Program: Doctor of Philosophy Program in Biochemistry and Biochemical Technology (International Program)
Degree: Doctor of Philosophy (Biochemistry and Biochemical Technology)
Study Plan:

1) Research Program (Scheme 1.1: for Master's Degree holder)

Year	First Trimester	Cr	Second Trimester	Cr	Third Trimester	Cr
Year 1	109891 Ph.D. Thesis	3	109881 Biochemistry Seminar I	0	109882 Biochemistry Seminar II	0
			109891 Ph.D. Thesis	3	109891 Ph.D. Thesis	3
	Total	**3**	**Total**	**3**	**Total**	**3**
Year 2	109891 Ph.D. Thesis	3	109883 Biochemistry Seminar III	0	109884 Biochemistry Seminar IV	0
			109891 Ph.D. Thesis	9	109891 Ph.D. Thesis	9
	Total	**3**	**Total**	**9**	**Total**	**9**
Year 3	109891 Ph.D. Thesis	9	109891 Ph.D. Thesis	9	109891 Ph.D. Thesis	12
	Total	**9**	**Total**	**9**	**Total**	**12**

2) Regular Program (Scheme 2.1: for Master's Degree holder)

Year	First Trimester	Cr	Second Trimester	Cr	Third Trimester	Cr
Year 1	1097XX Major Course	8	1097XX Elective Course	5	109881 Biochemistry Seminar I	1
			109891 Ph.D. Thesis	3	109891 Ph.D. Thesis	3
	Total	**8**	**Total**	**8**	**Total**	**4**
Year 2	109891 Ph.D. Thesis	3	109891 Ph.D. Thesis	8	109882 Biochemistry Seminar II	1
					109891 Ph.D. Thesis	7
	Total	**3**	**Total**	**8**	**Total**	**8**
Year 3	109891 Ph.D. Thesis	7	109891 Ph.D. Thesis	7	109891 Ph.D. Thesis	7
	Total	**7**	**Total**	**7**	**Total**	**7**

3) Regular Program (Scheme 2.2: for Bachelor's Degree holder)

Year	First Trimester	Cr	Second Trimester	Cr	Third Trimester	Cr
Year 1	109700 Graduate Biochemistry	4	1097XX Major Course	4	1097XX Elective Course	10
	109701 Biochemical Separation and Characterization Methods	4	1097XX Major Course	4		
	Total	**8**	**Total**	**8**	**Total**	**10**

Year	First Trimester	Cr	Second Trimester	Cr	Third Trimester	Cr
Year 2	109891 Ph.D. Thesis	3	109881 Biochemistry Seminar I	1	109882 Biochemistry Seminar II	1
			109891 Ph.D. Thesis	3	109891 Ph.D. Thesis	
	Total	**3**	**Total**	**4**	**Total**	**1**
Year 3	109891 Ph.D. Thesis	3	109883 Biochemistry Seminar III	1	109884 Biochemistry Seminar IV	1
			109891 Ph.D. Thesis	3	109891 Ph.D. Thesis	3
	Total	**3**	**Total**	**4**	**Total**	**4**
Year 4	109891 Ph.D. Thesis	7	109891 Ph.D. Thesis	7	109891 Ph.D. Thesis	7
	Total	**7**	**Total**	**7**	**Total**	**7**
Year 5	109891 Ph.D. Thesis	7	109891 Ph.D. Thesis	7	109891 Ph.D. Thesis	7
	Total	**7**	**Total**	**7**	**Total**	**7**

Program: Doctor of Philosophy Program in Biochemistry and Biochemical Technology (International Program)
Degree: Doctor of Philosophy (Biochemistry and Biochemical Technology)
Course Description:

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
Major Course				
109700 Graduate Biochemistry	4(4-0-8)	Consent of the School	Cellular structure, organelle function, structure and properties of lipids, carbohydrates and other biomolecules, methods of study, enzymes, intermediary metabolism, metabolic control, membrane structure and transport, bioenergetics, information transfer, cell signaling, DNA replication, RNA and protein synthesis	1. explain structure and function of different biological molecules existing in living cells 2. explain metabolic pathways of energy-conserved compounds and metabolic controls as different levels 3. explain cell signaling and cell-cell interactions through signaling molecules. 4. explain workflow of DNA replication, RNA and protein synthesis 5. communicate scientific knowledges in different forms effectively abd appropriately 6. be hornest and able to work with other and respect others opinions

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109701	Biochemical Separation and Characterization Methods	4(1-9-2)	Consent of the School	Laboratory studies and general principles, separation of organelles, separation detection, quantification of proteins, quantification of nucleic acids, quantification of carbohydrates, quantification of lipids, spectrophotometry and other spectroscopic methods.	1. conduct basic laboratory techniques used in biochemistry and able to choose the appropriated techniques for biochemical work 2. understand the basic principles between laboratory techniques for purification and characterization of biomolecules 3. document laboratory work in a notebook and write reports regarding experimental projects 4. classify, collect, and analysis the numerical data 5. evaluate and analyse scientific data according to the scientific information 6. communicate scientific knowledges in different forms effectively abd appropriately 7. have conscientious academic and professional conduct, work with others, and respect others opinions

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109702 Enzymology	4(4-0-8)	Consent of the School	Properties and control of enzyme activity, enzyme nomenclature and active-site characteristics, thermodynamics of enzyme-catalyzed reactions, orders of reactions and kinetics of Michaelis-Menten, experimental measurements and significance of the kinetic parameters, kinetic of substrate inhibition, kinetics of reversible reactions, and the Haldane relationship, kinetics of competitive, non-competitive, uncompetitive and mixed-type inhibition, effects of pH and temperature on enzyme activity, dose-response curves, protein-ligand binding equilibria, derivation of the Langmuir binding isotherm, binding kinetics using microcalorimetric assay, mechanisms of multisubstrate reactions as described by King-Altman schematic approach, kinetics of allosteric enzymes, enzyme mechanisms and active site determination, practical approaches for determination of enzyme activity.	1. explain enzyme property as a biocatalyst 2. describe the reaction rate, following the Michaelis-Menten equation. 3. determine the reaction rate of an enzyme with two substrates 4. distinguish different types of inhibition mechanisms 5. explain the binding principles based on Langmuir binding isotherm 6. understand how allosteric enzymes work 7. explain different types of reaction mechanisms, active site determination and principles of enzyme assay 8. communicate scientific knowledges in different forms effectively and appropriately 9. have conscientious academic and professional conduct, work with others, and respect others' opinions

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109703	Protein Structure and Engineering	4(4-0-8)	109700 Graduate Biochemistry /Consent of the School	Basic review of the structures and properties of amino acid peptide bonds, peptides, polypeptides & proteins, concepts for protein engineering, protein detection, purification and evaluation, electrophoresis, size determination, quaternary structure evaluation, protein primary structure determination, electronic structures and properties of amino acid residues and their reactivities, chemical synthesis of peptides & proteins; biological nucleic acid and protein synthesis & posttranslational modifications, Methods in genetic engineering of proteins, molecular evolution and the use of protein sequence alignment & analysis, physical basis of size and shape determination (e.g. diffusion, analytical centrifugation, light scattering, small angle X-ray scattering), spectroscopic evaluation of secondary structure and tertiary structure, protein structure determination by X-ray crystallography, NMR, & EM tomography, structural modeling and prediction, protein folding, protein interactions with ligands, proteins in membranes, student proposal on protein engineering.	1. explain principles of protein structure and the physical interactions involved in attaining protein structure 2. understand the basics of the methods and experiments used to study proten structure and structure-function relationships 3. evaluate and analyse scientific papers on protein structure and engineering and evaluate the quality of the data 4. have a basic understanding of the methods used to engineer proteins and to evaluate the effects of such engineering 5. have conscientious in their academic and professional conduct, and able to work with others 6. communicate scientific knowledge appropriately and effectively 7. Students are eager for knowledge and learning

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109704	Nucleic Acids and Recombinant DNA Technology	4(4-0-8)	Consent of the School	Structure and function of nucleic acid (including DNA and RNA) in both pakaryote and eukaryote, flow of genetic information, gene regulation, recombinant DNA techonology, gene cloning, polymerase chain reaction (PCR), hybridization of DNA or RNA, genomic and cDNA libraries, DNA sequencing, gene expression profiles, RNA interference, and mutagenesis.	1. explain structure and function of nucleic acid in both prokaryote and eukaryote 2. explain the process of gene regulation in both prokaryote and eukaryote 3. recognize the technology for DNA and RNA analysis 4. apply the knowledges for research works
109706	Biochemical Instrumentation	4(3-3-6)	Consent of the School	Principles of chromatography, TLC, LC, HPLC, GC, GC-MS, LC-MS/MS, Spectroscopy: visible and UV spectroscopy, fluorescence spectroscopy, circular dichroism, nuclear magnetic resonance, flow cytometry, fluorescence activated cell sorting (FACs), X-ray crystal diffraction, dynamic light scattering spectroscopy, isothermal microcalorimetry, DNA and protein separation by electrophoresis, DNA sequencers, single channel measurements	1. explain principles of chromatographic separation of various types. 2. explain principles of various type of spectroscopy 3. explain principles of advanced instrument for biomolecular analysis 4. describe principles of electrophoretic separation 5. analyse and interprete result from each instrument correctly 6. appropriately choose the instrument for doing research

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109707	Bioinformatics and Computer Usage	2(1-3-2)	Consent of the School	Basic computing, operating systems, languages, basic UNIX commands, internet, searching principles, basics of molecular evolution, tools for nucleotide and protein sequence analysis, protein sequence alignment, database searching, multiple sequence alignment, tree generation and meaning, sequence and structure databases, display of macromolecular structural models.	1. explain principles of bioinformatics. 2. have skill in using computers and computer programs in conducting biochemical evaluations 3. collect, classify, store, evaluate and analyse scientific data 4. conscious and aware of the academic and professional conduct, and are able to work with others 5. communicate scientific knowledge in different forms effectively and appropriately 6. eager for knowledge and learning of Bioinformatics and Computer Usage
109708	Selected Research Project	4(0-12-0)	109700 Graduate Biochemistry/Consent of the School	Develop skills in the use of biochemical methods in scientific research, writing and present a research proposal in coordination with their class advisor, conduct the small biochemical research project, report and present the results in a seminar to the biochemistry faculty academic staff and students.	Students understand the research problem; have ability to conduct a literature review on relevant documents; and understand theories, key concepts and instrument use. Students have basic skills to conduct the project, ability to analyze, discuss and conclude the obtained data. Finally, students are able to write a scientific report and present the obtained results systematically.
Elective Course					

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109711	Principles of Transport Across Membranes	2(2-0-4)	Consent of the School	Properties of biological membranes and types of membrane proteins, biophysics and kinetics of various types of molecular transports across membranes of prokaryotic and eukaryotic cells, types of membrane proteins involving signal transduction, fundamental methods for studying structures and function of membrane proteins, defects in membrane transport which lead to genetic diseases, mechanisms of multi-drug resistance involving transport across membranes	1. explain properties of biological membranes and types of membrane proteins 2. explain principles of molecular transports across membranes 3. explain fundamental methods for studying membrane proteins
109721	Advanced Bioinformatics and Biochemical Computing	3(3-0-6)	109705 Bioinformatics and Computer Usage	Computer programs and programming concepts, molecular evolution and biological sequences sequence alignment strategies and implementation, structural analysis of proteins and molecular modeling, analysis of other types of biological/biochemical data.	1. understand the general structure and utilization of public databases. 2. utilize tools for analysis of protein and nucleic acid sequences. 3. understand and explain basic approaches to designing and implementing simple scripts related to biochemical data and processing. 4. understand the structure of protein structure files and utilize graphics software to analyse protein structures. 5. utilize basic mRNA expression analysis programs and websites.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109724	Genomics, Functional Genomics	3(3-0-6)	109700 Graduate Biochemistry/109705 Bioinformatics and Computer Usage/ Consent of the School	Definition of genomics, genome and genome components, DNA sequence in human genome, genetic variation in human genome (mutation and SNPs), genomics study with high throughput technology in DNA levels (Exom re-sequencing), transcription profiling (cDNA microarray, EST, RNA seq and real time RT-PCR), functional study for interested gene with mutagenesis and RNA interference; RNAi, and its applications disease and medical application.	1. explain the basic ways to analyse genomic data for gene expression and function 2. explain the origin and use of gene expression data in the public databases 3. explain the use of SNPs and other genomic polymorphins
109731	Clinical Biochemistry	3(3-0-6)	109700 Graduate Biochemistry/Consent of the School	Cause of inherited and non-inherited metabolic disorders, cause of abnormal quality and quantity of macromolecules or body fluid in the body, pathogenesis of biochemical disorders, biochemical analysis for diagnosis and monitoring.	1. recognize biochemical disorders 2. explain the causes and mechanisms of diseases 3. explain and interpret the results from biochemical analyses
109732	Biochemical Immunology	4(4-0-8)	Consent of the School	Basic knowledge of biochemical mechanism of the immune system, nature and properties of immunological molecules, mechanism of host defense, principal mechanism of the immune responses, recognition of foreign pathogens, activation of immunological cells, related diseases of failure defense mechanism, evolution of immunological technology in scientific area.	1. identify types and functions of cells or molecules, which play important role in the immune system 2. describe the mechanism of the immune system 3. explain the defects caused by the failure of the immune system 4. search, interpret, and evaluate information from the literature 5. apply the knowledge about the immune system for scientific work

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109733	Biochemistry and Molecular Biology of Cancers	4(4-0-8)	109700 Graduate Biochemistry/Consent of the School	Definition of cancer cells, multistep carcinogenesis, cancer cell metabolism, cell cycle and regulation, oncogenes, tumor suppressor genes, genomic stability and DNA repair, cancer signaling pathways, cell death, cancer invasion and metastasis, cancer epigenetics.	1. explain the process of cancer development 2. differentiate the functional role between oncogenes and tumor suppressor genes 3. explain the molecular biology of cancer cell growth and cancer cell survival 4. apply the knowledges for research work
109734	Biochemistry for Healthcare Products and Cosmeceuticals	4(4-0-8)	109310 Principles of Biochemistry II, 109700 Graduate Biochemistry /Consent of the School	Background about biochemistry, physiology and morphology of epidermis connective tissue, hair teeth body liquids, types and active ingredients of healthcare and cosmeceutical products, uptake, transportation, functions and metabolism of healthcare and cosmeceutical products, clinical biochemistry of healthcare and cosmeceutical products, industry of healthcare and cosmeceutical products	1. understand and are able to explain princilples of biochemistry metabolism and function of healthcare products and cosmeceuticals 2. know about types, components, and active ingredients of for healthcare products and Cosmeceuticals 3. eagerly attain knowledge and learning of biochemistry for healthcare products and cosmeceuticals
109735	Formulation and Analysis of Healthcare and Cosmeceutical Products	4(2-6-4)		Lecture and Laboratory studies general principles about formulation, Analysis of chemical propeerties, physical propeerties, and biological propeerties quality safety-test, quality trest of healthcare and cosmeceuticals products	1. explain principles of healthcare and cosmeceuticals products 2. have skill in using scientific instruments and in conducting biochemistry experiments. 3. collect, classify, store, evaluate and analyse scientific data. 4. be conscious and aware of academic and professional conduct, and able to work with others. 5. communicate scientific knowledge in different forms effectively and appropriately. 6. eagerly attain knowledge, learning for healthcare and cosmeceuticals products

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109741	Plant Biochemistry	4(4-0-8)	Consent of the School	Biochemistry and basic physiology of plant such as photosynthesis and respiration, the biochemistry of intermediary metabolism and the secondary plant compounds, bioenergetics, hormone regulation of metabolism and application.	1. explain the biochemistry and physiology of plants 2. compare the biochemistry between plants and other living organisms. 3. explain how to apply to use the plant biochemistry knowledges in the fields of scientific researches and industries
109742	Plant Secondary Metabolism and Application	4(4-0-8)	None	Major of plant secondary metabolites, biosynthesis, function, metabolic control, application in industry, ecology and medical treatment, metabolic engineering. Expected Learning Outcomes	1. classify the plant secondary metabolites and explain their functions 2. explain how to apply to use the plant secondary metaobite knowledge in the fields of scientific research, industries and ecology
109743	Microbial Biochemistry	4(4-0-8)	109700 Graduate Biochemistry/Consent of the School	This course involves biochemistry and basic physiology of archaea, bacteria and viruses, such as growth (reproduction or multiplication), structures, functions and synthesis of cell wall and cell membrane, encapsidation and envelope formation of viruses, regulation of metabolism and genetic transfer, bioenergetics, chemical communication of bacteria, materials uptake and secretion of bacteria, enter to and exit form host cell, pros, cons and applications.	1. explain princilples of microbial biochemistry 2. have skill in using sciencitific instruments and in conducting microbial biochemistry experiments 3. eagerly attain knowledge and learning of microbial biochemistry

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109752	Antibody Technology	3(3-0-6)	109732 Biochemical Immunology/Consent of the School	Basic knowledge on biochemical structure, function, and production of antibody, evolution of antibody engineering and application, using of antibody in scientific area.	1. describe biochemical structure and function of the antibody 2. describe antibody production and type of the antibody 3. describe the suitable handling of the antibody for scientific work 4. explain evolution of antibody for research and therapeutic application 5. apply knowledge about antibody technology for research effectively and appropriately
109753	Molecular Bio-Product Development	3(3-0-9)	Consent of the School	Bio-product development from gene to product. Bio-product development requires integration of basic science and engineering. This course includes recombinant DNA technology, molecular research tools, manipulation of gene expression, protein engineering techniques, and synthetic biology. Moreover, it also reviews selected current research literature.	1. understand the principles and examples of biotechnology for product development 2. apply basic research to biochemical applications 3. communicate scientific information 4. conduct multidisciplinary research, particularly that aimed at product development
109771	Current Topics in Biochemistry	3(3-0-6)	109700 Graduate Biochemistry/Consent of the School	Current topics of interest in biochemistry and biochemical technology.	1. describe the importance of the selected current topics in biochemistry and biochemical technology 2. describve the theory about the current topics in biochemistry and biochemical technology 3. search, interpret, and evaluate information from the literature effectively and appropriately 4. update their knowledge about current topics in biochemistry and biochemical technology 5. apply the novel knowledge for research work effectively and appropriately

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109775	Principles of Macromolecular Crystallography and Small Angle X-ray Scattering	4(4-0-8)	109703 Protein Structure and Engineering/Consent of the School	Theory of macromolecular crystallography, indirect nature of macro-molecular crystal structures, overview of protein and amino acid X-ray crystal structure determination and its requirements, preparation of protein for crystallography, including introduction of selenomethionine; generation of protein crystals, introducing ligands and heavy atoms; diffraction, Fourier transform and its relation to diffraction and structure generation; indexing and scaling crystal data, indications of data quality, crystal symmetry and systematic absences; phasing of crystal structure factors, structure solution, refinement; structural convergence, measures of structure quality, evaluating published crystal data, other diffraction methods: fiber diffraction, X-ray scattering, electron diffraction, neutron diffraction, processing of EM images. Principles of small angle X-ray scattering in determining solution structur of protein and others macromolecules.	1. explain princilples of macromolecular crystallography and small angle X-ray scattering 2. eager for knowledge and learning of macromolecular crystallography and small angle X-ray scattering

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109776	Practical in Protein Crystallography and Small Angle X-ray Scattering	4(1-9-2)	109703 Protein Structure and Engineering/Consent of the School	Laboratory class in small angle X-ray Scattering and protein crystallography techniques, protein purification and evaluation, protein crystallization exercise, protein crystal seeding, crystal inspection and evaluation, crystal diffraction, data processing, structure solution by molecular replacement, software for other phasing methods, structure refinement with CCP4 or Phenyx, etc., Evaluation of structures on internet servers, i.e. Procheck, Molprobity, etc.	1. explain princilples of macromolecular crystallography and small angle X-ray scattering 2. have skill in using sciencitific instruments and in conducting macromolecular crystallography experiments and small angle X-ray scattering 3. collect, classify, store, evaluate and analyse scinctific data. 4. conscious and aware of the academic and professional conduct, and to work with others 5. communicate scientific knowledges in different forms, efficiently and appropriately 6. eagerly attain knowledge and learning of macromolecular crystallography and small angle X-ray scattering
Seminar Course					
109881	Biochemistry Seminar I	1(0-1-2)	None	Selectiong topics or issues, planning seminars in advance Biochemistry, presentation, discussion, clarifying for questions related to recently research publication in the filed of interest	impove scientific reading skills, identify 1. the main content and interpret the result of selecting articles 2. enhance their scientific communication skills through discussions, small-group work, presentations or debates 3. improve their critical thinking skill

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109882 Biochemistry Seminar II	1(0-1-2)	None	Selectiong topics or issues, planning seminars in advance Biochemistry, presentation, discussion, clarifying for questions related to recently research publication in the filed of interest	1. impove scientific reading skills, identify the main content and interpret the results of selecting articles 2. interpret published data, effectively review the literature, and write a scientific review 3. enhance scientific communication skills through discussions, small-group work, presentations or debates 4. have conscientiousness in their academic and professional conduct, ability to work with others, and respect others opinions 5. improve critical thinking skills 6. present the research work to the public
109883 Biochemistry Seminar III	1(0-1-2)	None	Selected topics or issues, planning seminars in advanced Biochemistry, presentation, discussion, clarifying for questions related to recent research publications in the filed of interest	1. enhance their scientific communication skills through discussions, small-group work, presentations or debates 2. improve their critical thinking skills 3. be conscientious in their academic and professional conduct, able to work with others, and respect others opinions 4. present their research work to the public in both national and international communities

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
109884 Biochemistry Seminar IV	1(0-1-2)	None	Selection of topics or issues, planning seminars in advanced Biochemistry, presentation, discussion, clarifying for questions related to recent research publications in the filed of interest	1. enhance scientific communication skills through discussions, small-group work, presentations or debates 2. improve critical thinking skill 3. have conscientiousness in their academic and professional conduct, work with others, and respect others opinions 4. present research work to the public in both national and international communities
Thesis Course				
109891 Ph.D. Thesis		Consent of the School	Creating hypotheses, thesis proposal writing, research, interpretation of scientific data, and report writing on a specific topic relevant to the field of interest in biochemistry and biochemical technology under the supervision of the thesis advisory committee.	perform a literature review, conduct and present research relevant to biochemistry and biochemical technology, improve existing knowledge and develop new knowledge; and write a final thesis report and defend it in an oral examination.