used for drug sensitivity testing. In a case of recurrent desmoid tumor, circulating sarcoma cells were expanded into cell clusters from the peripheral blood (bottom left), and drug screening found that the tumor responded sensitively to Tamoxifen (top left ; Histogram of drug response, right table: the percentage of drugs that inhibit cell proliferation relative to untreated cells detected). The patient was treated with Tamoxifen and dramatic clinical and image improvement were seen (lower row), which is consistent with cellular sensitivity results. In another case,



Major Publications

1. Chu HY*, Lu LS*, Cho W, Wu SY, Chang YC, Lin CP, Yang CY, Lin CH, Jiang JK, Tseng FG: Enumerating circulating tumor cells with selfassembled cell array (SACA) chip: a feasibility study in patients with colorectal cancer. Cancers (Basel). 2019 Jan 8;11(1). pii: E56. doi: 10.3390/cancers11010056.

2. Huang CF, Colley MMS, Lu LS, Chang CY, Peng PW, Yang TS: Performance characterization of continuous-wave laser-induced forward transfer of liquid bioink. Applied Physics Express, 2019 12(11)116504.

3. Lin CH, Lee HH, Kuei CH, Lin HY, Lu LS, Lee FP, Chang J, Wang JY, Hsu KC, Lin YF. Nicotinic Acetylcholine Receptor Subunit Alpha-5 Promotes Radioresistance via Recruiting E2F Activity in Oral Squamous Cell Carcinoma. J Clin Med. 2019 Sep 12;8(9). pii: E1454. PubMed Central PMCID: PMC6780171.

4. Lee HH, Lin CH, Lin HY, Kuei CH, Zheng JQ, Wang YH, Lu LS, Lee FP, Hu CJ, Wu D, Lin YF. Histone 2A Family Member J Drives Mesenchymal Transition and Temozolomide Resistance in Glioblastoma Multiforme. Cancers (Basel). 2019 Dec 30;12(1). pii: E98. doi: 10.3390/cancers12010098.

5. Wu YW, Huang CC, Changou CA, Lu LS, Goubran H, Burnouf TH: Clinical-grade cryopreserved doxorubicin-loaded platelets: role of cancer cells and platelets extracellular vesicles activation loop. J Biomed Sci 2020 (accepted)

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DAVID J. LUNDY : Cell therapy and extracellular vesicles

David J. Lundy, Ph.D.,
Associate Professor

Major Research Aims

Ischaemic diseases, such as myocardial infarction (heart attack), represent a major health challenge worldwide. Our lab is dedicated to advancing cell-based and biomaterial-based therapies to address these critical health issues. In particular, we explore the potential of extracellular vesicles (EVs), also known as exosomes, derived from human stem cells, blood serum, and platelets, as innovative treatments for conditions like myocardial infarction and kidney ischaemia. We are passionate about understanding how the origin of these EVs influences their cargo and, consequently, their therapeutic potential. Our investigations revolve around harnessing these tiny biological messengers to stimulate the growth of new blood vessels (angiogenesis), modulate the immune response (immunomodulation), and control cell death (apoptosis) in response to injury. To enhance their effectiveness, we are also exploring the synergy of EVs with biomaterials to extend their therapeutic activity. By combining cutting-edge science with practical applications, our research holds the promise of improving the lives of those affected by ischaemic diseases.

Research achievements:

1. Biomaterial and transplanted stem cells for paracrine, EV-based, therapy of critical limb ischaemia and myocardial infarction (Fig 1). Cell encapsulation improved retention and therapeutic efficacy of transplanted stem cells.
2. Assessing cardioprotective activities and mechanisms of action of EVs derived from human cardiac stromal cells on hypoxic human cardiomyocytes (Fig 2). The EVs increased cardiomyocyte responses to oxidative stress and greatly improved their survival.
3. Human platelet-derived EVs (SCPL-EVs) for treatment of myocardial ischaemia/reperfusion injury (Fig 3). SCPL-EVs greatly improved cardiac ejection fraction % and reduced scar formation.

Representative Figures

1. Biomaterial for cardiac stromal cell encapsulation

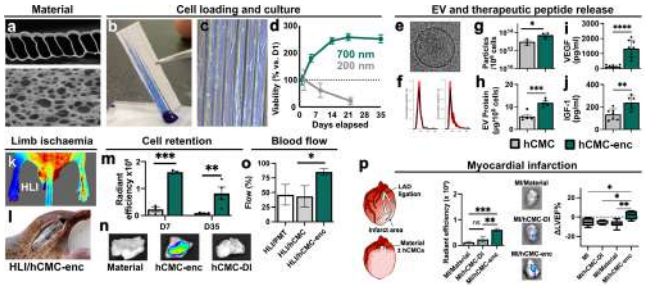

Figure 1. Stem cells cultured in a PLLA:PLGA scaffold show sustained high viability (a-d) and EV release (e-j). The scaffold extends cell survival *in vivo*, and promote recovery after limb ischaemia (k-o) and myocardial infarction (p).

2. Evaluating EVs secreted by human cardiac stromal cells

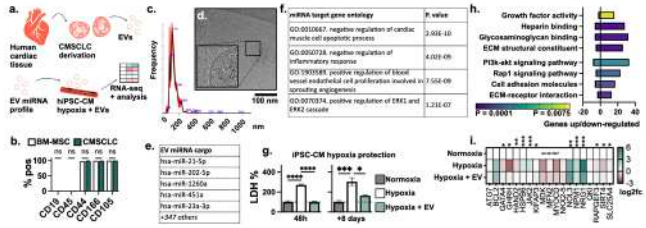

Figure 2. Stromal cells from human cardiac waste tissues (a-b) were analysed for EV secretion (c-d), EV microRNA cargo (e-f) and their ability to protect hypoxic cardiomyocytes from injury (g). Downstream pathways were then analysed (h-i).

3. Exploration of human platelet EVs for myocardial infarction therapy

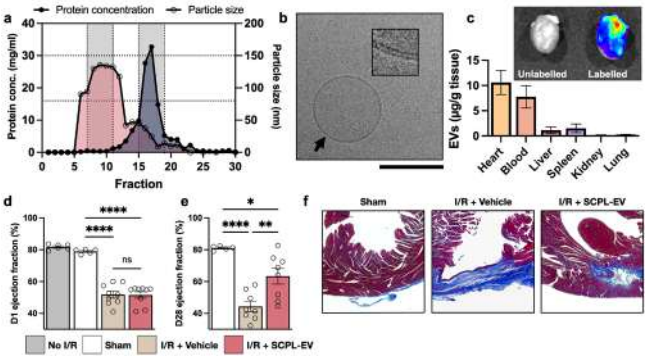

Figure 3. Human platelet-derived EVs (SCPL-EVs) were isolated by size-exclusion chromatography (a) and confirmed by cryoEM (b). After injection in mice, SCPL-EVs could be up-taken by the myocardial ischaemia/reperfusion-injured heart (c) where they significantly improved cardiac function after 28 days (d,e) and reduced scar formation (f).

Key publications:

1. Czosseck et. al., 2023.* Abstract P3162; Evaluating Cargo And Cardioprotective Effects Of Extracellular Vesicles From Human Right Atrial Appendage Mesenchymal Cells. **Circulation Research**
2. James & Liao et. al., 2023.* Assessment of circulating extracellular vesicles from calorie restricted mice and humans in ischaemic injury models. **Journal of Extracellular Biology**
3. Nguyen et. al., 2023.* Degradable biocompatible porous microtube scaffold for extended donor cell survival and activity. **ACS Biomaterials Science & Engineering**
4. Czosseck A et. al., 2022.* Porous scaffold for mesenchymal cell encapsulation and exosome-based therapy of ischemic diseases. **Journal of Controlled Release**
5. Cheng YY, Gregorich Z, Prajnamitra RP, Lundy DJ et. al., 2022. Metabolic Changes Associated with Cardiomyocyte Dedifferentiation Enable Adult Mammalian Cardiac Regeneration. **Circulation**
5. Chen, SL, Lundy DJ et. al., 2022. The gut microbiota regulates acute foreign body reaction and tissue repair after biomaterial implantation. **Biomaterials**

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JEN-CHANG YANG RESEARCH TEAM : Dental Materials & Medical Devices

Jen-Chang Yang, Ph.D., Professor

Major Research Aims

The Graduate Institute of Nanomedicine and Medical Engineering (GINME) aims to focus on translational researches on addressing unmet clinical needs through innovations and advances in nanotechnologies. Nanomaterials for medical devices as well as the nanotechnology based diagnostics are two major focused areas of GINME. The implementation of nanomaterials into medical device applications and long-term translational research toward clinical trials will be the main tasks. My personal interested fields are the dental materials and medical devices toward preventive and minimum invasive medical applications. Bio-inspired and digital design (MGI+AI) driven silk protein fibers in design, synthesis, fabrication for translational researches are under development for new applications.

Major Achievements

1. **Fast-setting Root Canal Filling Materials**

   Root canal therapy is a common dental procedure to treat the inside of the tooth. Endodontic treatment is necessary when the pulp becomes inflamed or infected. Mineral trioxide aggregate (MTA) has been successfully used in multifaceted endodontic applications such as root end filling, apexification, pulpotomy, and vital pulp therapy because of its unique biocompatibility, antibacterial nature, sealability, and its capacity to promote hard tissue formation. However, MTA is difficult to use for practitioners because of its properties of granular consistency, slow setting time, and initial looseness. The SavDen® MTA developed at TMU using a proprietary dual-function additive resulting in a fast setting, cement based filling material.

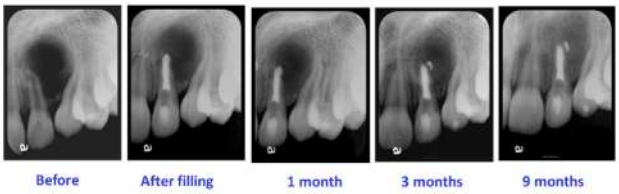

Figure 1.

The clinical efficacy of SavDen MTA for rood canal filling materials developed in TMU.

2. **Bio-inspired and digital design (MGI+AI) driven silk protein fibers in design, synthesis, fabrication for translational researches**

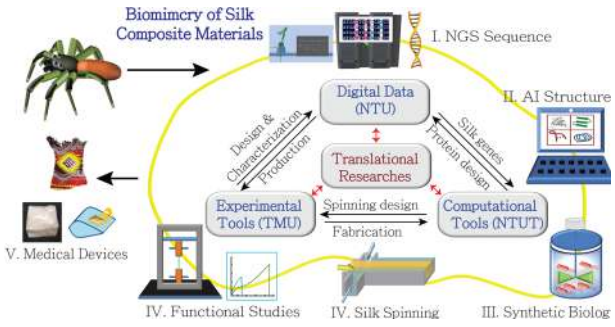

Figure 2.

The Framework for Spider Silk Integrated Project.

3. **Long Lasting (CLP) Based Desensitizing Agent**

   Dentinal hypersensitivity (DH) has been researched extensively due to its widespread prevalence and is a painful oral health problem that affects many individuals. To take advantages of remineralizing agents as a desensitizing agent, calcium lactate phosphate (CLP), a soluble calcium salt of calcium oxide, lactic acid, and phospheric acid, was developed in our laboratory. Figure 1 showed that using CLP pastes as desensitizing agents offers good prospects for instant and 14 days constant-increasing dentinal tubule occlusion. The newly developed CLP paste may be a good alternative treatment for dentin hypersensitivity relief.

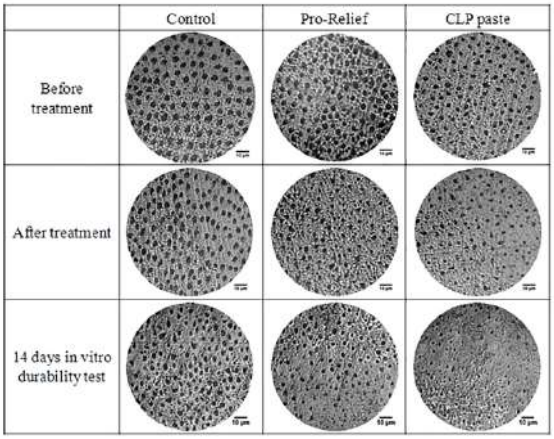

Figure 3.

The optical micrographs of occlusal dentin disk surface pre-treatment, immediately post-treatment, and 14 days post-treatment of various desensitizing pastes.

Major Publications

1. Pandey, A.; Yang, T.-S.; Yang, T.-I.; Belem, W.F.; Teng, N.-C.; Chen, I.-W.; Huang, C.-S.; Kareiva, A.; Yang, J.-C*. An Insight into Nano Silver Fluoride-Coated Silk Fibroin Bioinspired Membrane Properties for Guided Tissue Regeneration. Polymers 2021, 13, 2659. (IF = 3.426, 18%)

2. Pandey A, Yang TS, Cheng SL, Huang CS, Brangule A, Kareiva A, and Yang JC*. A Novel One-pot Synthesis and Characterization of Silk Fibroin/□-Calcium Sulfate Hemihydrate for Bone Regeneration. Polymers 2021, 13, 1996. (IF = 3.426, 18%)

3. L. Sinusaite, A. Popov, E.R. Svirbutaviciene, J.C. Yang, A. Kareiva, A. Zarkov, Effect of Mn doping on hydrolysis of low-temperature synthesized metastable alpha-tricalcium phosphate, Ceramics International, 2021, in press. [IF = 3.830, 7.1%]

4. H.C. Wu, A. Pandey, L.Y. Chang, C.Y. Hsu, Thomas C.K. Yang, I.M. Tso, H.S. Sheu, J.C. Yang. Hydrothermal Effect on Spider Silk Spidroin Properties of Nephila pilipes. Polymers-BASEL 12(5):1013, 2020, (IF = 3.426/18.0%).

5. A. Pandey, C.L. Kuo, C.J. Liang, L.Y. Chang, C.Y. Hsu, S.Y. Lee, N.C. Teng, J.C. Yang*. 3D Pore-Interconnected Calcium Phosphate Bone Blocks for Bone Tissue Engineering. Ceramic International. March 25, 2020, Vol 46 (10), Part B, Pages 16465-16471, 2020 (3.450/7.1%)

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JIUNN-HORNG KANG : Artificial Intelligence in Medicine, Assistive Technology and Neuromodulation

Jiunn-Horng Kang
M.D.,M.Sc.,Ph.D, Professor

Major Research Aims

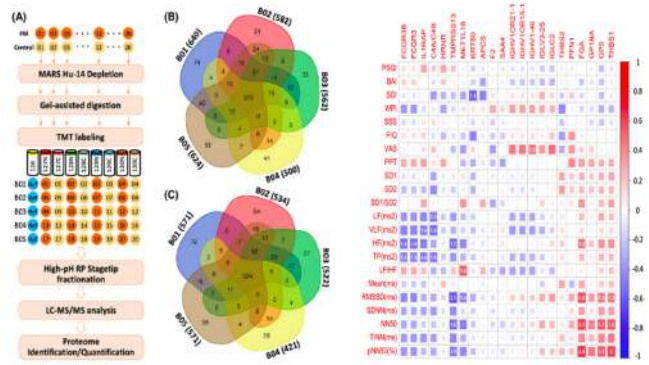
Dr. Jiunn-Horng Kang is a consultant physician in the Department of Physical Medicine and Rehabilitation at Taipei Medical University Hospital. He serves as a professor in the School of Medicine and holds the position of dean at the College of Biomedical Engineering, Taipei Medical University. Dr. Kang has a rich history of leadership, both in the past and presently. He is the Vice CEO of the Lien I-Nan Promotion of Rehabilitation Medicine and Education, the Vice director of the TMU Research Center for Artificial Intelligence in Medicine, and the director of Pain Disorders at the Taipei Neuroscience Institute. Furthermore, he is an esteemed committee member of the Taiwan Academy of Neurorehabilitation.
Dr. Kang's research is focused on exploring biomarkers and AI-based assessment tools and management strategies for chronic pain patients. Additionally, he actively contributes to the development of new devices for non-invasive brain stimulation in clinical pain disorders.

Major Fields

1. AI-assisted biomarkers discovery for chronic pain
2. Functional connectivity analysis and AI-based neuroimage classification for fibromyalgia
3. Non-invasive brain neuromodulation for pain intervention

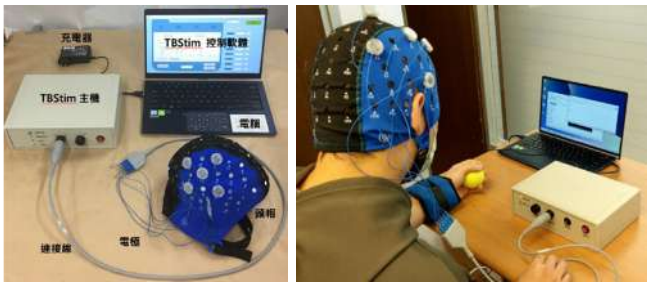
Representative Figures

1. **To investigate the proteomics profiles in the serum of fibromyalgia (FM) patients**



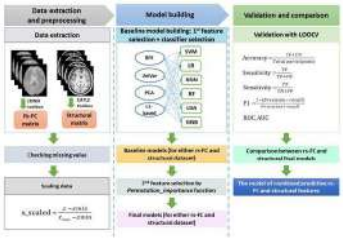
- Patients with FM have differential serum proteomics pattern compared with healthy pain-free controls
- Combining the levels of METTL18, IGLV3-25, IL1RAP, and IGHV1OR21-1 can successfully differentiate FM patients from healthy pain-free controls.
- Differentially expressed proteins may serve as potential biomarkers for diagnosis and clinical evaluation of FM in the future.

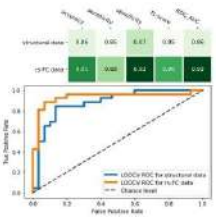
2. **Effects of high-definition transcranial electrical stimulation in patients with fibromyalgia**



- Intervention in patients with fibromyalgia under repetitive transcranial magnetic stimulation and transcranial direct current stimulation

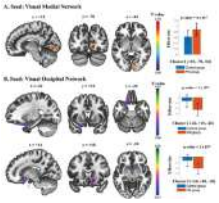
3. **To investigate whether functional connectivity and structural features with machine learning approaches could be used to classify fibromyalgia from a healthy population or not.**





- Applications of feature selection methods and machine learning algorithms on functional connectivity and structural features measured by MRI to classify fibromyalgia patients from healthy controls.

4. **To examine the associations between the neural visual networks and fibromyalgia pathomechanisms by evaluating the changes in functions and structures of the visual neural networks**



- Functional connectivity from the visual networks to several brain regions was changed in fibromyalgia patients compared to healthy controls.

Major Publications

1. Han CL, Sheng YC, Wang SY, Chen YH, Kang JH*.(2020, Jul) Serum proteome profiles revealed dysregulated proteins and mechanisms associated with fibromyalgia syndrome in women. Sci Rep. 2020 Jul 23;10(1):12347.

2. Huang YD, Li W, Chou YL, Hung ES, Kang JH*. (2021, July) Pendulum test in chronic hemiplegic stroke population: additional ambulatory information beyond spasticity. Sci Rep. 2021 Jul 20;11(1):14769.

3. Lin AP, Chiu CC, Chen SC, Huang YJ, Lai CH, Kang JH*. (2022,Aug)Using High-Definition Transcranial Alternating Current Stimulation to Treat Patients with Fibromyalgia: A Randomized Double-Blinded Controlled Study.Life (Basel). 2022 Aug 31;12(9):1364.

4. Nhu NT, Chen DY, Kang JH*. (2023, May)Functional Connectivity and Structural Signatures of the Visual Cortical System in Fibromyalgia: A Magnetic Resonance Imaging Study. J Rheumatol. 2023 Aug;50(8):1063-1070.

5. Thanh Nhu N, Chen DY, Kang JH*. (2022, Nov)Identification of Resting-State Network Functional Connectivity and Brain Structural Signatures in Fibromyalgia Using a Machine Learning Approach. Biomedicines. 2022; 10(12):3002.

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YI-PING CHEN : NANO THERANOSTICS

Yi-Ping Chen, Ph.D.,
Associate Professor

Major Research Aims

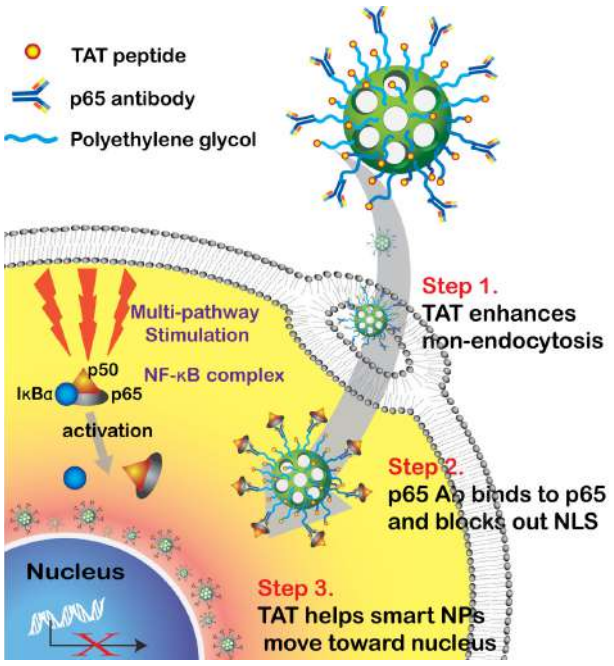
Multifunctional mesoporous silica nanoparticle (MSN) has become a promising and widely applicable platform for different biomedical applications on bioimaging, biosensing, drug delivery, and so on. Our groups aim to design an ideal MSN for use in vivo to achieve the characteristics of biocompatible, stability, and not accumulate in organs after administration. Our research interests lie in the nanoscale therapeutics and diagnostics focused on the approach to deliver protein or antibody into cells using silica nanoparticle strategies for enzyme replacement therapy (ERT) and targeting therapy. The results include: (1) denatured proteins conjugated onto MSN are capable of refolding and enhancing delivery efficiency because of decreasing steric hindrance, followed by an activation of enzyme that triggers a cascade reaction, leading it to prevent ROS induced cell death; (2) a MSN-antibody complex is employed to catch the Rel protein (NF-κB p65) in perinuclear region thus blocking the translocation near the nuclear pore gate because the size of the p65 bound nanoparticle becomes too big to enter nucleus. We expect our studies would push the nano carrier into preclinical, as well as attempt to address the current developmental and therapeutic challenges.

Major Achievements

1. Developed biocompatible and therapeutic MSN applied in medicine, especially in cancer and neurodegenerative disease.
2. Investigated enzyme replacement therapy (ERT) using MSN-based protein delivery strategies .
3. Designed MSN as a smart antibody-targeting nanoparticle to block nuclear translocation of the activated NF- κB p65 for cancer therapy
4. Conjugated biological peptides onto MSN, which enhanced tumor targeting, intracellular uptake, and lysosomal targeting.

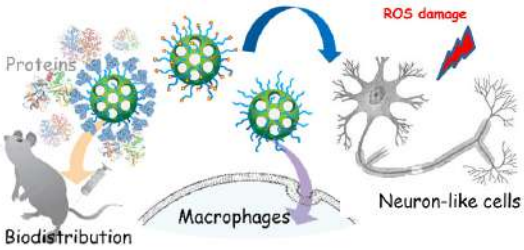
Representative Figures

1.



1. Catcher in the Rel: Nanoparticles-antibody conjugate as NF-κB nuclear translocation blocker.
2. Impacts of protein corona on biological effects of mesoporous silica nanoparticles.
3. Peptide-mediated delivery of pH-sensing mesoporous silica nanoparticles into lysosome in living cells.

2.



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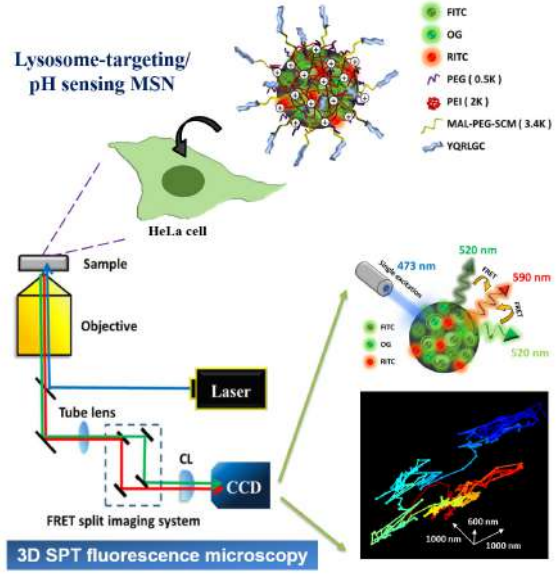

Major Publications

1. Chen YP, Chen CT, Hung Y, et al. A new strategy for intracellular delivery of enzyme using mesoporous silica nanoparticles: superoxide dismutase. J. Am. Chem. Soc. 2013; 135, 1516-23.
2. Chen YP, Wu CH, Wu SH, et al. Enhanced non-endocytosis cellular uptake of medium-size mesoporous silica nanoparticles by shortening the peptide transporter arginine side chain. ACS Appl. Mater. Interfaces 2013; 5, 12244–48.
3. Chang FP, Chen YP, and Mou CY. Intracellular implantation of enzymes in hollow silica nanospheres for protein therapy: cascade system of superoxide dismutase and catalase. Small 2014; 10, 4785-95.
4. Lin YH, Chen YP*, Liu TP, et al. Approach to deliver two antioxidant enzymes with mesoporous silica nanoparticles into cells. ACS Appl. Mater. Interfaces 2016; 8, 17944-54.
5. Chen YP, Wu SH, Chen IC, et al. Impacts of crosslinkers on biological effects of mesoporous silica nanoparticles. ACS Appl. Mater. Interfaces 2017; 9, 10254-265.

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TSUNG-RONG KUO : NANOMATERIALS & NANOTECHNOLOGY

Tsung-Rong Kuo, Ph.D., Professor

Major Research Aims

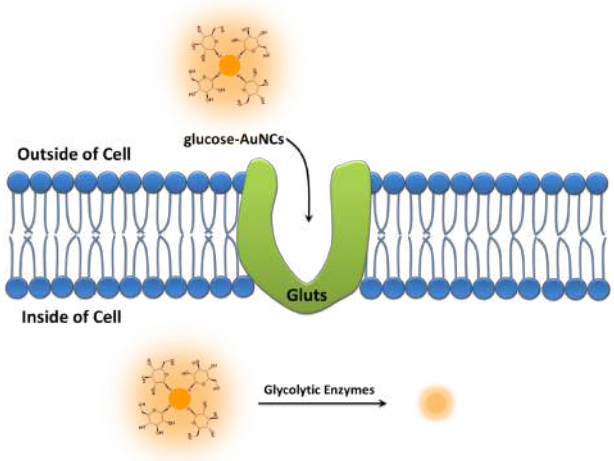
The metabolic mechanism of nanomaterials in bacteria is crucial for evaluating the antibacterial efficacy of nanomaterial-based antibacterial agents. In our research team, we have developed metal nanoclusters to study their metabolic mechanisms and antibacterial activity in bacteria. We investigated the metabolic kinetics of these metal nanoclusters by monitoring their fluorescence changes in bacteria. Additionally, a better understanding of the metabolic mechanisms of metal nanoclusters in bacteria can help us design high-performance photosynthetic biohybrid systems (PBSs). Therefore, in our research team, we have also investigated PBSs that use metal nanoclusters and bacteria. These systems are applied to harvest solar energy and then convert that energy into CO2-derived chemicals by leveraging the metabolic pathways in living organisms. Ultimately, our goal is to develop a practical PBS that utilizes metal nanoclusters and bacteria.

Major Achievements

1. Quantitative analysis of glucose metabolic cleavage in glucose transporters overexpressed cancer cells by target-specific fluorescent gold nanoclusters.
2. Metabolic mechanism investigation of antibacterial active cysteine-conjugated gold nanoclusters in *Escherichia coli*.
3. Light-activated heterostructured nanomaterials for antibacterial applications.
4. Development of high-performance artificial photosynthetic biohybrid systems based on metal nanoclusters and bacteria.

Representative Figures

1.



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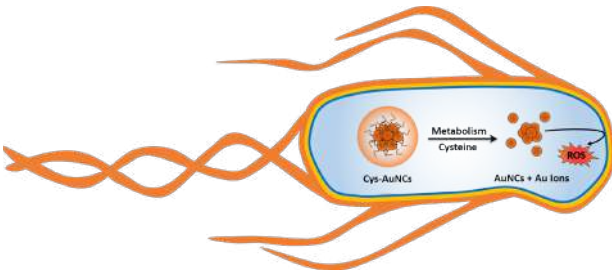

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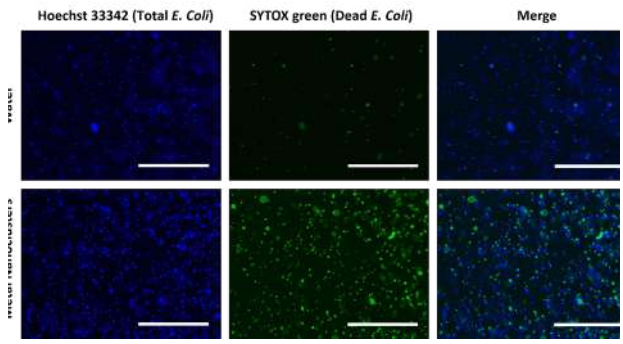

1. Schematic illustration of glucose conjugated gold nanoclusters as a fluorescent probe for glucose transporters overexpressed cancer cells.
2. Schematic illustration of the metabolism of cysteine conjugated gold nanoclusters in E. coli and the significant intracellular ROS generation induced by the nanoclusters to kill E. coli due to lack of reactive oxygen species scavenger of cysteine.
3. Fluorescence images of cysteine conjugated gold nanoclusters incubation with E. coli. The blue and green pseudocolors represent the fluorescent signals of total E. coli (stained with Hoechst 33342) and dead E. coli (stained with SYTOX green), respectively. With incubation of water, no significant E. coli death was observed in the fluorescence image. In comparison with incubation of cysteine conjugated gold nanoclusters, drastic death of E. coli was revealed in the fluorescence image.

Major Publications

1. Chang TK, Cheng TM, Chu HL, et al. Metabolic Mechanism Investigation of Antibacterial Active Cysteine-Conjugated Gold Nanoclusters in Escherichia coli. ACS Sustain. Chem Eng 2019; 7: 15479-15486.
2. Cheng TM, Chu HL, Lee YC, et al. Quantitative Analysis of Glucose Metabolic Cleavage in Glucose Transporters Overexpressed Cancer Cells by Target-Specific Fluorescent Gold Nanoclusters. Anal Chem 2018; 90:3974-3980.
3. Tung CW, Kuo TR, Hsu CS,et al. Light-Induced Activation of Adaptive Junction for Efficient Solar-Driven Oxygen Evolution: In Situ Unraveling the Interfacial Metal-Silicon Junction. Adv Energy Mater 2019; 9: 1901308.
4. Kuo TR, Lee YC, Chou HL, et al. Plasmon-Enhanced Hydrogen Evolution on Specific Facet of Silver Nanocrystals. Chem Mater 2019; 31:3722-3728.
5. Kuo TR, Liao HJ, Chen YT, et al. Extended visible to near-infrared harvesting of earth-abundant FeS2-TiO2 heterostructures for highly active photocatalytic hydrogen evolution. Green Chem 2018; 20:1640-1647.

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SI-HAN WU : HYBRID SILICA

Si-Han Wu, Ph.D.,
Associate Professor

Major Research Aims

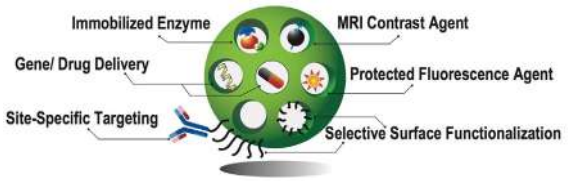
Nanomedicine holds great promise for integrating therapeutics with nanocarriers to improve cancer treatment. However, a recent review published in Nature Reviews Materials emphasized that only 0.7% (median) of a systemically administered dose of nanoparticle-based drugs reaches the tumor, and targeting efficiency has not improved over the past decade. Additionally, hypoxia plays a crucial role in tumor progression, leading to resistance to cancer therapy. Therefore, addressing these challenges one at a time is insufficient to advance the field of nanomedicine. Mesoporous and hollow silica nanoparticles (MSN/HSN) offer exciting opportunities for efficient and cell-specific delivery of proteins, enzymes, and anti-cancer drugs to improve disease treatment. Despite promising in vitro results, such as enhanced uptake, intracellular processing, and efficacy, the practical applications of MSN/HSN are often limited due to issues like poor stability, aggregation, and short in vivo circulation lifetimes in biological environments. Our research aims to elucidate the relationship between the composition of synthetic materials and physiological responses. We focus on developing clinically translatable MSN/HSN-based nanomedicine to target and eliminate hypoxic tumor cells.

Major Achievements

1. The first report on directly injecting MSN into mice and visualizing the in vivo localization of MSN via MRI.
2. The first report on utilizing a microemulsion system to fabricate uniform HSN, capable of encapsulating both organic and inorganic materials for biological and catalytic reactions.
3. Investigation of the effects of MSN size, charge, and cross-linkers on biological responses in cells, zebrafish, and mice.
4. Development of compartmentalized HSN for encapsulating both hydrophobic and hydrophilic molecules.
5. Development of highly dispersed PEGylated silica nanoparticles in physiological media to enhance tumor targeting.

Representative Figures

1.



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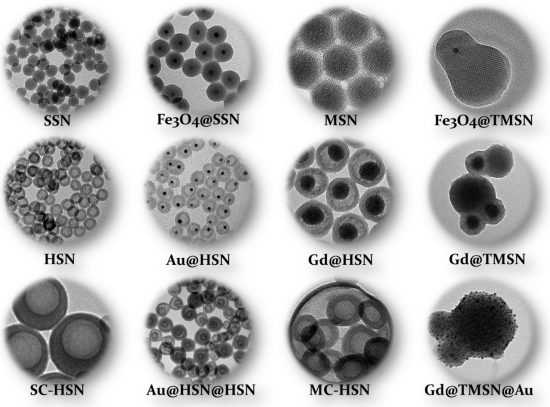

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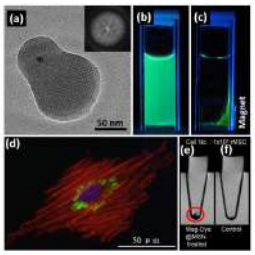

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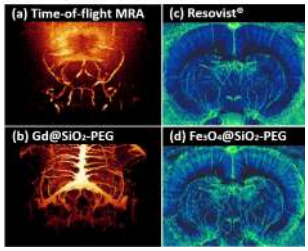

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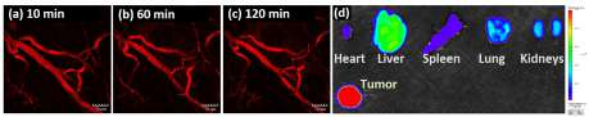

1. Biological applications of porous silica nano-platform.
2. TEM images of various hybrid silica nanoparticles.
3. (a) TEM and (b) photographs of Mag-Dye@MSN after UV-light irradiation and (c) magnetic capture; (d) confocal image of Mag-Dye@MSN in rMSC cells; (e-f) T2-weighted MR images of rMSC.
4. (a) Time-of-flight magnetic resonance angiography (MRA) images of vasculature in rat brains; (b) contrast-enhanced MRA with Gd@SiO2-PEG; (c) volume rendering 3DΔR2-mMRA of Resovist® and (d) Fe3O4@SiO2-PEG.
5. (a-c) Time-dependent two-photon fluorescent images of PEGylated MSN in blood circulation; (d) Ex vivo IVIS images 24h post-injections of PEGylated MSN into a tumor-bearing mouse.

Major Publications

1. Wu SH, Hung Y, Mou CY. Mesoporous Silica Nanoparticles as Nanocarriers. Chem. Commun. 2011, 47, 9972-9985.
2. Wu SH, Hung Y, Mou CY. Compartmentalized Hollow Silica Nanospheres Templated from Nanoemulsions. Chem. Mater. 2013, 25, 352-364.
3. Wu SH, MouCY, Lin HP. Synthesis of Mesoporous Silica Nanoparticles. Chem. Soc. Rev. 2013, 42, 3862-3875.
4. Liu TP, Wu SH, Chen YP, Chou CM, Chen CT. Biosafety Evaluations of Well-Dispersed Mesoporous Silica Nanoparticles: Towards in Vivo-Relevant Conditions. Nanoscale, 2015, 7, 6471-6480.
5. Chen YP, Wu SH, Chen IC, Chen CT. Impacts of Cross-Linkers on Biological Effects of Mesoporous Silica Nanoparticles. ACS Appl. Mater. Inter. 2017, 9, 10254–10265. (*co-first author)

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CHIH-HSIN (MELODY) LIN : TISSUE ENGINEERING

Chih-Hsin Lin,Ph.D.,
Assistant Professor

Major Research Aims

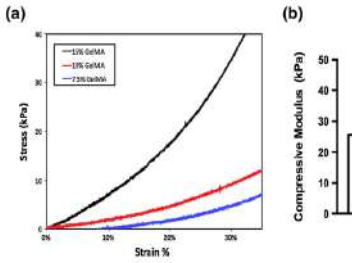
Although there are many drug screening methods, only very few drugs meet the requirements set by the US Food & Drug Administration for clinical use. Many previous studies have attempted to develop a platform for drug screening but provided limited information due to the difficulty of mimicking real human tissue and the human tissue's response to drugs. Here, we propose using 3D bioprinting technology to fabricate a 3D engineered liver tissue construct with integrated functional vessels for drug discovery applications. Using this new approach, the timeframe for drug discovery can be shortened, and we can better predict human tissue responses. Creating an effective drug screening platform will likely have a significant positive impact and help accelerate new drug discovery. This work has great potential to provide a useful method that can mimic realistic human liver tissue, enabling high-throughput drug library screening or chemical compound screening and, in the future, for transplantation.

Major Achievements

1. Creating a 3D culture system for endothelial differentiation from bone marrow mesenchymal stem cells using a new light-cured gelatin methacrylate (GelMA) hydrogel for bioprinting, with applications in dental clinical settings.
2. Fabricating liver tissue with integrated vasculature by combining bioprinting and liver tissue slices to develop a high-throughput system for drug screening.
3. Using a 3D printed gelatin scaffold with adipose stem cells and endothelial colony-forming cells, in combination with negative pressure, to create vascularized adipose tissue.

Representative Figures

1.



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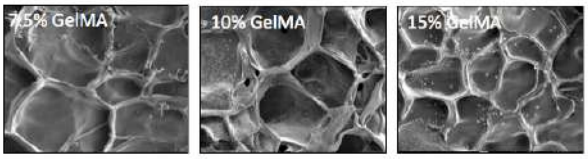

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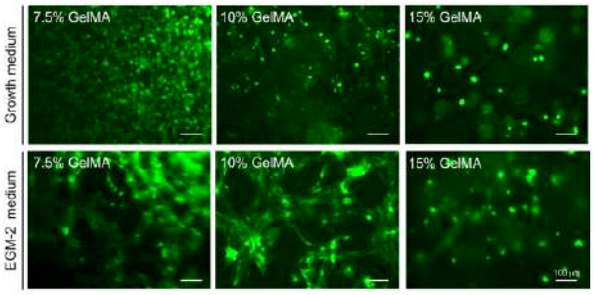

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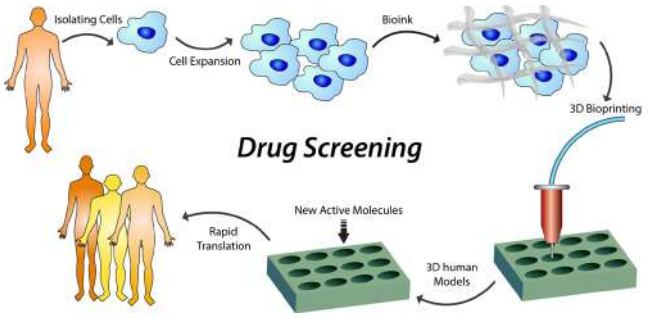

1. Mechanical properties of GelMA at different concentrations. Stress-strain curves (a) and compressive modulus (b) for 7.5%, 10%, and 15% (w/v) GelMA.
2. Electron microscope images of freeze-dried GelMA hydrogel surfaces at different concentrations (7/5%, 10%, and 15%).
3. Fluorescent images of LIVE/DEAD assays of MSCs photoencapsulated using either growth medium or EGM-2 and different GelMA concentrations (7/5%, 10%, and 15%).
4. Scheme of 3D printed liver tissue with integrated vasculature for drug screening application.

Major Publications

1. Lim J, Bupphathong S, Huang W, Lin CH*. 3D bioprinting of biocompatible photosensitive polymers for Tissue Engineering Application. Tissue Eng. Part B Rev 2023.
2. Shi YH#, Lin CH#, Reker D#, Steiger C, Hess K, Joy C, Tamang S, Lopes A, Wainer J, Hayward A, Walesky C, Goessling W, Traverso G. Machine Learning and Tissue Engineering for the Development of Functional Formulations to Prevent Adverse Drug Metabolism. bioRxiv 2022. (#Equal contributions)
3. Bupphathong S, Quiroz C, Huang W, Chung PF, Tao HY, Lin CH*. Gelatin Methacrylate Hydrogel for Tissue Engineering Applications – a Review on Material Modifications. Pharmaceuticals 2022; 15:171.
4. Chiang CL, Cheng MH, Lin CH*. From Nanoparticle to Cancer Nanomedicine: Old Problems with New Solutions. Nanomaterials 2021; 11:1727.
5. Lin CH, Lin YM, Chen CY, et al. Mechanical property, accuracy and cytotoxicity of the UV-cured 3D printing resins composed of BisEMA, UDMA and/or TEGDMA. J Prosthet Dent 2019; 123: 349-354.
6. Lin CH, Su Jimmy, Lee SY, et al. Stiffness modification of photopolymerizable gelatin-methacrylate hydrogels influences endothelial differentiation of human mesenchymal stem cells. J Tissue Eng Regen Med 2018; 1-13.
7. Lin CH, Lin LH, Chang MC, et al. Bioactive surface modification of polycaprolactone using MG63-conditioned medium can induce osteogenic differentiation of mesenchymal stem cells. J Mater Sci 2017; 52: 3967-3978

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TZU-SEN YANG : 5206 MOLECULAR DYNAMICS LABORATORY

Tzu-Sen Yang, Ph.D.,
Associate Professor

Major Research Aims

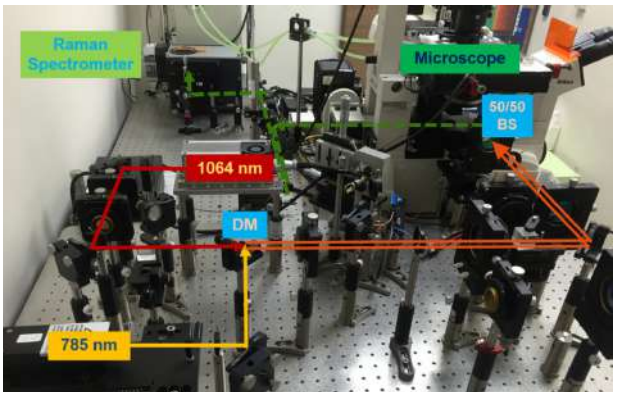
Probing the structure, dynamics, and mechanisms of live-cell systems is fundamental to gaining a quantitative understanding of how biological systems function. Recently, single-molecule techniques, including optical tweezers and single-molecule fluorescence microscopy, have become widely used for applications in living cells. Additionally, the surface functionalization and bioconjugation of nanoparticles, such as quantum dots, silver nanoparticles, and gold nanoparticles, hold great promise for various biomedical applications, including imaging, therapeutics, and diagnostics. We have developed a versatile biophotonics platform at the single-cell level, which combines optical tweezers, single-molecule fluorescence detection, a temperature control system, microfluidics, micro-scale surface-enhanced Raman spectroscopy (μSERS), and laser-assisted cell printing techniques. With this integrated system, we have conducted experiments to visualize the effects of the EGFR tyrosine kinase inhibitor PD153035 on cell locomotion, investigate amphotericin B-induced permeability changes across ergosterol-containing membranes, study the disinfection effects of silver-doped ceria nanoparticles, and utilize a combination of photothermal and surface-enhanced Raman spectroscopy using gold nanoparticles.

Major Achievements

1. Single-molecule dynamics of DNA-drug interactions.
2. Disinfection effects of silver-doped ceria nanoparticles.
3. Single-cell NF-kB dynamics.
4. Effect of low level laser therapy on mitochondrial function and biphasic dose response.
5. Development of laser-assisted bioprinting techniques.

Representative Figures

1.



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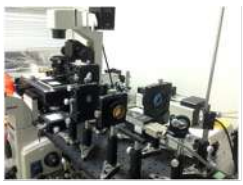
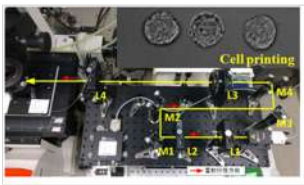
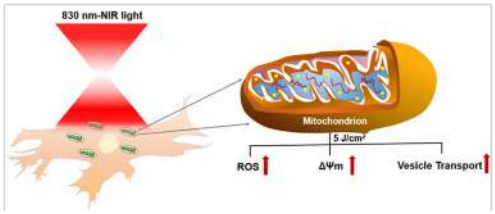
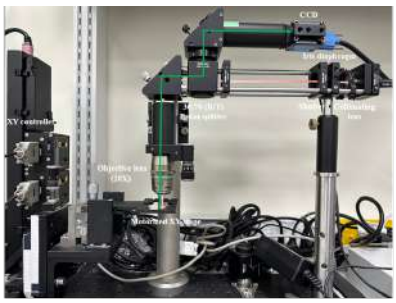


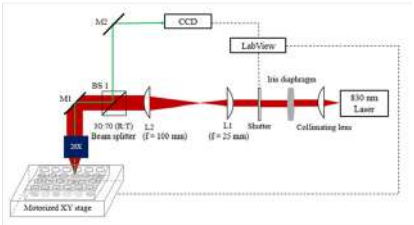




1. Platform for single-cell manipulation and detection.
2. A single-cell study of mitochondrial function during photobiomodulation and photodynamic therapy.
3. High-precision photobiomodulation and photodynamic therapy system.
4. High-precision photobiomodulation and photodynamic therapy system.

3.





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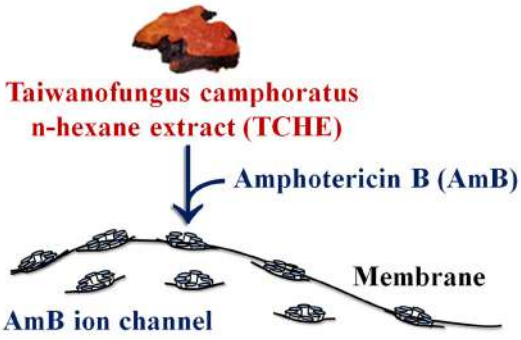

Major Publications

1. Pan L-C, Hang N-L-T, Colley MMS, Chang J, Hsiao Y-C, Lu L-S, Li B-S, Chang C-J, Yang T-S. Single Cell Effects of Photobiomodulation on Mitochondrial Membrane Potential and Reactive Oxygen Species Production in Human Adipose Mesenchymal Stem Cells. Cells. 2022; 11(6):972.
2. Gbetuwa M, Lu L-S, Wang T-J, Chen Y-J, Chiou J-F, Su T-Y, Yang T-S. Nucleus Near-Infrared (nNIR) Irradiation of Single A549 Cells Induces DNA Damage and Activates EGFR Leading to Mitochondrial Fission. Cells. 2022; 11(4):624.
3. Yang, T.-S.; Nguyen, L.-T.-H.; Hsiao, Y.-C.; Pan, L.-C.; Chang, C.-J. Biophotonic Effects of Low-Level Laser Therapy at Different Wavelengths for Potential Wound Healing. Photonics 2022, 9, 591.
4. Yang, T.-S.; Hsiao, Y.-C.; Chiang, Y.-F.; Chang, C.-J. Imaging and Histopathological Analysis of Microvascular Angiogenesis in Photodynamic Therapy for Oral Cancer. Cancers 2023, 15, 1110.
5. Chang, C. J., Hsiao, Y. C., Hang, N. L. T., & Yang, T. S. (2023). Biophotonic Effects of Low-Level Laser Therapy on Adipose-Derived Stem Cells for Soft Tissue Deficiency: WAPSCD Submission. Annals of Plastic Surgery, 10-1097.

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LI-CHERN PAN : MICROFLUIDIC BIOCHIPS

Li-Chern Pan, Ph.D.,
Associate Professor

Major Research Aims

Our lab specializes in designing and developing novel microfluidic biochips for the capture of rare biological entities, offering significant advantages over traditional centrifugation-based methods. For instance, we have successfully isolated Circulating Tumor Cells (CTCs) using a patented cell-based auto-adherence method. Additionally, we've created a high-throughput acquisition assay for sorting progressive spermatozoa. In our designs, we carefully incorporate the intrinsic physiological properties of the target biological entities into the microfluidic flow system. As a result, we can often isolate rare live cells with minimal damage to their morphology or DNA. To broaden the clinical applications of these new technologies, our laboratory has implemented FDA-compatible protocols to ensure the bio-compatibility of our glass-based biochips. This approach will enable us to bridge the gap between academic research and the commercialization of MEMS-based biochip devices.

Major Achievements

1. High Throughput Sorting of Progressive Motile Sperms from Raw Semen.
2. FDA Biocompatibility Accessibility for Microfluidic Devices.
3. Method for Auto-adherence-based Capture and Analysis of Circulating Tumor Cells.
4. Non-centrifugal Removal Method for Low Damage Blood Sample Purification.
5. Design Microfluidic Automatic Dispenser and Diagnosis Systems.

Representative Figures

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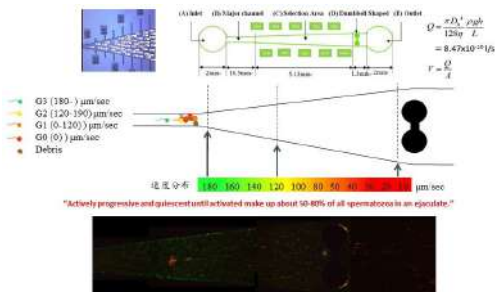
2.



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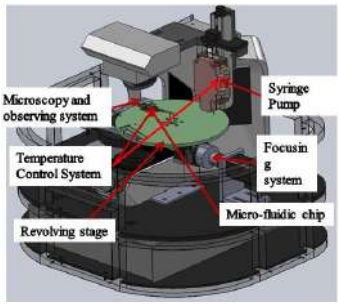


4.

***LIFESORTER* count (0 hr):**

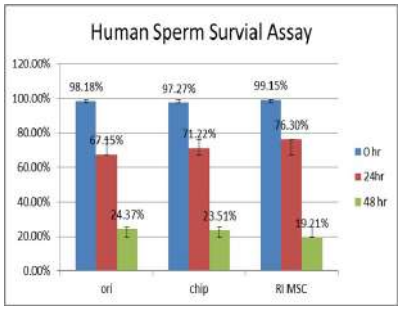
COUNT SUMMARY

Category	Cells Counted	Sample (M)	Concentration (M/ml)	Percent
Total	1770	0.0	30.3	100
Motile	1694	0.0	29.0	96
Progressive	1142	0.0	19.6	65

***LIFESORTER* count (24 hr):**

COUNT SUMMARY

Category	Cells Counted	Sample (M)	Concentration (M/ml)	Percent
Total	283	0.0	4.5	100
Motile	252	0.0	4.0	89
Progressive	233	0.0	3.7	82



Major Publications

1. Chen YC, Pan LC, Lai CW, Chien YS, Wu TH. Silymarin and protein kinase A inhibitor modulate glucose-mediated mouse sperm motility: An in vitro study. Reproductive biology 2015, 15 (3), 172-177.
2. Pan LC, Hsu FC, Yu WS, Lin YL, Tseng FG, Wang CW, Tzeng CR. Sorting of sperms with reverse progressive characteristic may provide another option for acquiring spermatozoa with significant improvement in fertility related quality for patients with oligospermia. Fertility and Sterility 2014, 102 (3), e353-e354.
3. Pan LC, Liu SY, Yen CC, Hsiu HW, Wang CW, Tzeng CR. Preliminary evaluation of methylcellulose as an alternative rate control medium for the acquiring of high quality spermatozoa in swim-up. Fertility and Sterility 2013, 100 (3), S453.

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YU-CHENG HSIAO : PHOTONICS AND SOFT MATTERS

Yu-Cheng Hsiao, Ph.D.,
Associate Professor

Major Research Aims

We specialize in biosensors and the application of photonics, materials, soft matter, and novel liquid crystal devices within the TMU research team. Additionally, we endeavor to utilize optical technology to enhance the biomedical field. Professor Hsiao's expertise lies in experimental physics related to chiral soft matter, including cholesteric and blue phase liquid crystals. The growing demand for green technology devices and biosensors has served as our inspiration. In recent years, we have experimentally demonstrated a wide range of potential applications based on cutting-edge concepts, including:

1. Bistable dual-frequency liquid crystals: Fast-switching bistable cholesteric intensity modulators.
2. Electrohydrodynamic instabilities: Polymer stabilization of electrohydrodynamic instabilities in non-iridescent cholesteric thin films.
3. Photonic crystal spectral manipulations: Electro-optical devices based on photonic structures with dual-frequency cholesteric liquid crystals.
4. Biosensors: Highly sensitive color-indicating and quantitative biosensors based on cholesteric liquid crystals.

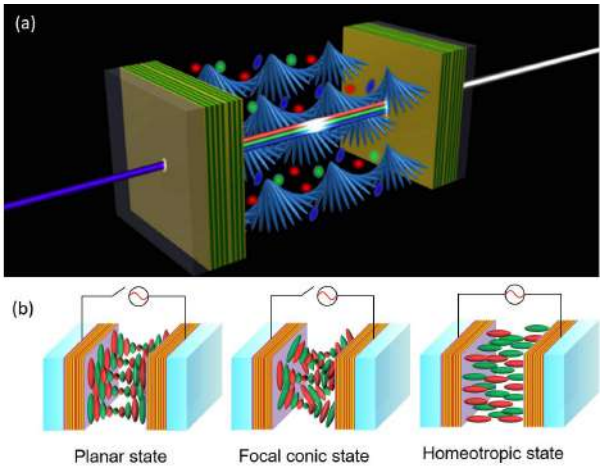
We are committed to making continued contributions to these intriguing research areas.

Major Achievements

1. Electrically switchable organo–inorganic hybrid for a white-light laser source.
2. Red, Green, and Blue Reflections Enabled in an Electrically Tunable Helical Superstructure.
3. Highly sensitive color-indicating and quantitative biosensor based on cholesteric liquid crystal.
4. Electrically active nanoantenna array enabled by varying the molecular orientation of an interfaced liquid crystal
5. Liquid crystal-based tunable photonic crystals for pulse compression and signal enhancement in multiphoton fluorescence.

Representative Figures

1.



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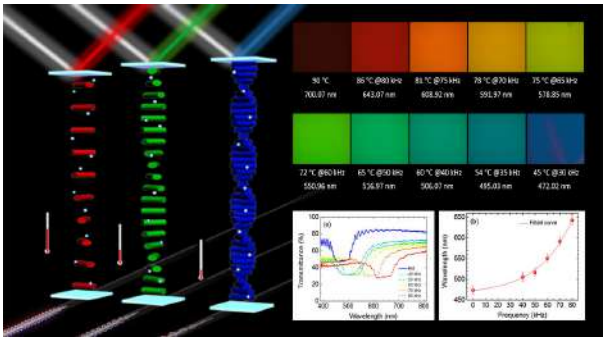

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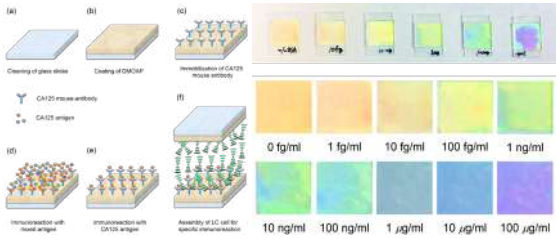

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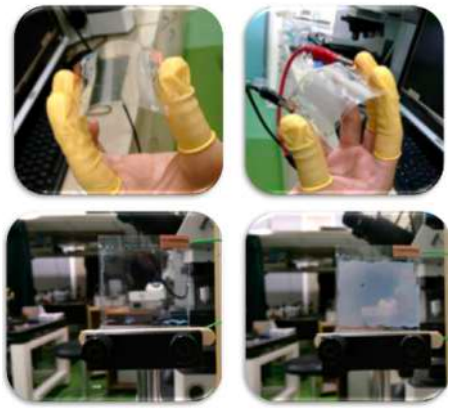

1. Schematics of (a) the CPC and (b) the corresponding configurations of the three CLC states. The red and green ellipsoids represent the dye and the LC molecules, respectively.
2. Colors of a DFTC materials derived from various frequencies at the fixed applied voltage.
3. Representative VAC cells featuring the color-indicating properties of the VAC biosensor at different BSA concentrations.
4. Photographs of the fast-switching bistable cholesteric device in the planar state and the focal conic state at null voltage.

Major Publications

1. Hsiao YC. Liquid crystal-based tunable photonic crystals for pulse compression and signal enhancement in multiphoton fluorescence. Opt. Mater. Express 2016, 6 (6), 1929-1934.
2. Hsiao YC, Su CW, Yang ZH, Cheypesh YI, Yang JH, Reshetnyak VY, Chen KP, Lee W. Electrically active nanoantenna array enabled by varying the molecular orientation of an interfaced liquid crystal. RSC Advances 2016, 6 (87), 84500-84504.
3. Hsiao YC, Sung YC, Lee MJ, Lee W. Highly sensitive color-indicating and quantitative biosensor based on cholesteric liquid crystal. Biomed. Opt. Express 2015, 6 (12), 5033-5038.
4. Hsiao YC, Yang ZH, Shen D, Lee W. Red, Green, and Blue Reflections Enabled in an Electrically Tunable Helical Superstructure. Advanced Optical Materials 2018, 6 (5), 1701128.
5. Huang JC, Hsiao YC, Lin YT, Lee CR, Lee W. Electrically switchable organo–inorganic hybrid for a white-light laser source. Scientific Reports 2016, 6, 28363.

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ZHAO-CHI CHEN RESEARCH TEAM :
ADVANCED LASER PROCESS AND FUNCTIONAL BIOMEDICAL DEVICE

Major Research Aims

Over the past decade, advancements in innovative process technology have opened up new possibilities for Lab-on-a-Chip systems, enabling rapid detection and increased sensitivity in the field of biomedicine. These developments have illustrated the potential for creating functional biomedical device systems. Laser ablation technology, which is a non-contact processing method, focuses high-energy-density laser beams on material surfaces. This process induces functional structural characteristics, including instantaneous dissolution and vaporization of the material. Laser ablation can be used to fabricate and extend multi-scale micro/nano functional structures with unique properties. Moreover, it allows for the customization of regional surface properties, such as hydrophilicity and hydrophobicity, making it highly advantageous for applications in biomedical microfluidics. By integrating laser-functional materials, multi-scale micro/nano structures with biomimetic properties, and microelectronic biomedical signals, we can significantly enhance the efficiency of biomolecule analysis.

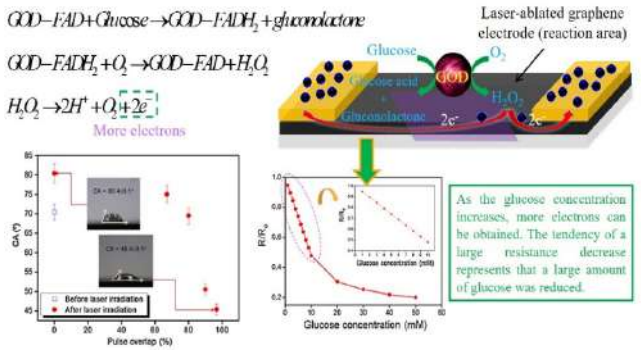
Zhao-Chi Chen, Ph.D.,
Assistant Professor

Major Achievements

1. The flexible NO gas wound sensor fabricated using graphene/silver nanoparticles stacked electrode structures.
2. The self-heating graphene reinforced polyvinyl alcohol nanowires to high-sensitivity human humidity detection.
3. Functionalized surface modification of aluminum oxide with fish-scale structures for cell culture.
4. Thermally stable and uniform DNA amplification with picosecond laser ablated graphene rapid thermal cycling device.
5. Surface patterning of multilayer graphene by ultraviolet laser irradiation in biomolecule sensing devices.

Representative Figures

1.



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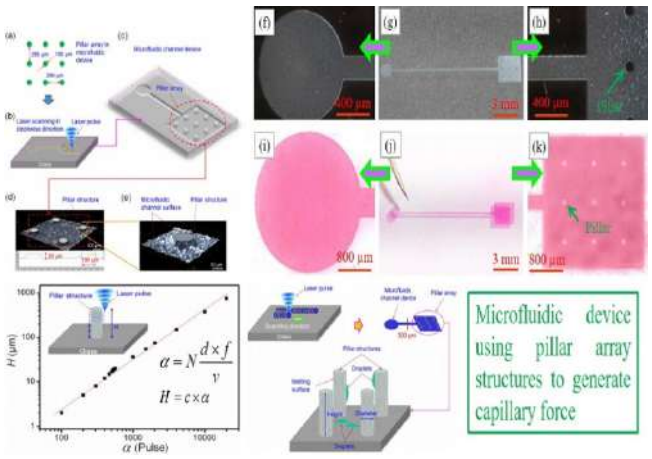

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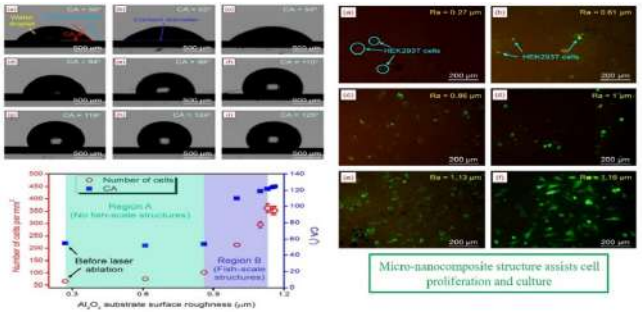

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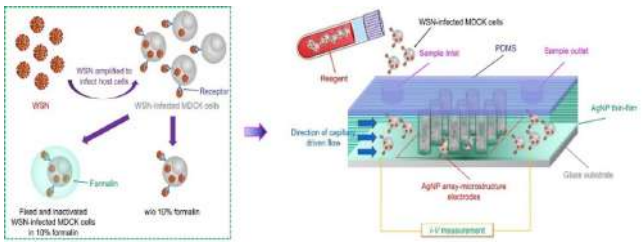

1. Laser ablation electrode for glucose detection-enzyme catalysis.
2. Capillary device with micro-pillar structures formed by laser ablation.
3. Laser ablation micro-nanocomposite structures applied in cell culture.
4. Capillary-driven rapid detection of WSN influenza virus with laser ablation.

Major Publications

1. Chen ZC, Chang TL, Liou DS, Fan JY, Wang CP. Fabrication of a bio-inspired hydrophobic thin film by glutaraldehyde crosslinking electrospun composite self-cleaning nanofibers. Mater Lett 2021; 298: 129975.
2. Chen ZC, Chang TL, Chen CH, Liou DS, Han TY, Wu QX. Flexible NO gas sensor fabricated using graphene/silver nanoparticles stacked electrode structures. Mater Lett 2021; 295:129826.
3. Chen ZC, Chang TL, Su KW, Lee HS, Wang JC. Application of self-heating graphene reinforced polyvinyl alcohol nanowires to high-sensitivity humidity detection. Sens Actuators B Chem 2021; 327: 128934.
4. Chen ZC, Chang TL, Liu CC, Hsiao WT, Huang CH. Picosecond laser surface modification of aluminum oxide with fish-scale structures for cell culture. Ceram Int 2020; 46: 17651-17658.
5. Chen ZC, Chang TL, Li CH, Su KW, Liu CC. Thermally stable and uniform DNA amplification with picosecond laser ablated graphene rapid thermal cycling device. Biosens Bioelectron 2019; 146:111581.

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Pei-Chun Wong : Integrated BioFabrication Lab

Pei-Chun Wong Ph.D.
Assistant Professor

Major Research Aims

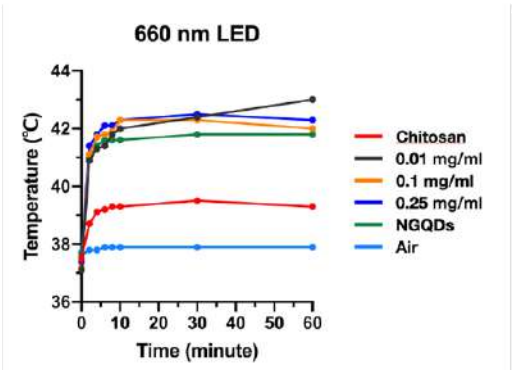
Our laboratory is dedicated to the development of functional biomedical materials to enhance regenerative medicine and biomedical sensing, with the ultimate goal of improving clinical efficiency and efficacy. In the field of tissue engineering, we combine expertise in biology, materials science, and photonics technology to create artificial tissues and organs for medical research and treatment. In the realm of biomedical materials, we conduct research to advance the flexibility, biocompatibility, and strength of biomanufacturing technology. We rigorously test these materials in both cells and animals to ensure they meet the necessary application requirements. Additionally, in the field of photobiomodulation, we explore the application of phototherapy to enhance the efficiency and effectiveness of biofabrication. Our work involves studying the biological effects of light and developing novel optical technologies for use in biomanufacturing.

Major Achievements

1. Development of laser/LED-induced photothermal materials and study on tissue engineering effects
2. Using spatial light modulators for photobiological regulation and exploring its biological effects
3. Design and develop metallic, polymeric, and biomaterials to utilize tissue engineering strategies for tissue repair and regeneration
4. Using 3D printing technology and tissue engineering strategies to develop organ chips for drug screening

Representative Figures

1.



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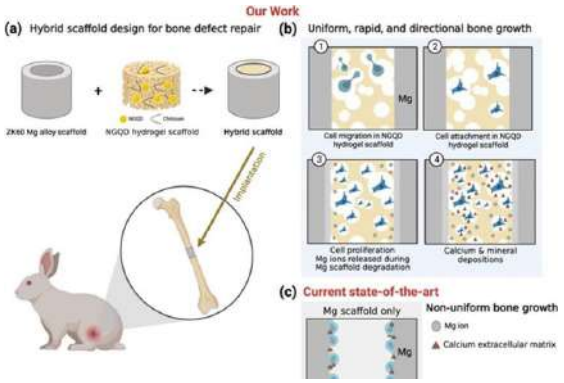

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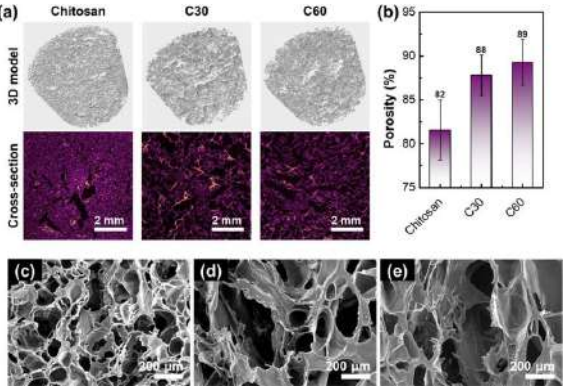

1. Temperature rises curve of different types of scaffolds after 60 minutes of 660 nm LED exposure
2. Conceptual design and key features of the hybrid NGQD–Mg alloy scaffolds for bone defect repair.
3. Structural analysis of composites scaffold. (a) Micro-CT images of composites in 3D and cross-sectional views. (b) Porosity of composites calculated from micro-CT. SEM images of scaffolds

Major Publications

1. Wong PC, Kurniawan D, Wu JL, Wang WR, Chen KH, Chen YC, Chen YC, Ostrikov KK, Chiang WH. Plasma-Enabled Graphene Quantum Dot Hydrogel Magnesium Composites as the Bioactive Scaffolds for In Vivo Bone Defect Repair. ACS Appl. Mater. Interfaces 2023; 15: 44607-44620.
2. Wong PC, Tsai PH, Maqnun MJ, Chen YC, Jang JSC. Fabrication of TiZr-based bulk metallic glass foams with different gradient porosity for biomedical applications. Mater Lett 2023; 347: 134651
3. Wong PC, Song SM, Nien YY, Wang WR, Tsai PH, Wu JL, Jang JSC. Mechanical properties enhanced by the dispersion of porous Mo particles in the biodegradable solid and bi-phase core–shell structure of Mg-based bulk metallic glass composites for applications in orthopedic implants. J Alloys Compd 2021; 877: 160233.
4. Wong PC, Fan TE, Lee YL, Lai CY, Wu JL, Chang LH, Su TY. Detection and identification of the stages of DH5-alpha Escherichia coli biofilm formation on metal by using an artificial intelligence system. Microsc Microanal 2021; 1-8.
5. Song SM, Wong PC*, Chiang CW, Tsai PH, Jang JSC*, Chen CH*. A bi-phase core–shell structure of Mg-based bulk metallic glass for application in orthopedic fixation implants. Mater Sci Eng C 2020; 111: 110783.

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YEN-LING SUNG : CARDIOVASCULAR DISEASES AND OPTICAL MAPPING

Yen-Ling Sung
Ph.D. Assistant Professor

Major Research Aims

Our research primarily focuses on cardiovascular diseases and the development of novel therapies to address pressing issues in advanced medical and biomedical technologies. One aspect of our research investigates the impact of East Asian-specific aldehyde dehydrogenase deficiency (ALDH22) on arrhythmias associated with alcohol consumption. We have observed that individuals with the ALDH2 rs671 variant who habitually consume alcohol exhibit prolonged QT intervals and an increased occurrence of ventricular tachyarrhythmias compared to habitual alcohol users without this variant. Importantly, we have identified QT prolongation and a higher risk of premature ventricular contractions in ALDH2 variant carriers who engage in light-to-moderate alcohol consumption. A mouse model with the ALDH22 variant was treated with ethanol. Our findings reveal significant alterations in connexin43 levels, sarcolemmal expression of key ion channels (Nav1.5, Kv1.4, Kv4.2), and action potential duration. Importantly, this model demonstrates a higher susceptibility to ventricular arrhythmias, including the formation of rotors when exposed to ethanol.

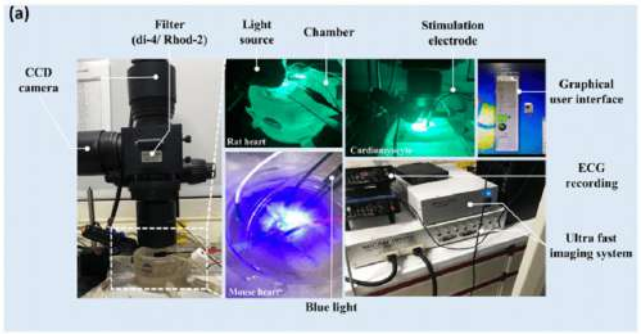
Ultimately, our research aims to contribute to the establishment of safe alcohol consumption guidelines for individuals with ALDH2 deficiency and the development of protective strategies for this population.

Major Achievements

1. Common East Asian ALDH2*2 Variant: The study identified a prevalent ALDH2*2 gene variant in East Asian populations, linked to alcohol metabolism.
2. Mild-to-Moderate Alcohol Use and Ventricular Arrhythmia: Individuals with the ALDH2*2 variant were found to have an increased risk of ventricular arrhythmia with light-to-moderate alcohol consumption.
3. Elevated Cardiac Arrhythmia Risk: Those carrying the ALDH2*2 variant faced a significantly higher risk of cardiac arrhythmia when consuming moderate amounts of alcohol.
4. Validation through Mouse Models: The study used mouse models to confirm these findings, supporting the connection between the ALDH2*2 variant and alcohol-related cardiac issues.

Representative Figures

1.



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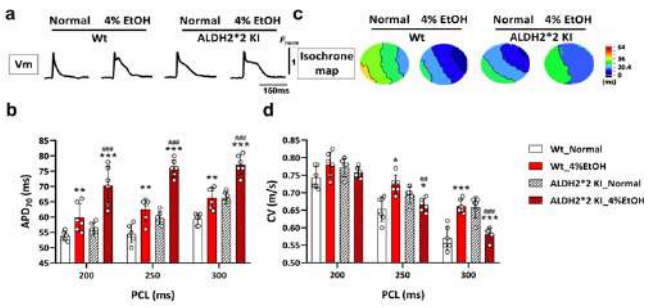

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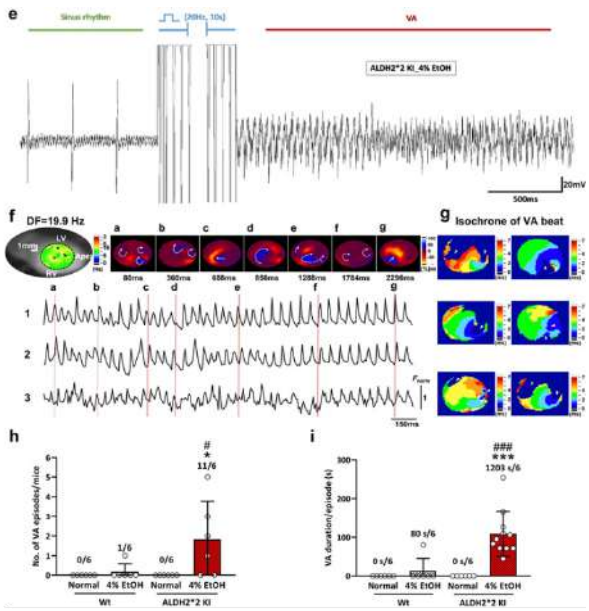

1. Optical mapping system for cardiac electrophysiology experiments.
2. Optical action potential and electrical propagation as isochrone maps in the ventricle at 300 ms pacing cycle length (PCL).
3. Programmed electrical stimulation induction arrhythmia

Major Publications

1. Lee AS, Sung YL, Pan SH, Sung KT, Su CH, Ding SL, Lu YJ, Hsieh CL, Chen YF, Liu CC, Chen WY, Chen XR, Chung FP, Wang SW, Chen CH, Mochly-Rosen D, Hung CL, Yeh HI, Lin SF. A Common East Asian aldehyde dehydrogenase 2*2 variant promotes ventricular arrhythmia with chronic light-to-moderate alcohol use in mice. Commun Biol. 2023 Jun 6;6(1):610.
2. Chen Z, Sung YL, Chen PS, Li X, Guo J. Na+, K+-Pump/ Phospholemman Are Concentrated at Intercalated Discs for Conduction. Circ Res. 2022 Jul 22;131(3):283-285.
3. Akira Ueoka, Yen-Ling Sung, Xiao Liu, Carine Rosenberg, Zhen-Hui Chen, Thomas H. Everett, Michael Rubart, James E. Tisdale, Peng-Sheng Chen, "Testosterone does not shorten action potential duration in Langendorff perfused rabbit ventricles", Heart Rhythm, Accept for Publication JHRM-D-21-01511R2, 2022.06.09
4. Yen-Ling Sung, Ting-Wei Wang, Ting-Tse Lin, Shien-Fong Lin, "Optogenetics in Cardiology: Methodology and Future Applications", International Journal of Arrhythmia, vol. 23, no. 1, p. 9, 2022.

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ANUP PANDITH : CHEMICAL-BIOLOGY AND BIOANALYTICAL CHEMISTRY

Anup Pandith, Ph.D.,
Assistant Professor

Major Research Aims

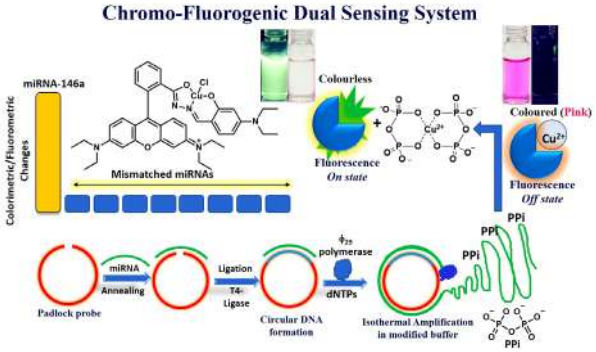
The optimal levels of cellular metabolites (viz., ions, molecules), biochemically fully functional proteins, and nucleic acids are essential components for the healthy survival of cells. Aberrated metabolites level or anomalous up/down-regulation of nucleic acids/proteins in the cellular system either through the external stimulus or organelle dysfunction leads to fatal disease. Considering these facts, our research team aims to develop simple, robust, non-invasive, point-of-care chromo-fluorogenic diagnostic tools for identifying disease states by selectively targeting metabolites and biomolecules. Current rationale associated with the sequential implementation of label-free and labeled approach for initial and advanced level disease state identifications respectively. In order to gain deep insights into probe-analyte interactions at the molecular level, experimental evidence will be additionally validated through computational tools. I believe this strategy, could be helpful in building a more secure and sustainable healthcare system.

Major Achievements

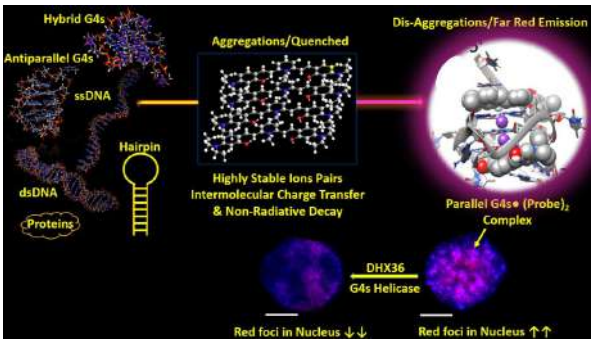
1. Ratiometric peptidyl-fluorescent conjugates for selective discrimination of G-quadruplexes over canonical forms of nucleic acids (dsDNA, ssDNA) in the mitochondrial genome.
2. Site-specific and nucleotide selective fluorescence labelling tools for the recognition of non-canonical forms of nucleic acids (G4s, i-motifs, hairpin, three-way junctions etc.) and their diagnostics applications in cellular conditions.
3. Fluorescence-based real-time identification of cancer biomarkers such as alkaline phosphatase, miRNAs etc. invitro and in-cellulo models (salivary gland and human fibroblast cell lines) through the pyrophosphate recognition.
4. Detailed investigation of chromo-fluorescent materials photophysics and their interaction mechanism with cancer-related metabolites and biomolecules: A Combined experimental and computational approach.

Representative Figures

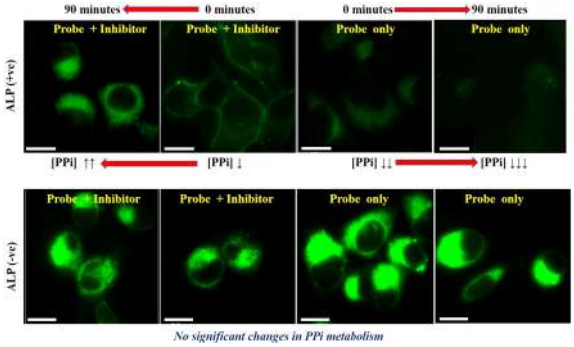
1.



2. Nuclear G-Quadruplex Recognizing Fluorescent Probe



3. Real-time Monitoring of Alkaline Phosphatase Activities in Cells



4. Mitochondrial G-Quadruplex Recognizing Fluorescent Peptidyl Conjugates

Major Publications

1. Pandith A, Luo Y, Jang Y, Bae J, Kim Y*, Self-Assembled Peptidyl Aggregates for the Fluorogenic Recognition of Mitochondrial DNA G-Quadruplexes, Angewandte Chemie, 2023, e202215049.
2. Kumar P, Pandith A*, Tseng CL, Burnouf T, Recent Advancements in Mitochondrial G-Quadruplex Recognizing Fluorescent Probes: A Review, J. Photochem. Photobiol. C Rev. 2023; 56, 100619.
3. Pandith A, Nagarajachari U, Kumara GKS et al. Loop-Mediated Fluorescent Probes for Selective Discrimination of Parallel and Antiparallel G-Quadruplexes. Biorg Med Chem 2021; 35:116077.
4. Kumara GSR, Pandith A, Seo YJ, Direct and Selective Metal Free N6-Arylation of Adenosine Residues for Simple Fluorescence Labelling of DNA and RNA. Chem Commun 2021; 57: 5450-5453.
5. Pandith A, Seo YJ, Label-Free Sensing Platform for miRNA-146a Based on Chromo-Fluorogenic Pyrophosphate Recognition. J Inorg Biochem 2020; 203: 110867.
6. Pandith A, Bhattarai KR, Kumara GKS et al. Novel Fluorescent C2-Symmetric Sequential on-off-on Switch for Cu2+ and Pyrophosphates and its Application in Monitoring of Endogenous Alkaline Phosphatase Activity. Sens Actuators B 2019; 282:730-742.

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LUCAS A. LANE :CANCER IMAGING AND SPECTROSCOPIC DETECTION

Lucas A. Lane, Ph.D.,
Assistant Professor

Major Research Aims

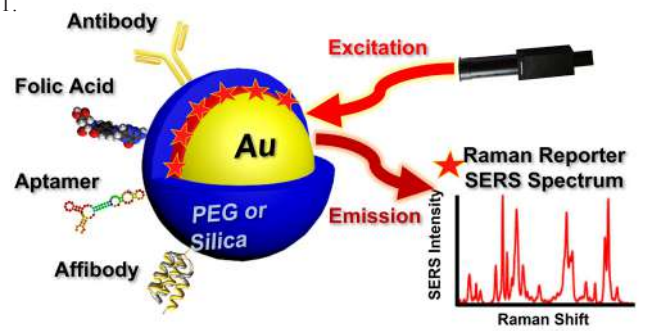
My lab's research focuses on utilizing optical-based technologies and biophysical theory to advance the study of cancer. Current projects include using surface-enhanced Raman scattering (SERS) and fluorescence techniques for image-guided surgery, quantitative diagnostics, and understanding underlying biophysical phenomena in nanomedicine and cancer pathophysiology. Above all, I aim for scientific contributions that can increase survival rates and quality of life for patients struggling with complex diseases.

Major Achievements

1. Demonstrated the utility of SERS tags in intraoperative tumor margin identification and distal micrometastases detection in-vivo.
2. Reported that by alternating between two different types of stealth polymer coatings between nanomedicine administrations, we find each dose maintains favorable in vivo behaviors and tumor accumulation at the height of the antibody immune response to the previous administration. Furthermore, our strategy increases the clearance of particles uptaken by macrophages and hepatocytes, resulting in marked decreases in hepatotoxicity.

Representative Figures

1.



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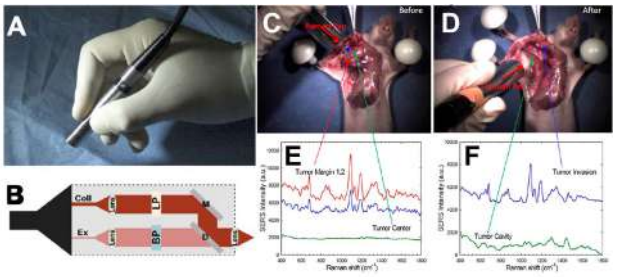

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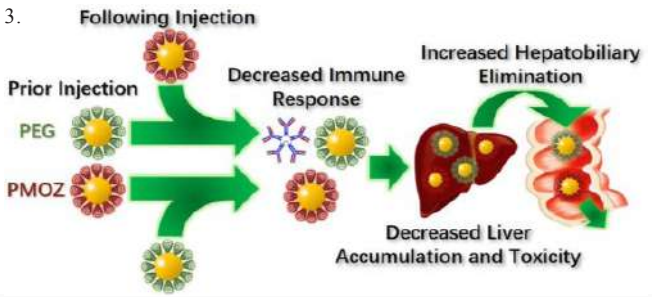

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1. Schematic diagram of a biocompatible SERS tag that is encoded with Raman reporter molecules and its biocompatible layer is conjugated with targeting ligands for in vivo and intraoperative cancer detection.
2. (A) Photograph of a handheld spectroscopic device. (B) Optical beam paths of the spectroscopic device photographed in (a). Photographs of a mouse tumor model before (C) and after (D) its primary tumor resection procedure. (E) SERS spectra before the tumor resection procedure where three areas were inspected: the tumor margins 1 and 2 (red and blue) and the tumor center (green). (F) SERS spectra are taken across the surgical bed after the primary tumor has been resected. Though scanning revealed a complete resection of the primary tumor, additional scanning of the surrounding areas around the resected tumor cavity surprisingly revealed an invasion of a micrometastatic lesion distal to the primary tumor indicated by a strong SERS tag signal plotted in blue.
3. (A) Nanoparticle (NP) coated with either polyethylene-glycol (PEG) or polymethyloxazoline (PMOZ) polymers. (B) By alternating between PEG and PMOZ nanoparticle coatings in a nanomedicine treatment regimen, each administration experienced a decreased immune response along with less liver accumulation due to reduced particle clearance from the blood and increased hepatobiliary elimination.

Major Publications

1. Li B, Chu F, Lu Q, Wang Y, Lane LA. Alternating stealth polymer coatings between administrations minimizes toxic and antibody immune responses towards nanomedicine treatment regimens. Acta Biomaterialia. 2021 Feb 1;121:527-40
2. Lane LA. Physics in nanomedicine: Phenomena governing the in vivo performance of nanoparticles. Applied Physics Reviews. 2020 Mar 20;7(1):011316.
3. Lane LA, Xue R, Nie S. Emergence of two near-infrared windows for in vivo and intraoperative SERS. Current opinion in chemical biology. 2018 Aug 1;45:95-103.
4. Li B, Lane LA. Probing the biological obstacles of nanomedicine with gold nanoparticles. Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology. 2019 May;11(3):e154.
5. Wang Z, Ni K, Zhang X, Ai S, Guan W, Cai H, Wang Y, Lu Q, Lane LA. Method for real-time tissue quantification of indocyanine green revealing optimal conditions for near infrared fluorescence guided surgery. Analytical chemistry. 2018 Jun 4;90(13):7922-9.
6. Wang J, Lee GY, Lu Q, Peng X, Wu J, Wu S, Kairdolf BA, Nie S, Wang Y, Lane LA. Quantitative examination of the active targeting effect: The key factor for maximal tumor accumulation and retention of short-circulated biopolymeric nanocarriers. Bioconjugate chemistry. 2017 May 17;28(5):1351-5

TMU HEALTHCARE SYSTEM

Taipei Medical University Hospital

Taipei Municipal Wanfang Hospital

TMU Shuang-Ho Hospital

TMU Taipei Cancer Center

TMU Taipei Neuroscience Institute

TMU Hsin Kuo Min Hospital

TMU HEALTHCARE SYSTEM

The Taipei Medical University Healthcare System comprises the renowned Taipei Medical University and six affiliated hospitals: TMU Hospital, Taipei Municipal Wanfang Hospital, Shuang-Ho Hospital, Taipei Cancer Center, Taipei Neuroscience Institute, and Hsin Kuo Min Hospital. With a collective capacity exceeding 3000 beds, we stand as one of the largest healthcare systems in metropolitan Taipei. Our commitment extends to providing comprehensive and seamlessly coordinated services that integrate primary and specialty care with cutting-edge research and educational initiatives.

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Founded in 1976

TAIPEI MEDICAL UNIVERSITY HOSPITAL

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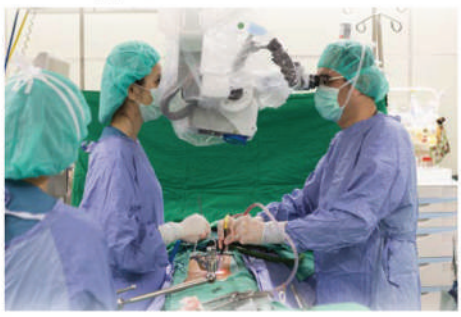
Taipei Medical University Hospital (TMUH), the first affiliated hospital of Taipei Medical University (TMU), was founded in 1976 and has established a strong foundation connecting clinical service and medical research education.

Situated near the TMU campus, the university and the hospital seamlessly integrate. As a university-affiliated hospital, TMUH upholds the core values and developmental focus of "Service, Education, and Research."

Embracing the core principles of "patient-centered, staff-oriented, and pride in TMUH," the hospital has actively promoted holistic healthcare in recent years. It advocates for the "five wholeness" in medical care, encompassing perspectives such as the "whole person," "whole family," "whole team," "whole journey," and "whole community." This approach broadens the scope of medical care from disease treatment to mental well-being, providing patient-centered healthcare and aspiring to be the strongest support for patients.

Aligned with TMU's dedication to sustainable operation, TMUH is committed to achieving sustainable development goals, with a deeper focus on health, well-being, and quality education. In 2022, it received three awards at the Asia-Pacific Sustainability Action Awards, and in 2023, it became one of the first healthcare institutions to sign the Hospital Sustainable Development Initiative with the Taiwan Institute for Sustainable Energy (TAISE).

As TMUH strives for excellence, it continues to develop its medical specialties, enhance teaching and education, and deepen research and innovation. The hospital aims to be recognized internationally as a university medical center, establishing a trusted hospital through high-quality medical care and building a medical brand of excellence that fills its staff with pride.



Founded in 1997

TAIPEI MUNICIPAL WANFANG HOSPITAL

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Wanfang Hospital, inaugurated on February 15, 1997, was entrusted by the Taipei Municipal Government to operate under Taipei Medical University as its second affiliated hospital. With a foundation built on seamless communication between clinical services and teaching and research at Taipei Medical University, Wanfang Hospital achieved recognition as a medical center-level hospital in 2004, following evaluation by the medical policy committee.

The journey of "Progress" is unceasing at Wanfang Hospital, where the commitment to enhancing the health and quality of life of individuals persists. The hospital consistently strives for breakthroughs in medical treatment, service, teaching, research, and more. Through collaborations with medical institutions worldwide, Wanfang Hospital endeavors to elevate the standards of Taiwan's medical profession, aspiring to be a world-class university hospital with global reach.

Founded in 2008

TMU SHUANG-HO HOSPITAL

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WEBSITE: www.shh.org.tw

Established in 2008, Shuang-Ho Hospital provides outpatient, inpatient, and emergency services across over 40 different specialties and sub-specialties. With a capacity of 1,578 beds, the hospital achieved JCI accreditation in 2009, reaffirmed in 2012, 2015, and 2018.

Certified with ISO 9001, ISO 14001, and ISO 27001 standards, Shuang-Ho Hospital boasts advanced capabilities, including PET-CT, 3T-MRI, gamma knife radiosurgery, tomotherapy, and more. Additionally, it is equipped with state-of-the-art technologies such as the da Vinci Surgical System, Robotic Stereotactic Assistance (ROSA), and Magnetic Resonance-guided Focused Ultrasound (MRgFUS) for complex surgeries.

The "Robotic Stereotactic Assistance" (ROSA) is a surgical navigation system designed to assist surgeons in minimally invasive thoracolumbar spine procedures. Tailored for surgical precision, it utilizes a robotic arm and navigational guidance to support operations.

The "Magnetic Resonance-Guided Focused Ultrasound" (MRgFUS) enables non-invasive treatment for various conditions, avoiding surgery and minimizing impact on healthy tissues.

Committed to providing a comprehensive medical system for acute and critical conditions, Shuang-Ho Hospital brings together top teams from diverse disciplines. It also serves as a training hospital for senior ambulance technicians in New Taipei City and coordinates with the city's Emergency Operations Center (EOC) to facilitate a network of hospitals for effective responses during medical disasters.

Shuang-Ho Hospital, driven by determination, embraces a mission to wholeheartedly care, serve, and dedicate itself to patients with innovation and high-quality standards.




Founded in 2013

TMU TAIPEI CANCER CENTER

Contact Information

ADD: No.250, Wuxing St., Xinyi Dist., Taipei City 11031, Taiwan

TEL: +886-2-6636-9060

EMAIL: itcc@h.tmu.edu.tw

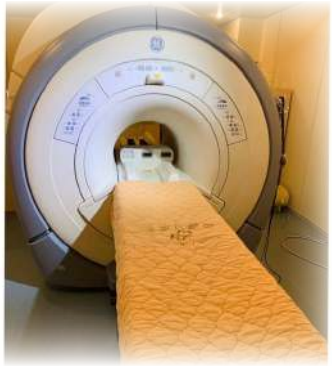
WEBSITE: www.cancertaipei.tw

Established in 2017, the Taipei Neuroscience Institute (TNI) emerged through the integration of all neurosurgery, neurology, neuroradiology, rehabilitation, and psychiatry departments from the university's three affiliated hospitals in Taipei. This integration aims to elevate our practice standards in clinical neuroscience, enhance the quality of clinical training and education, and foster collaborative research between clinicians and basic neuroscientists.

Founded on a robust foundation, TMU-TNI encompasses 15 departments, including Neuro-oncology, Radiosurgery, Cerebrovascular Disease, Neurorehabilitation, Degenerative Disease, Neuropsychology and Cognitive Function, Spinal Disorder, Peripheral Nervous Disorder, Pain Disorder, Pediatric Neurology, Neurotraumatology and Intensive Care, Dizziness, Sleep Disorders and Headache, Epilepsy, Neuroimmunology, and Neuroradiology. We prioritize interdisciplinary discussions to deliver optimal medical services to our patients.

Regarding integration and research, TMU-TNI collaborates closely with TMU. Clinicians and scientists engage in joint research projects and conduct trials with other universities or research institutes in Taiwan and abroad. We actively foster collaboration between the university and the medical industry, encouraging our teams to host neuroscience seminars and large conferences. Additionally, we've established a neuroscience research institute at TMU, offering training courses for new students and investing considerable effort in nurturing clinical and research talent.

Founded with a commitment to medical care, TMU-TNI envisions a future dedicated to advancing neuroscience both locally and internationally. Our goal is not only to become a globally recognized vanguard medical center but also to provide the highest-level healthcare to the people of Taiwan and neighboring countries.



Founded in 2017

TMU TAIPEI NEUROSCIENCE INSTITUTE

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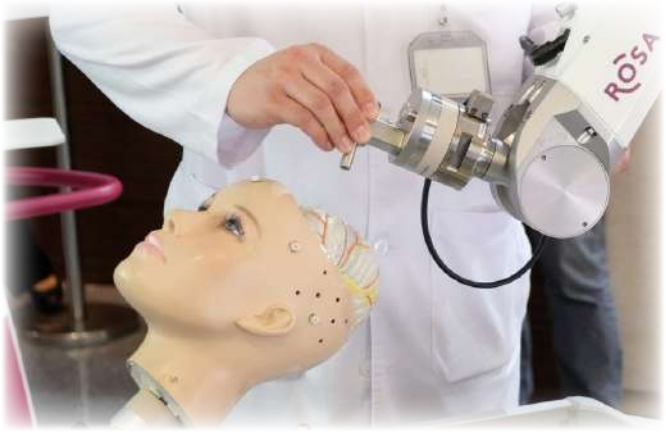
TEL: +886-2-2249-0088 ext. 8809, 8803, 8804, 8682

EMAIL: ims@s.tmu.edu.tw

WEBSITE: www.shh.org.tw



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Underpinned by a robust foundation, TMU-TNI comprises 15 departments, including Neuro-oncology, Radiosurgery, Cerebrovascular Disease, Neurorehabilitation, Degenerative Disease, Neuropsychology and Cognitive Function, Spinal Disorder, Peripheral Nervous Disorder, Pain Disorder, Pediatric Neurology, Neurotraumatology and Intensive Care, Dizziness, Sleep Disorders and Headache, Epilepsy, Neuroimmunology, and Neuroradiology. Emphasizing interdisciplinary discussions, we strive to deliver the best medical services to our patients.

In terms of integration and research, TMU-TNI closely collaborates with TMU. Clinicians and scientists collaborate on research projects and conduct trials with universities and research institutes both in Taiwan and abroad. We actively promote collaboration between the university and the medical industry, encouraging our teams to host neuroscience seminars and large conferences. Additionally, we have established a neuroscience research institute at TMU, offering training courses for new students and dedicating significant efforts to nurture clinical and research talent.

Driven by a commitment to medical care, TMU-TNI envisions a future where neuroscience is continually advanced, not only on a global scale as a recognized vanguard medical center but also in providing the highest-level healthcare to the people of Taiwan and neighboring countries.

Founded in 2019

TMU HSIN KUO MIN HOSPITAL

Contact Information

ADD: No. 152, Fuxing Rd., Zhongli Dist., Taoyuan City 320, Taiwan
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EMAIL: skmh@skmh.tmu.edu.tw
WEBSITE: www.skmh.com.tw

Hsin Kuo Min Hospital, the fourth affiliated hospital of Taipei Medical University, aspires to rank among the world's premier medical schools.

Furnished with a highly skilled and professional medical team, Hsin Kuo Min Hospital excels in orthopedic care, addressing the prevention, diagnosis, and treatment of disorders related to bones, joints, ligaments, tendons, muscles, and nerves. The orthopedic department specializes in various areas, including minimally invasive surgery, spine disorders, joint reconstruction and revision, foot and ankle injuries, hand surgery, and trauma. The Department of Rehabilitation Medicine offers a range of services, such as physical therapy and occupational therapy, catering to patients with diverse musculoskeletal disorders, injuries, or diseases.

In response to the diverse healthcare needs of the community, the hospital has established a comprehensive service center encompassing clinics specializing in nephrology, urology, neurology, immunology and rheumatology, hepatobiliary gastroenterology, and dermatology. Furthermore, a state-of-the-art hemodialysis center ensures that patients receive top-notch vascular access care and treatment.

Hsin Kuo Min Hospital is dedicated to continual upgrades and enhancements in its medical management system, consistently striving to provide the highest quality of care and services to the local community.

TMU CAMPUS LIFE

Sports Facilities

Student Clubs

Library

Food Court and Restaurants

TMU CAMPUS LIFE

About

Taipei Medical University encompasses two campuses: the Xin-Yi campus, nestled in the heart of Taipei City, and the Shuang-Ho campus, situated in New Taipei City. The university offers a free roundtrip shuttle bus service for faculty, staff, and students traveling between the Xin-Yi and Shuang-Ho Campuses, with the duration ranging from 20 to 40 minutes depending on traffic.

Xin-Yi Campus

Address: No.250, Wuxing St., Xinyi Dist.,
Taipei City 110, Taiwan
Tel: +886-2-2736-1661

The following colleges are located on the Xin-Yi campus:
College of Medicine
College of Oral Medicine
College of Pharmacy
College of Nursing
College of Nutrition

Shuang-Ho Campus

Address: No.301, Yuantong Rd., Zhonghe Dist.,
New Taipei City 235, Taiwan
Tel: +886-2-6620-2589

The following colleges are located on the Shuang-Ho campus:
College of Biomedical Engineering
College of Public Health
College of Medical Science and Technology
College of Humanities and Social Sciences
College of Management

Sports Facilities

The Xin-Yi campus boasts comprehensive sports facilities, featuring indoor amenities such as a standard heated swimming pool, sauna, fitness studio, weightlifting room, table tennis area, badminton court, and dedicated spinning bike room. Outdoors, the campus is adorned with facilities for volleyball, baseball, softball, basketball, tennis, and even pétanque. Additionally, the Shuang-Ho campus is equipped with a fitness gym for enthusiasts.

Student Clubs

Student clubs are abundant at Taipei Medical University! Eighty-five clubs offer opportunities in service, entertainment, academics, performance and management. TMU leads Taiwan's universities in student activities, which are important part of the TMU experience, especially medical service activities. Normally nine groups serve in remote villages or foreign countries each winter vacation, while in summer a dozen groups offer help in underserved areas. Students participating in these groups are not only offered free medical services and health care education, but also perform live shows to entertain their host communities.

Library

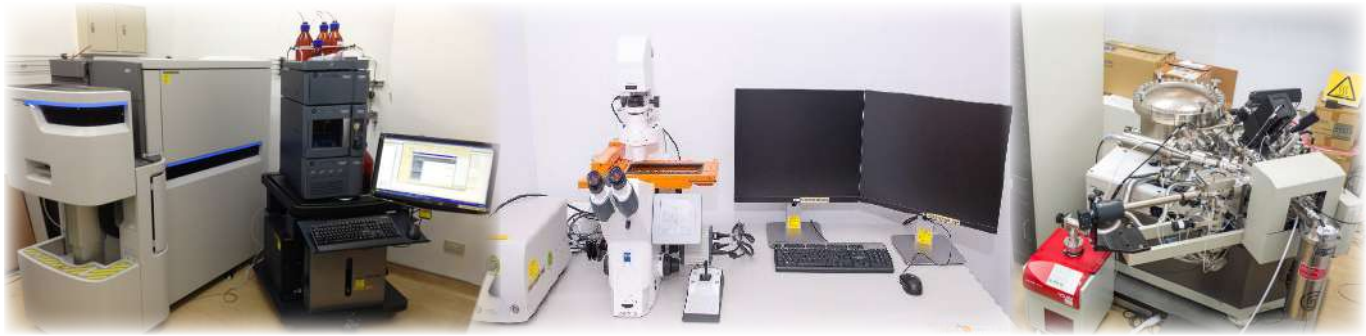
The Taipei Medical University Library was established in 1962. It currently contains about 150,000 volumes of books and bound journals within its collection. In addition to circulation services, the library also provides high quality information services such as reference services, inter-library loans, and library instruction. It also contains plenty of academic electronic resources while continuously improving the quality and quantity of services to fulfill every patron's needs. Currently, the library has subscriptions to around 17,000 e-Journal titles, 90,000 e-books, and 120 different e-Databases. Two branches of the library have been opened in Wan-Fan Hospital (1997) and Shuang-Ho Campus (2023).

Food Court and Restaurants

Inexpensive and nutritious meals are easy to find on Xin-Yi and Shuang-Ho campuses. The food court offers sandwiches, hamburgers, Chinese lunch boxes, fresh fruit drinks, noodles, and vegetarian food. Additional meal options are also available at convenience stores on both campuses.

Core Facility Center

The TMU Core Facility operates as part of the Office of Research and Development at Taipei Medical University. It supports innovative research at TMU by providing highly specialized services, equipment, and staff that would be too costly or impractical for a single laboratory or department to provide. It houses several high-end equipment that are available on a pay-for-use basis to researchers throughout Taipei Medical University, as well as to non-TMU researchers. It manages seven individual cores, such as Imaging Core, Mass Spectrometry Core, NMR Core, Flow Cytometry Core, Bioinformatics Core, Natural Compound Isolation Core and Single Cell Genomics Core. These staffed facilities provide researchers access to high-end instruments, technical support, and expertise; as well as training in various instrumental operations. To better service the faculties and students at Taipei Medical University, several instruments in the Basic Research Core are available 24 hours a day. In addition, the TMU Core facility also hosts instrument-related seminars and training programs every year.



College of Biomedical Engineering, Taipei Medical University,Taiwan

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臺北醫學大學
TAIPEI MEDICAL UNIVERSITY

臺北醫學大學 醫學工程學院
TMU BIOMEDICAL ENGINEERING