

Curriculum

Ph.D. (Bioinnovation and Entrepreneurship)

1.Program Learning Outcomes (PLOs)

Knowledge

K1 Learners can clearly explain the fundamental principles and theories of related disciplines.

K2 Learners can design business plans to develop research into innovations.

K3 Learners are capable of selecting and applying foundational knowledge to create innovations.

Skills

S1 Learners demonstrate self-directed learning skills.

S2 Learners appropriately utilize information technology to acquire knowledge for self-development.

S3 Learners create novel innovative knowledge.

Ethics

E1 Learners demonstrate basic ethics and morality.

E2 Learners demonstrate ethical reasoning and professional codes of conduct within the discipline.

Character

C1 Learners demonstrate leadership, assertiveness, responsibility, and rationality.

C2 Learners embody the characteristics of innovators and entrepreneurs.

2. Year Learning Outcomes (YLOs)

Academic Year	Knowledge, Skills, Attitudes, and Other Attributes Attained upon Completion of Each Year
Year 1	Students possess knowledge and understanding of the fundamental principles essential to the field of Bio-Innovation and Entrepreneurship.
Year 2	Students are able to apply knowledge of essential fundamental principles from the Bio-Innovation and Entrepreneurship (International Program) courses to correctly and appropriately conduct research, create innovations, and publish their works.
Year 3	Students are able to apply knowledge of the essential fundamental principles from courses within the Bio-Innovation and Entrepreneurship (International Program) to correctly and appropriately conduct research, create innovations, and publish their works.

3. Program Structure, Courses and Credits

3.1 Total credits throughout the Program: 48

3.2 Program Structure: Doctoral Degree

Plan 2.1: Coursework and Thesis

Basic supplementary category (not counting credits) 3 credits

Compulsory Courses 6 credits

Elective Courses 6 credits

Thesis 36 credits

4. Course Descriptions

4.1 Basic supplementary category

CME 601 Physiology for Bioinnovation and Entrepreneurship

Basic physiology of the human body; mechanisms of body function; homeostasis; maintaining internal constancy; cell physiology; nervous system; musculoskeletal system; digestive system; lymphatic system; respiratory system; endocrine system; reproductive system; circulatory system. (Evaluation: Pass/Not Pass)

CME 602 Introduction to Engineering Design and Process

Explore the engineering design process in this project-based course. Through lectures and openended design problems, the students will learn about the design process, teamwork, engineering specialties and tools, creative and analytical thinking, and engineering professionalism, basic electrical wiring, digital logic, and sensors. (Evaluation: Pass/Not Pass)

4.2 Compulsory category

CME 603 Bioinnovation and Entrepreneurship

Innovation investment in biotechnology, opportunity analysis and evaluation, market assessment, startup strategies, business plan development, startup management, and venture financing

CME 604 Innovation Laboratory

Experiential and practicum that uses a multidisciplinary and collaborative approach to teach students innovative and creative design thinking at the intersection of business and basic laboratory research, as well as the practical aspects of launching and leading a bioinnovation start-up venture.

4.3 Elective category

CME 611 Materials for Biomedical Applications

Surface properties of materials, polymers, hydrogels, bioresorbable and bioerodible materials, metals, ceramics, glasses, and glass-ceramics, pyrolytic carbon, engineered natural materials, composites, host reaction to biomaterials, innate and adaptive immunity, testing biomaterials, In vivo assessment of tissue compatibility, application of materials in medicine. Engage in projects that encourage innovative thinking, market analysis, and the development of business models tailored to biomedical materials.

CME 612 Laboratory Techniques and Medical Device Approvals

Regulatory affairs for the design of experimental procedures for medical device approval, laboratory techniques for the production of medical devices, approval processes necessary for the sale and use of medical devices in the market, review of medical research data, techniques for testing the compatibility of materials and medical equipment, and the use of technology in developing new medical products.

CME 613 Nanotechnology in Healthcare

Amperometric sensors, potentiometric sensors and neuronal-electronic communication, immunosensors, fluorescence and quantum dots, protein immobilization, electrochemical impedance spectroscopy (EIS), biomimetic membranes, lab-on-a-chip, bioactive/drug delivery, tissue engineering, stem cells and scaffolds, market analysis for nanobiotechnology products, innovation development and entrepreneurship in nanobiotechnology.

CME 621 Biomimetic Approach in Medical Applications

Technological in biomimetic methods, physical, chemical, and biological aspects of biomimicry, mechanisms of mimicking structures, functional characteristics, and biological processes at the nano, micro, and macro levels, advanced technologies in biomimetic methods, medical applications of biomimetic technologies, market analysis for biomimetic products.

CME 622 Biomedical Materials

Principles of biomedical materials science and technology; classification, chemical composition, molecular structure, physical chemistry, physical characteristic, processing, medical application, and advance in biomedical materials technology

CME 623 Polymeric Biomaterials

Polymeric biomaterials for applications in biomedical engineering, principles of polymeric biomaterials science, classification, chemical composition, molecular structure, chemical-physical characteristics, physical properties of materials, material analysis techniques, various manufacturing processes, improvement of molecular structure and physical characteristics of materials, biocompatibility of materials, and advancements in medical applications with polymeric biomaterials.

CME 631 Current Topics in Stem Cells Innovation

Searching for and reading academic articles and journals related to stem cell research is a crucial process for acquiring up-to-date and reliable information. This helps in understanding the research process, studies, and technologies in stem cell biology for medical applications. It also enables the presentation of research articles, the design of experiments, and the accurate and ethical analysis of data. Additionally, answering questions and critiquing research articles are significant components that help strengthen expertise and confidence in research from a scientific standpoint.

CME 632 Medical Innovation of Stem cells

The principle of stem cell biology and technology encompasses understanding the mechanisms governing the behavior and function of stem cells, both embryonic and adult, at cellular and molecular levels, including their unique characteristics, signaling transduction pathways, and interactions within their microenvironment. Expanding on this foundation, exploring the potential uses of stem cells in clinical practices involves leveraging their regenerative properties and plasticity to develop innovative therapeutic interventions for medical conditions and diseases.

CME 633 Molecular Medical Biology

Structure of cell organization, cell cycle, functions of extracellular matrix and bio- membranes, mitochondria and nucleus, stem cell, cell cloning, cell culture, chromatin, DNA replication, mutations and repair, transcription, post transcriptional modification and translation, DNA recombination, noncoding RNAs (small RNAs, long-noncoding RNAs and circular RNAs), bacterial genetics and transcriptional regulation in prokaryotes, bacteriophages and viruses, molecular basis of cancer, molecular basis of genetic diseases

CME 634 Genetic Engineering

Molecular cloning, vectors (cloning vectors, expression vectors), restriction enzymes, polymerase chain reaction technologies (primer design, cDNA synthesis, PCR, multiplex PCR, RT-PCR, real-time PCR, digital PCR, isothermal amplification of nucleic acid), DNA fingerprint, fundamentals of sequencing technologies including Sanger sequencing, next-generation and third- generation sequencing, bacterial expression system, yeast expression system, eukaryotic expression system, in vitro transcription and translation, transgenic animals, transgenic plants, viral vectors and its application, protein engineering and display technologies (phage, yeast, ribosomal and mammalian cells), gene silencing and editing technologies, recombinant DNA technology in biotherapeutics and vaccine development

CME 635 Practice in Molecular Biology and Genetic Engineering

Concept and practice in molecular biology and genetic engineering techniques e.g., polymerase chain reaction and electrophoresis, gene cloning and recombinant protein production, cell culture, gene silencing and editing, immunoblotting, immunofluorescence and immunohistochemistry, microscopic techniques, Southern and northern blot, protein purification techniques and mass spectrophotometry data analysis, sequencing data analysis, flow cytometry and cell isolation

CME 636 Nanomedicine: Molecular and Engineering Aspects

Up-to-date scientific developments and discoveries in the field of nanomedicine, use of precisely engineered nanomaterials at the length scale of 1 - 100 nm to develop novel therapeutic and diagnostic modalities for medical applications; criticizing discussion of related research in nanomedicine

CME 637 Biosensors for Biomedical Engineering

Principles of biosensors, biological elements, transducers; characteristics of biosensors immobilisation of biological elements focusing on electrochemical biosensors; fundamental of electrochemistry, nanomaterials for surface coatings, examples in medical application; development and design of biosensors for real-time clinical monitoring using microfluidics and microdialysis

CME 638 Advanced Immunology

Structure, function and cells in the immune system, antigens, immunogens, antigen presentation and major histocompatibility complex (HLA), cytokines, chemokines and cellular interactions, structure and function of immunoglobulin genes, structure and function of T-cell receptor genes, immune tolerance and mechanism of autoimmunity, complement system, transplantation, immune response to microbes, tumor immunology, immunogenetics, vaccination, immunodiagnostics and immunotherapeutics

CME 639 Current Topics in Biotherapeutics

A critical discussion on biotherapeutics and the technologies employed in their research and development delves into the intricate landscape of biopharmaceuticals, exploring the advancements in molecular biology, protein engineering, and bioprocessing techniques utilized to create novel therapeutic agents. This comprehensive examination encompasses not only the efficacy and safety of biotherapeutics but also the challenges associated with their production, purification, and delivery, fostering a deeper understanding of their potential applications in treating various diseases and disorders.

CME 640 Directed Evolution and its application

Principle of directed evolution and its application, display technologies: its design and application (phage, yeast, ribosomal and cell display systems), protein and enzyme engineering, peptide and antibodies engineering.

CME 641 Recombinant Protein Production and Purification

Host cell systems for therapeutic protein production including bacteria, yeast, mammalian cells, and plant, cell-free protein expression, protein purification methods — gel-filtration chromatography, Ion-exchange chromatography, affinity chromatography, dialysis, salting out, high performance liquid chromatography (HPLC) and fast protein liquid chromatography (FPLC)

CME 642 Gene Silencing, Gene Editing and Gene Transfer Methods

RNA interference (RNAi) technology, design, and its applications, gene editing technologies, design and its applications — zinc-finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), clustered regularly interspaced short palindromic repeats (CRISPR) and their associated proteins (Cas) [CRISPR-Cas], gene transfer techniques including transformation, electroporation, conjugation, liposome-mediated transfection, transduction, and direct transfer of DNA

CME 643 Technology in Reproductive Longevity and Aging

Basic genetics, gametogenesis, reproductive anatomy, normal physiology, pregnancy and childbirth, hormone changing with age, ovarian aging, female advanced reproductive age and infertility, age-related hormonal changes in males, treatment of age-related infertility, assisted reproductive technologies (ART)

CME 651 Biomedical

Principles of science, materials sciences and engineering for biomedical researches; definition and terminology in biomedical; principles of biomedical instrumentation and measurement; computational and programming methods for biomedical research

CME 652 Research Skills and Ethic in Biomedical

Essential skills in research as research question, literature review, research planning, research design, research discussion, research presentation, concept paper writing, academic writing, important research ethics

CME 653 Current Topics in Medical Parasitology

Advanced topics in medical parasitology are covered in-depth. Topics covered include current diagnosis, treatment, prevention and control, and research in medical parasitology

CME 654 Biomedical Engineering Entrepreneurship

Introduction to entrepreneurship principles and bridging research in biomedical engineering to commercialization; the inspiration of business start-up; business concept development; product design and development; business and market strategy; financial planning; intellectual properties management; technology utilization in business

CME 655 Precision Medicine and Applications

Applications of biomarkers and genetic on diagnosis, prognosis, follow-up, targeted therapy and prevention in genetic diseases, cancers, cardiovascular diseases, hematological diseases, immune mediated diseases, infectious diseases, forensic medicine, electronic health records.

CME 656 Principles of The One Health

Study of general principles of diseases in the context of ecological systems, food safety and global health. Topics covered include fundamentals of the zoonotic, water- and food-borne diseases, and common One Health issues. The core concepts of One Health, history, evolution and scope of the field, and the One Health triad, specifically human health, animal health, and environmental health.

CME 661 Research to Revenue

Seeking opportunities to generate revenue from innovations derived from intellectual property, seeking opportunities from academic research, idea creation, market research, securing funding, intellectual property management, business model development, commercialization strategies, legal and ethical considerations, case studies and best practices.

CME 662 Intellectual Property for Entrepreneurs

Definitions and limitations of intellectual property: patents, copyrights, trademarks, trade secrets, research and registration strategies, protection and enforcement strategies, dispute resolution and problem-solving related to legal principles of intellectual property, utilization of intellectual property, financial return generation from intellectual property, strategies for utilizing intellectual property to generate financial returns, case studies, and tools for analyzing financial returns

CME 663 Bioinnovation and Entrepreneurship Law and Regulation

Patent law, strategies for protecting bioinnovations through patents, case studies on patent disputes and resolutions, regulatory law, overview of regulatory bodies and their roles (e.g., fda, ema), post-market surveillance and regulatory updates, contract law, importance in bioinnovation, drafting and negotiating business contracts, licensing agreements and technology transfer, business formation and legal structure, types of business entities (e.g., llc, corporation, partnership), legal steps to start a bioinnovation business, legal risk management, regulatory strategy and product development.

CME 664 Marketing Management

The fundamental marketing concepts and their application by business and non-business organizations, The various settings include consumer goods firms, manufacturing and service industries, and small and large businesses, Overview of marketing strategy issues, elements of a market (company, customers, and competition), as well as the fundamental elements of the marketing mix (product, price, placement/distribution, and promotion).

CME 665 Corporate Finance

An introduction to the economic principles underlying the financial decisions of companies, The topics covered include bond and stock valuations, capital budgeting, dividend policy, market efficiency, risk valuation, and risk management.

4.4 Academic dissertation

CME 900 Thesis

Formulate thesis proposal and conduct dissertation research on the topics/problems related to Bioinnovation and Entrepreneurship. The research must contribute new findings in the related field. The student must present the dissertation and allow the general public to attend the defense. The student must present the ethics for conducting a research project, as well as for publications.

5. Requirements for Thesis, Independent Study, and Comprehensive Examination

5.1 Thesis Requirements

(1) Students are eligible to register for the thesis once they have completed at least 2 regular semesters, accumulated no fewer than 12 credits, and maintained a cumulative grade point average (GPA) of not less than 3.00.

(2) Students must write their thesis in English.

(3) After registering for the thesis, students must submit a thesis proposal to the Administrative Committee of the Bio-Innovation and Entrepreneurship Program. This is to enable the Dean of Chulabhorn International College of Medicine to appoint a thesis advisory and examination committee consisting of at least 5 members, who will provide guidance to the students as well as conduct both the thesis proposal examination and the final thesis defense.

(4) The qualifications of the thesis advisor must comply with the Graduate Program Standard Criteria established by the Ministry of Higher Education, Science, Research and Innovation.

5.2 Thesis Defense (or Thesis Examination)

(1) The qualifications of the thesis examiners must comply with the Graduate Program Standard Criteria established by the Ministry of Higher Education, Science, Research and Innovation.

(2) Students are eligible to take the thesis defense only after passing the English proficiency examination or achieving the required English test score meeting the university's criteria.

(3) The thesis defense must comply with the regulations and directives of Thammasat University. Furthermore, a grade of "S" (Satisfactory) for the thesis defense requires a unanimous vote from the thesis examination committee.

5.3 Qualifying Examination

(1) Students are eligible to take the qualifying examination once they have completed all the courses required by the curriculum, and they will be given the opportunity to take the examination in the first semester of their expected graduation, provided they have maintained a cumulative grade point average (GPA) of not less than 3.00.

(2) The program will administer the qualifying examination, which is a written exam, 3 times per academic year. The Dean of Chulabhorn International College of Medicine shall appoint the qualifying examination committee.

(3) Students must pass the qualifying examination with a grade of "P" (Pass) within 3 attempts; otherwise, they will be dismissed from the university registry (or dismissed from student status).

6. Graduation Requirements

1) Complete and pass all courses specified in the curriculum.

2) Achieve a cumulative grade point average (GPA) of not less than 3.00 on a 4.00 scale or its equivalent.

3) Pass the qualifying examination.

4) Pass the English proficiency examination in accordance with the criteria set by the university.

5) Pass the final oral defense, which must be conducted as an open forum accessible to interested attendees.

6) The thesis or a part of the thesis must be published, or at least accepted for publication, in an international journal of recognized quality in compliance with the committee's regulations; or be granted a patent; or be a bio-innovation/creative work that can be commercially, socially, or economically utilized. In the case of an innovation or creative work, the thesis must be evaluated and approved by an external expert committee consisting of at least 3 members in the same or a related field who possess widely recognized high-level knowledge, expertise, and experience, with the endorsement of the University Council.