Program: Master of Science Program in Environmental Biology
Degree: Master of Science (Environmental Biology)
Study Plan:

1) Research Program (Scheme A 1)

Year	First Trimester	Cr	Second Trimester	Cr	Third Trimester	Cr
Year 1	104799 M.Sc. Thesis	6	104799 M.Sc. Thesis	6	104799 M.Sc. Thesis	6
	Total	**6**	**Total**	**6**	**Total**	**6**
Year 2	104799 M.Sc. Thesis	10	104799 M.Sc. Thesis	10	104799 M.Sc. Thesis	10
	Comprehensive Examination				Thesis Defense	
	Total	**10**	**Total**	**10**	**Total**	**10**

2) Regular Program (Scheme A 2)

Year	First Trimester	Cr	Second Trimester	Cr	Third Trimester	Cr
Year 1	104600 Advanced Environmental Biology	4	104601 Environmental Impact Assessment	3	104604 Environmental Planning and Management	3
	104602 Research Methods and Statistics in Environmental Biology	4	Major Course	4	and/or	
			Elective Course	3	104603 Environmental Cell Biology	3
					104791 Seminar in Environmental Biology 1	1
	Major Course	4				
					Major Course	4
	Total	**12**	**Total**	**10**	**Total**	**8/11**
Year 2	104798 M.Sc. Thesis	3	104798 M.Sc. Thesis	6	104798 M.Sc. Thesis	7
	104792 Seminar in Environmental Biology 2	1	104793 Seminar in Environmental Biology 3	1	Thesis Defense	
	Comprehensive Examination					
	Total	**4**	**Total**	**7**	**Total**	**7**

Program: Master of Science Program in Environmental Biology
Degree: Master of Science (Environmental Biology)
Course Description:

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
Core Course				
104600 Advanced Environmental Biology	4(4-0-8)	104101 Principles of Biology I or Consent of the School	The studies of advanced environmental biology including human population, pollution and toxicology, diaster and climate change, environmental stress, current research issues in environmental biology, and field trips.	1. Explain the factors influencing population dynamics, human population change and environmental problems that follow; 2. Explain the factors affecting terrestrial and aquatic biomes, ecosystem component and nutrient cycling; 3. Explain the important of biodiversity, biological resource ploblems and ways to solve them; 4. Explain the factors causing water, air and soil pollution; solid waters; toxicology; urban problems and ways to solve them; 5. Explain the problems from using different energy resources and ways to solve them; 6. Explain the incease of disasters that related to global climate change; 7. Present examples of the current research in environment biology.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104601 Environmental Imoact Assessment	3(3-0-6)	None	Importance and background, environment impact assessment processes in Thailand and in other countries, types of projects to be assessed impact assessment methods for biological and physical environments, quality of life, health impact assessment, economic and social impact assessments, economics value of environment, strategic environmental assessment, environmental impact and monitoring report, case studies in Thailang and other countries, and field studies.	1. Explain the importance and background of environment impact assessment processes in Thailand and in other countries; 2. Explain the types of projects need to be assessed; 3. Explain the methods for biological and physical environments, quality of life and health impact assessment; 4. Explain the economic and social impact assessment; 5. Explain the strategic environmental assessment; 6. Explain the environmental impact and monitoring reports; 7. Present case studies in Thailand and from other countries.
104602 Research Methods and Statistics in Environmental Biology	4(4-0-8)	None	Concepts and applications of experimental research designs, research methods and processes, ethics for researchers, ethical use of animals for scientific, purposes, experimental research design analysis, survey and sampling techniques, the corresponding appropriate parametric and non-parametric statistical analysis, non-parametric testing, analysis of variance, comparison of multiple data, use of computer packages for statistical analysis.	1. Build skills in construcing appropriate statistical tests pertaining to measure of central tendency and non-parametric tests; 2. Be capable of answering biological questions using test statistics and understanding the underlying assumptions of the core statistical tests; 3. Interpret the results of ststitical test outcomes in order to make decisions based on statistical summaries of a dataset 4. Construct a basic experimental design that yields a testable hypotheis; 5. Use programs for statistical computing at proficient level for basic statistical analyses; 6. Use ethics for research and animals used for scientific purposes.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104603 Environmental Cell Biology	3(3-0-6)	None	Biological studies at the cellular level, including biomolecules of cell composition, structures and functions of organelles (cell membrance, cell wall, cellular matrix, cytoskeleton, chloroplast, mitochondria, and nucleus), cell junctions, cell motility, metabolism and bioenergy transformation in cells, DNA- replication, transcription, translation, cell cycle and controls, cell division, and basic tecniques to study cells.	1. Explain principles of biomolecules of cell composition, structures and functions of organelles (cell membrance, cell wall, cellular matrix, cytoskeleton, chloroplast, mitochondria, and nucleus), cell junctions, cell motility, metabolism and bioenergy transformation, DNA-replication, transcription, translation, cell cycle and controls, cell division, and basic techniques to study cells; 2. Self-learning via different learning sources, including information technology, on the current techniques to study cells for presenting and discussing with others in the classroom; 3.Apply the learning knowledge to analyze and solve the set problems of cell biology.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104604 Environmental Planning and Management	3(3-0-6)	None	Laws, policies and action plan for environmental management at local and national levels, international environment law and agreement, roles and structures of government and non-government environmental management organizations, wastewater, air, solid waste, hazzardous waste and other pollutants management technology, environmental economics, environmental management system standards, life cycle assessment, ecological footprint, carbon and water footprints, environmental labeling, environmental management in rural and urban areas, environmental psychology, environmental conflict negotitation and management, public participation, environmental campaign, case studies in Thailand and aboard, and field trips.	1. Explain the laws, policies and action plan for environmental management at local and national levels; 2. Explain the important international environment law and agreement; 3. Explain the roles and structures of governemnt and non-government environmental management organizations; 4. Explain the wastewater, air, solid waste, hazardous waste and other pollutants management technology; 5. Explain how to use economic tools for environmental management; 6. Explain how to apply for environmental management system standards; 7. Expkain how to study life cycle assessment of products; 8. Explain how to assess ecological, carbon and water footprints of products and organization; 9. Explain how to make the environmental labeling of products; 10. Explain the environmental management in rural and urban areas; 11. explain how to use environmental psychology for envirnmental conflict negotiation, managemnet and campaign;
Major Courses (Ecology)				

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104610 Advanced Ecology	4(3-3-6)	None	Concepts of advanced ecology and ecosystems management, earth systems science, structure and function of major terrestrial, freshwater and marine ecosystems, ecosystems relationship, impacts of anthropogenic activities on the ecosystems and their mitigations, modern analytical methods and data collection, and field studies.	1. Examine and interpret up to date academic literature pertaining to ecological theory; 2. Utilize methods from current academic papers in order to develop analytical skills and theoretical skills; 3. Build skills in order to discriminate between well-designed ecological studies and poorly designed ecological studies; 4. Compile a thorough literature review upon a narrow ecological topic in order to produce a final term paper; 5. Manipulate ecological datasets to build ecological analytical skillsets.
104611 Freshwater Ecology	4(4-0-8)	None	Concepts and principles of limnology, analysis of the complex interactions of physicochemical, biological and socio-economic factors in the watershed area, rivers, bog, mash, and lakes affecting the ecosystem productivity, population and community structures and functions, impact of anthropogenic activities on the ecosystem and management, water and wastewater treatment, modern analytical methods, and field studies.	1. Implement the practical and theoretical knowledge of aquatic ecosystems, with emphasis of central topics in the management of freshwater; 2. Monitor and analyze the limnology and water quality to understand the impact of eutrophication; 3. Define the predation and the significance of predation in water; 4. Demonstrate the cascade effects and regulation of freshwater system.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104612 Terrestrial Ecology	4(4-0-8)	None	Types and importance of terrestrial ecosystems, climatic, soil and topographic influences, water, carbon and energy balances, terrestrial production, decomposition, nutrient cycling, trophic dynamics, temporal and spatial dynamics of ecosystem from plant, animal and climate change, sustainable ecosystem management, case studies and field trips.	1. Develop a primarily analytical skillset for working with ecological datasets on land; 2. Be capable of using a variety of population level techniques to assess growth or decline in terrestrial populations; 3.Understand baseline modeling techniques in order to assess organismal interactions with the environment; 4. Design an independent project based on available online data in order to assess ecological questions; 5. Perform basic ecological field research activities on a variety of taxa (both plants and animals).
104615 Soil Ecology	4(4-0-8)	None	Soil components, soil forming factors and processes, soil characteristics, nutrient cycling, soil biodiversity, relationships of plants and soil organisms, soil trophic dynamics, decomposition, soil fertility, impacts of human activities on soil, soil pollution and degradation, soil conversation, climate change and soil, and field trips.	1. Explain soil components, forming factors and processes; 2. Explain soil charactoristics, nutrient cycling and biodiversity; 3. Explain relationships of plants and soil organisms; 4. Explain soil trophic dynamics, decomposition and fertility; 5. Explain the impacts of human activities on soil; 6. Explain the cause of soil pollution and degradation; 7. Explain the soil conservation methods; 8. Explain the impacts of climate change to soil; 9. Present case studies in Thailand and from other countries.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104711 Human Ecology	4(4-0-8)	None	Growth and evolution of human population, primate sociobiology-biological origin of human behavior, cultural evolution, population genetics and eugenics, human community types and their common environmental problems, environment conservation and management, and field trips.	1. Identify the human expansion globally and current population trends throughout planet Earth; 2. Desribe shifts in human development and their subsequent impacts on the Earth; 3. Distinguish between anthopogenic environment and biodiversity crises and naturally caused extinction events; 4. Compose a recociliation ecology plan for community incorporating both humans and the external environmentp; 5. Rank various anthropogenic influences upon the environment in terms of magnitude an severity.
104714 Biological Control	4(4-0-8)	104600 Avanced Environmental Biology or Concent of School	Principles and processes of biological control, molecular biology of biological control, control agents and biological control of insects, mitrs, medical and veterinary pests, vertebrates and weeds, research and future of biological control, case studies and field trips.	1. Explain the principles and processes of biological control; 2. Explain how to use molecular biology in biological control; 3. Explain how to use control agents and microbs in biological control; 4. Explain how to control insects, mites and medical and veterinary pests; 5. Explain how to biological control vetebrates and weeds; 6. Present research and future of biological control.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104716 Tropical Forest Ecology and Management	4(4-0-8)	None	Origin, evolution, succession and distribution of tropical forests, forest structures, the abiotic components such as water, soil, nutrient, and fire, and biotic components such as plants and animals, forest dynamic, human influence, technology and sustainable management of tropical forest, forest certification, and field trips.	1. Organise relevant literature pertaining to the decline of tropical forests in Southeast Asia and th eneotropics; 2. Illustrate the main dynamics underlying tropical forest systems in term of energy cycling and nutrients; 3. Compare methods of diversity assessment among various forest structural levels; 4. Estimate community interactions within forested systems within the tropics; 5. Examine management plans and reserve types in Thailand and internationally to rank the effectiveness of different management strategies.
104718 Wetland Ecology and Management	4(4-0-8)	None	The importances of wetland, major wetland ecosystems, bog marsh, lake and estuary, importance and factors effecting wetlands, restoration and creation of wetland, economics value of wetland, the Ramsar Convention, sustainable management of wetlands, and field trips.	1. Expalin the importances of wetland; 2. Explain major wetland ecosystems such as bog, marsh, lake, and estuary; 3. Explain the factors affecting wetlands; 4. Explain how to create and restore wetlands; 5. Explain the sustainable managemnet of wetlands; 6. Present case studies in Thailand and from other countries.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104719	Wildlife Ecology and Management	4(4-0-8)	None	Wildlife diversity, water, food and habitat requiremenr, growth, reproduction, migration, competition, predation, behavior, population dynamic, genetic diversity, disease dispersal, wildlife survey techniques, conservation, propagation and management of wildlife.	1. Define wildlife and assess the up to date liturature of wildlife in both tropical and temperate ares; 2. Discuss model wildlife systems and predator prey interactions in terms of ecological systems; 3. Assess management techniques for maintaining wildlife populations and stable systems; 4. Construct a basic management plan for wildlife human conflict prevention; 5. Interpret and assess a wildlife management report from a protected area in the United State of America.
104818	Marine and Coastal Ecology and Management	4(4-0-8)	None	Concept and principles of oceanograpy, biological zoning of marinem coastal and mangrove, the physico-chemical, biological and socio-economic factors, affecting the productivity of marine, coastal zones and mangroves, succession, biological and environmental data collecting for marine and coast, impact of anthropogenic activities on the ecosystems, sustainable fishery and acuaculture, and field studies.	1. Explain the concepts and principles of oceanography; 2. Explain the biological zoning of marine, coastal and mangrove; 3. Explain the physico-chemical, biological and socio-economic factor, affecting the productivity of marine, coastal zones and magroves; 4. Explain the impacts of anthropogenic activities on marine and coastal ecosystems; 5. Explain the sustainable fishery and aquaculture methods; 6. Present case studies in Thailand and from other countries.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104819 Ecological Statistics and Modeling	4(4-0-8)	None	Sampling methods, analysis of variance, analysis of covariance, regression, multiple regression analysis, multivariate analysis of variance, principal component analysis, facor analysis, cluster analysis, canonical correlation analysis, discriminatinant analysis, logistic regression analysis, non-parametric analysis, Bayesian methods, model building and software.	1. Be capable of interpreting classical methods and linear models used ecological assessments; 2. Use program R to answer complex ecological questions with non-nomalized data and alternative distributions; 3. Become familiar models used in both grouped and non-independent models (mixed effects models); 4. Model non-independent data that cannot be grouped using generalized least squares; 5. Interpret and assess appropriateness of particular statistical techniques with a dataset.
Major Courses (Biodiversity)				
104620 Biodiversity and Conservation	4(4-0-8)	None	Analysis of biodiversity in genetic level, species, and ecosystem levels, possible world's biodiversity, especially in biodiversity surveys in the tropics, biodiversity preservation both in situ and ex situ, minimum viable population size, extinction, genetics conservation, ecological restoration and sustainable development, including introduce concepts of international legal protection such as Convention on Biodiversity (CBD) and build understanding to apply at local and regional levels.	1. Students should be able to assess the scientific capacity for measuring biodiversity at various scales from local to globally; 2. Interpret academic literature pertaining to biodiversity metrics and utilze diversity measues from specific datasets; 3. Examine conservation techniques for maintaining biodiversity rich regions, and interpret state of the art literature; 4. Develop a conservation management plan applicable to a real-world biodiversity conservation example.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104621 Biogeography	4(4-0-8)	None	Evolution of earth and life on earth, distribution and distribution assumption, environmental factors affecting distribution, relationships between organisms and land form, climate and soil types, adaption of organisms, geographical identification, and field trips.	1. Students should be able to apply island biogeographic theory to specific examples of systems; 2. Explain the theoretical framework for how oranisms are geographically situated; 3. Be capable of composing a full biogeographic summary of a particular organism of interest; 4. Dvelop basic range maps for organisms of interest. Use fundamental geographic skills (GIS) to build quality maps; 5. Interpret species distribution models and maps to identify hotspots for species locations.
104622 Diversity of Plants	4(3-3-6)	None	Studies of major plant families, especially those found in Thailand and Southeast Asia, practical methods for identifying plant species, including protected species and economically and medicinally important species, phenology of plants, and attendance on field trips to natural forest areas or botanical gardens.	1. Recognize plant family of plant sample in field and indicate the taxonomic character of the family; 2. Identify plant species; 3. Provide th photographic illustration and description of plant sample.
104623 Diversity of Animals	4(4-0-8)	None	Diversity and taxonomic treatment of invertebrate and vertebrate animals, emphasizing on structure, functions, life cycles, behaviors and phylogeny, and phenology of animals.	1. Explain by topic as a stated; 2. Have skill for work as a team and individually; 3. Apply the knowledge for daily life.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
10624	Paleontology	4(4-0-8)	Consent of the School	Studies of the evolutionary history of life on earth, origin and evolution of major taxa, extinctions and radiations, charges in climates and environments over time, use of fossils in biostratigraphy and biogeography, and field trips to museums or fossil sites.	1. Be capable of describing the general evolutionary history of planet earth; 2. Apply theoretical framework to taphonomic biases in order to interpret recent paleontological academic literature; 3. Assess various fossil preparation methods and museum culture to determine ideal fossil storage techniques; 4. Use basic paleo-climateic interpretation skills to reconstruct the paleo-environment based of fossil dating.
104721	Advanced Biosystematics	4(3-3-6)	104600 Advanced Environmental Biology or Consent of the School	Comparison of modern analytical methods used in systematic and phylogenetic reconstruction.	1. Explain the concepts of the field and principles of phylogenetic analysis; 2. Discuss and apply methods to generate relevant molecular data, mainly sequence data; 3. Choose and apply software to generate relevant molecular datat to phylogenetic analysis; 4. Analyse and evaluate the results of phylogenetic analyses.
104722	Speciea and Speciation	3(3-0-6)	None	Investigations of various concepts of species and possible mechanism of speciation, approached from both the genetic and organismic levels, discussion of methods of protection of species, especially in endangered species.	1. Explain and compare the species concepts; 2. Explain the mainmechanisms behind speciation; 3. Assess the most recent literature pertaining to evolutionary history and speciation; 4. Present the idea concept for species conservation.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104724 Plant Geography	4(4-0-8)	104621 Biogepgraphy or Consent of the School	Concept, general aspects, and taxonomic basis of plant geography, patterns and factors affecting plants distribution, plant geography of the world, Southeast Asia, and Thailand, and field studies.	1. Explain the theoretical framework for how plants disperse and expand ranges; 2. Examine the potential for propagule pressure in predicing plant species distributions; 3. Develop basic range maps for plant species of interest. Using explanded geographic skill (GIS) to build quality maps; 4. Use species distribution models with real plant locations to predict feographic distribution on variety of scale.
104725 Zoogeography	4(4-0-8)	104621 Biogepgraphy or Consent of the School	Studies of the pattern of the pasr, present, and the future distributions of animals in nature and the processes that regulate these distributions.	1. Use various movement models to measure and predict animal movement patterns; 2. Build tools for assessment of animal distributions using species distribution models and expanded assessment of geographic information systems (GIS; 3. Interpret recent literature pertatining to animal locations and distributions including ranges and movement patterns; 4. Complie recent literature pertaining to the mechanisms of animal dispersal and vicariance throughout evolutionary history.
104726 Ethnobotany	4(4-0-8)	None	Meaning of ethnobotany, diversity and development of folk taxonomies, people and plant utilization such as food, construction, medicine, plant in culture and religion etc., traditional home garden, and field trip on Thai ethnobotany case study.	1. Give example of plant used by local people; 2. Collect plant specimens and utilized information by local people.
Major Courses (Environmental Physiology)				

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104731 Environmental Plant Physiology	4(3-3-6)	None	Acquisition of resources, energy and carbon, mineral nutrients, and water, physiological and behavioral responses of plants to naturally occurring and modified environmnetal factors, mechanisms underlying physiological processes that give rise to ecologically important responses at virous levels of organization, and field studies included in some practical exercises.	1. Explain the acquisition of resources, energy and carbon, mineral nutrients, and water of plants; 2. Explain physiological and behavioral responses of plants to naturally occurring and modified environmental factors; 3. Explain mechanisms underlying physiological process that give rise to ecologically important responses at various levels of organization; 4. Use information technology to search knowledge or current topics from different sources related to environmental plant physiology to present and discuss with others in the classroom; 5. Apply the learning knowledge to analyze and solve the set problems of environmental plant physiology.
104732 Environmental Animal Physiology	4(3-3-6)	104630 Environmental Physiology or Consent of the School	Selected aspects of animal physiology as they related to environmental adaptation, effects of natural and anthropogenic environmental stresses on animal physiology including movement, feeding, respiration, reproduction, behavior, energy utilization, endocrine and nervous responses, and field studies included in some practical exercises.	1. Explain principle and theory related to environmental animal physiology and the effects of environments upon the physiology of animals; 2. Explain techniques used in studying of animal physiology; 3. Research analyze, and integrate with other related academic fields aas basic knowledge to utilizing for further special academic field study; 4. Create and solve problems related to environmental animal physiology by analyzing, synthesizing, and evaluating from gained knowledge that might lead to new innovation; 5. Research the topics related to environmental animal physiology and then aooly for daily life.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104733 Cooperative Endocrinology	4(4-0-8)	None	Physiology of endocrine systems, mechanisms of hormone action, and physiological roles of hormones and overall integration in regulating development, rreproduction, and homeostasis of vertebrates and invertebrates, examples of the experimental basis for current understanding of the endocrine system in various organisms.	1. Explain principle and theory related to endocrine system of vertebrates and invetebrates; 2. Explain types of hormone, functions of hormone, and mechanism of action of each hormone; 3. Explain types of endocrine gland, hormone(s) of each endocrine gland, abnomality and pathophysiology of endocrine glands; 4. Explain the association of hormones in the regulation of homeostasis; 5. Explain techniques used in studying of endocrine system; 6. Research, analyze, and integrate with other related academic fields as basic knowledge to utilizing for further special academic field study; 7. Create and solve problems related to endocrinology by analyzing, synthesizing, and evaluating from gained knowledge that might lead to new innovation; 8. Research the topics related to endocrinology and then apply for daily life.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104734	Avian Physiology	3(3-0-6)	None	Systemic physiology and its regulation of wild and domestic birds, endocrine control of each system, phusiology and its mechanism underlying avian behaviors such as migrattion, incubation, flight, and diving.	1. Explain principle and theory related to the regulation of systemic physiology of wild or domestic avian species; 2. Explain the relation/association of organ systems in the regulation of homeostasis. Migration, incubation, flying, and diving birds; 3. Explain techniques used in studying of avian physiology; 4. Research, analyze, and integrate with other related academic fields as basic knowledge to utilizing for further special academic field study; 5. Create and solve problems related to avian physiology by analyzing, synthesizing and evaluating from gained knowledge that might lead to new innovation; 6. Research the topics related to avian physiology and then apply for daily lifr.
104831	Plant Responses to Environmental Stress	4(4-0-8)	None	Molecular, metabolic, and physiological aspects of plant responses to environmental stresses including heat-shock stress, climate change, air pollution and hypoxia, nutrient stress, heavy metal stress, wounding stress, pathogen stress, phytohormones and other modulators, discussion of defense response system and genetic analyses.	1. Explain the molecular, metabolic, and physiological aspects of plant responses to environmental stresses; 2. Discuss about defense system and genetic analyses of plants; 3. Use information technology to search knowledge of current topics from different sources related to plant responses to environmental stresses to present and discuss with others in the classroom; 4. Apply thelearning knowledge to analyze and solve the set problems of plant responses to environmental stress.
Major Courses (Environmental Molecular Biology)					

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104640 Molecular Genetics	4(4-0-8)	None	Genes, genomes, chromosomes, transcription, posttranscriptional mechanisms, translation, regulation of gene expression, molecular genetics of development, molecular genetics and evolution, laboratory techniques in molecular biology.	1. Explain meaning and function of genem genome and chromosome; 2. Explain mechanisms of how genetic information is used in controlling traits of organisms; 3. Explain molecular genetic mechanisms that affect gene expression; 4. Explain roles of genetic control at the molecular level in development of animal models; 5. Explain molecular genetic mechanisms that have effects on evolution; 6. Provide laboratory techniques for molecular genetic studies.
104641 Ecgenetics	4(4-0-8)	None	Concepts and analytical methods of investigating environment-gene interactions in phenotypic variations in various mating or breeding systems and levels of organization, genetic heterogeneity and ecology, applications of ecogenetics in agriculture and public health.	1. Explain the importance of ecogenetics; 2. Provide the principles of markers and samplings in ecogenetics; 3. Explain the relationship between genetic diversity and mating systems; 4. Explain the importance of biological and environmental factors of gene flow; 5. Analyze case studies ecogenetics.
104642 Population Genetics	4(4-0-8)	None	Concepts and analytical methods of investigating gene frequesncies and the mechanisms of their changes within populations and between populations, mechanisms of speciation evolution, genetic veriation in population in relation to environmental changes.	1. Use the Hardy-Weinberg principle to explain when microevolution occurs; 2. Provide techniques that can be used to identify genetic variation within and among population; 3. Explain how mutations, gene flow, nonrandom mating, genetic drift, and natural selection contribute to the process of microevolution.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104644 Molecular Evolution	4(4-0-8)	None	Methodology in molecular evolution, molecular evolution and morphology, role of mutations, selection and drift in molecular evolution, molecular clock theory, natural theory of molecular evolution, evolution through domain duplication and domain shuffling, evolution via horizontal gene transfer and transportation, concerted evolution of multigene families, genome, organization, protein evolution.	1. Provide and explain principles of methods used in molecular evolution; 2. Provide and explain mechanisms at molecular level that lead to evolution; 3. Explain the significance of natral theory and its application in molecular evolution study; 4. Discuss case studies in molecular evolution.
104645 Evolutionaary Genetics	4(4-0-8)	None	The processes that influence the creation, maintaenance and distribution of genetic variation in natural populations, the utility of genomic data to infer the evolutionary history of taxa above and below the species level.	1. Explain roles of genetic variation and population genetic structure in species conservation; 2. Explain why rapidly evolving genes are good choice to infer relatively close evolutionary relationships whereas genes that evolve more slowly are better choice to infer relatively distant evolutionary relationships; 3. Build and interpret phylofeographic networks and phylogenetic trees to infer the evolutionary history of populations and species, both orally and in writing.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104852 Principles of Molecular Biology Techniques	4(4-0-8)	None	Studies of concepts, principles and applications of main techniques in molecular biology, principle techniques of DNA, principle techniques of RNA, principle techniques of protein, and principle techniques of molecular binding and cell biology.	1. Explain the principle techniques of DNA and compare the advantages and disadvantages of those techniques; 2. Explain the principle techniques of RNA and compare the advantages and disadvantages of those techniques; 3. Explain the principle techniques of proteins and compare the advanatages and disadvantages of those techniques; 4. Explain the principle techniques of molecukar binding and compare the advantages and disadvantages of those techniques; 5. Be able to choose molecular techniques suitable for solving a research problem.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104853 Cellular Signal Transduction	3(3-0-6)	Consent of the School	Principles and concepts of signal transduction at cellular level covering classifications and regulation mechanisms of signaling receptors, and effector pathways, examples of specific signaling pathways, signifiances of signal transduction in endocrinology and immunology, and cancer biology.	1. Explain principle and theory related to signal transduction at cellular level covering classifications and regulation mechanisms of signaling ligands, signaling receptors, and effector pathways, effector pathways, examples of specific signaling pathways, significances of signal transduction in endocrinology and immunology, and cancer biology; 2. Explain techniques used in studying of signal transduction; 3. Research, analyze, and integrate with other related academic fields as basic knowledge to utilizing for further special academic field study; 4. Create and solve problems related to signal transduction by analyzing, synthesizing, and evaluating from gained knowledge that might lead to new innovation; 5. Research the topics related to signal transduction and then apply for daily life.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104854 Techniques in Molecular Biology	4(2-6-4)	None	Emphasizing on principles and basic methods in molecular biology. Lecture topics covering plasmids and their usefulness in molecular cloning, preparation and analysis of genetic materials, gel electrophoresis of DNA and RNA, Southern and Northern hybridization, the polymerase chain reaction, radio and non-radio labeled DNA and RNA probes, mutagenesis, molecular markers, and bioinformatics, laboratory-based works including construction and expression of gene in *Echerichia aoli* , DNA and RNA extraction, gene electrophoresis, polymerase chain reaction, and bioinformatics in molecular biology.	1. Describe the basic techniques in molecular biology; 2. Have skills in using information technology for searching data from bioinformatics data base; 3. Able to design and carry out experiment to obtain recombinant DNS; 4. Have skills in animal tissue culture; 5. Able to analyze and detect protein; 6. Able to analyze and conclude the results.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104855 Plant Genetic Engineering	4(4-0-8)	None	Studies of the development and current status of DNA technology, genetic engineering in generating new-desirable plant species, macromolecular interactions, control mechanisms, and alteration in transgenic plants.	1. Explain the development and current status of DNA technology and genetic engineering in generating ne- desirable plant species; 2. Explain about macromolecular interactions; 3. Explain about control mechanisms and alteration in transgenic plants; 4. Use information technology to search knowledge or current topics from different sources related to plant genetic engineering to present and discuss with others in the classroom; 5. Apply the learning knowledge to analyze and solve the set problems of alteration in transgenic plants.
104856 RNA Interference Technology	4(4-0-8)	None	The discovery of interference RNA (RNAi), and its biochemical action, RNAi in modulating gene expression, application of RNAi in disease prevention and cure, as wekk as functional genomics.	1. Explain the meaning of interference RNA (RNAi) and its biochemical actions; 2. Discuss how RNAi is used in modulating gene expression; 3. Discuss application of RNAi in disease prevetion and cure, as well as functional genomics; 4. Use information technology to search knowledge or current topics from different sources related to RNA interference technology to present and discuss with others in the classroom; 5. Apply the learning knowledge to analyze and solve the set problems of RNAi in diseas prevention and cure, as well as functional genomics.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104858 Advanced Plant Molecular Biology	4(4-0-8)	None	Nuclear genome organization, genetic information in organelles and its expression, transposable element, signal transduction, molecular genetics of plant development, discovery of plant genes, application of gene transfer technology in plants, and current issues in plant molecular biology.	1. Explain about nuclear genome organization, genetic information in organelles and its expression; 2. Explain steps and molecular mechanisms of plant development including seed germination, plant growth, development of leaf, flower, fruit and seed, as well as leaf senscence; 3. Explain techniques and methods for discovery of plant genes; 4. Discuss the application of gene transfer technology in plants to solve problems including yield increase, disease resistance, stress resistance, etc; 5. Use information technology to search knowledge or current topics from different sources related to current topics on plant molecular biologt to present and discuss with others in the classroom; 6. Apply the learning knowledge to analyze and solve the set problems of gene transfer technology in plants.
Major Courses (Environmental Nanotechnology and Toxicology)				

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104660 Environmental Toxicology	4(4-0-8)	None	Types of environmental pollutants, fate and transport to environment, toxicity analyses in living organisms, bioaccumulation and effects in living organisms, human and ecological risk asssessment, controls, management and legislations of environmental pollutant, and current topics on environmental toxicology.	1. Explain types of environmental pollutants, fate and transport to environment, toxicity analyses in living organisms, bioaccummulation and effects in living organisms, human and ecological risk assessment, controls, management and legistration of environmental pollutant; 2. Self-learning on the current topics on environmental tozicology via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of environmental toxicology.
104661 Industrial Toxicology	4(4-0-8)	None	Exposure and mechanisms of toxic chemical in industries, transport and storage of chemicals, problems and diseases related to occupation, control and safety for using chemicals in industries, and current topics associated with industrial toxicology.	1. Explain principles of exposure and mechanisms of toxic chemicals in industries, transport and storage of chemicals, problems and diseases related to occupation, control and safety for using chemicals in industries; 2. Self-learning on the current topics on the industrial toxicology via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of industrial toxicology.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104766 Environmental Impacts of Nanomaterials	4(4-0-8)	None	Nanomaterials in commercial products, nanomaterials in detergents and cosmetics, behaviors of nanomaterials in environment, uptake and protential mechanisms of nanomaterials in living organisms, effect of nanomaterials in aquatic organisms, soil organism and human health, environmental risk assessment of nanomaterials and current topics related to biological and environmental impacts of nanomaterials.	1. Explain principles of nanomaterials in daily life, behaviors of nanomaterials in environment, uptake and potential mechanisms of nanomaterials in living organisms, effects of nanomaterials in aquatic organisms, soil organisms and human health, environmental risk assessment of nanomaterials; 2. Self-learning on the current topics on the biological and environmental impacts of nanomaterials via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of biological and environmental impacts of nanomaterials.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104767 Nanotoxicology	4(4-0-8)	None	Stability of nanomaterials in environment and living organisms, physiochemical properties of nanomaterials, models for studying nanotoxicology, toxic mechanisms related to stress and inflammation, toxic mechanisms related to genotoxicity, toxicity studies of nanomaterials in different forms at cellular and genetic levels, monitoring, prevention and risk to human health of nanomaterial exposure in the workplace, nanothics and regulation of the control of nanomaterials in environment, and current topics of nanotoxicology.	1. Explain principles of stablity of nanomaterials in environment and living organisms, physiochemical properties of nanomaterials, models for studying nanotoxicology, toxic mechanisms related to stress and inflammation, toxic mechanisms related to genotoxicity, toxixity studies of nanomaterials in different forms at cellular and genetic levels, monitoring, prevention and risk to human health of nanomaterial exposure in the workplace, nanoethics and regulation of the control of nanomaterials in environment; 2. Self-learning on current problems on the nanotoxicolology via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of nanotoxicology.
104768 Environmental Nanotechnology	4(4-0-8)	None	Eco-friendly nanotechnology, nanotechnology for purified water, removal of organic compounds, air cleaning, disinfection, remediation of contaminated chemicals in surface and ground water, detection and elimination of pesticides, and current topics related to environmental nanotechnology.	1. Explain principles of eco-friendly nanotechnology for purified water, removal of organic compounds, sir cleaning, disinfection, remediation of contaminated chemicals in surface and ground water, detection and elimination of pesticides; 2. Self-learning on current topics on the environmental nanotechnology via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of environmental nanotechnology.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104769 Green Technology of Nanomaterials	4(4-0-8)	None	Principles and mechanisms of eco-friendly syntheses of nanomaterials, emphasis on the uses of extracts derived from plant, animals, and microorganisms to systhesize nanomaterials, the uses of biopolymers in the groups of polysaccharides, proteins, and nucleic acids to synthesize nanomaterials, the uses of living cells (such as bacteria and plants) as biofactories to synthesize nanomaterials, and current topics of green technology of nanomaterials.	1. Explain principles and mechanisms of eco-friendly systheses of nanomaterials, emphasis on the uses of extracts derived from plant, animals, and microoganisms to systhesize nanomaterials, the uses of biopolymers in the groups of polysaccharides, proteins, and nucleic acids to sythesize nanomaterials, the uses of living cells (such as bacteria and plants) as biofactories to synthesize nanomaterials; 2. Self-learning on current topics on the green technology of nanomaterials via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of green technology of nanomaterials.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104862	Nano-innovations for Water Treatment	4-(4-0-8)	None	Principles of nanomaterial applications for a production of clean water and wastewater treatment by removing of contaminated compounds (organic and organic compounds, and heavy meals) via adsorption, functional membrance, photocatalysis, microbrial control and disinfection, innovation development for detecting water contaminants, and current topics of nano-innovations for water treatment.	1. Explain principles of nanomaterial applications for a production of clean water and wastewater treatment by removing of contaminated compounds (organic and organic compounds, and heavy metals) via adsorption, functional membrane, photocatalysis, microbial control and disinfection, innovation development for detecting water contaminants; 2. Self-learning on current topics on the nano-innovations for water treatment via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of nano-innovations for water treatment.
104863	Silver Nanoparticies and Bio-applications	4(4-0-8)	None	Principles of silver nanoparticle synthesis via chemical, physical and biological approaches, morphology, properties, and mechanisms of anti-bacterial, anti-fungal, anti-viral, anti-inflammation, anti-angiogenic, anti-cancer activities, applications as antibacterial agents and sensors for detecting, biomolecules and metal ions, and current topics of bio-applications of silver nanoparticles.	1. Explain principles of silver nanopaticle synthesis via chemical, physical and biological approaches, morphology, properties, and mechanisms of anti-bacterial, anti-fungal, anti-viral, anti-inflammation, anti-angiogenic, and anti-cancer activities, applications as antibacterial agents and sensors for detecting biomolecules and metal ions; 2. Self-learning on current topics on the bio-applications of silver nanoparticles via differnt learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of modification of silver nanoparticles for bio-applications.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104864	Risk Assessment of Nanomaterials	4(4-0-8)	None	Principles of risk assessment of nanomaterials, including risk assessment process, description and usages of nanomaterials, physical and chemical specificity, hazard and tests, health and environmental hazard data, environmental transformation data, contacts of nanomaterials, assessment of alternative risk management, decision, records, implementation, revision, development, and regulation by government, and current topics of risk assessment of nanomaterials based on other international standards.	1. Explain principles of risk assessment of nanomaterials, including risk assessment process, description and usages of nanomaterials, physical and chemical specificity, hazard and tests, health and environmental hazard data, environmental transformation data, contacts of nanomaterials, assessment of alternative risk management, decision, records, implementation, revision, deployment, and regulation by government, and current topics of risk assessment of nanomaterials based on other international standards; 2. Self-learning on current topics on the risk assessment of nanomaterials based on other international standards, via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of risk assessment of nanomaterials.
104865	Nanomaterial Waste Management	4(4-0-8)	None	Principles of classification of nanomaterial waste, management waste via recycle, incineration, landfill, and organic process, and current topics of nanomaterial waste management.	1. Explain principles of classification of nanomaterial waste, management of nanomaterial waste via recycle, incineration, landfill, and organic process; 2. Self-learning on current topics on nanomaterial waste management via different learning sources, including information technology, to present and discuss with others in the classroom; 3. Apply the learning knowledge to analyze and solve the set problems of nanomaterial waste management.
Elective Course					

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104686	Scientific Writing in Environmental Biology	3(3-0-6)	None	Scientific writing, paragraph structure, graph, table and statistics explanation, essay writing, opinion, classification, cause-and-effect, argumentative and comparison-contrast essay writing, literature review, citation-handling software, research and thesis proposal, research report, disseration, and scientific journal publication.	1. Write a paragraph to enplain graph, table and statistics of research data; 2. Write opinion, classification, cause-and-effect, argumentative and comparison-contrast essay; 3. Write literature review; 4. Write research proposal, thesis proposal, research report, dissertation or manuscript for publication upon student's interest; 5. Use citation-handling software such as Endnote.
104687	Scientific Research Understanding and Evaluation	3(3-0-6)	None	Research and journal databases, integrity of reaearch authors and their results, conflict of interest, research authors and their results, conflict of interest, research ethics, complete and updated references, recent, well-approved and objective corresponding metjod, simply and easy-to-understand data analysis and presentation, appropriateness and correct interpretation of statistics, logical, complete and direct discussion writing, not beyond research scope and limitation conclusion, research implication and application.	1. Evaluate research and journal sources by journal impact factor and the integrity of research authors and their articles; 2. Explain the conflict of interest and research etics; 3. Evaluate the abstract; 4. Evaluate the research and journal article by the complete and updated references, objective-method correspondent, easy-to-understand data presentation, appropriate and correct interpretation of statistics, logical discussion and resonable conclusion.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104771	Bioinformatics	3(3-0-6)	None	Biological basics of bioinformatics, biological databases, uses of programs to search and compare the nucleotide and amino acid swquences, decoding of genomes, analysis and prediction of structures and functions of nucleotide and amino acid sequences, similarity and homology analyses, and phylogeny analysis.	Explain principles of biological basics of bioinformatics, biological databases, search and comparison of the nucleotide and amino acid sequences, decoding of genomes, analysis and prediction of structures and functions of nucleotide and amino acid sequences, similarity and homology analyses, and phylogeny analysis; 2. Use programs to analyse nucleotide and amino acid sequences to obtain biological data; 3. Apply the learning knowledge to analyze and solve the set problems of bioinformatics.
104772	Sensor-Based Ecology	4(4-0-8)	None	Sensor technology; deployment and monitoring protocols; error and validity consideration; data retrival, acquisition and data analysis; extreme environment cases e.g. cloud forests, deciduous forest.	1. Explain the concepts of sensor technology; deployment and monitoring protocols; error and validity consideration; data retrival, acquisition and data analysis; 2. Choose the appropriate sensor technology for collecting physical data corresponding to research study.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104781	Intelectual Property in Bio-research	3(3-0-6)	None	Trademark, patent, petty patent, product design patent, copyright, geopraphical indication, trade secret, search of Thai and international patent databases, plant protection act, patents relating to the uses of microoranisms, plants, and animals, management of intellectual property from research, advantages and disadvantages of patenting, and current topics relating to intellectual property in bio-research.	1. Explain principles of tradamarks, patent, petty patent, product design patent, copyright, geopraphical indication, trade secret, patents relating to microoranisms, plants, and animals, management of intellectual property from research, advantages and disadvantages of patenting; 2. Search Thai and international patent databases; 3. Self-learning in current topics on the intellectual propeerty in bio-research via different learning sources, including information technology, to present and discuss with others in the classroom; 4. Apply the learning knowledge to analyze and solve the set problems of the intellectual property in bio-research.
104888	Ecotourism and Management of Protected Areas	4(4-0-8)	None	Definition of ecotourism, components and kinds of tourism resource ecosystems, relationships between tourism resources and ecosystems, community income, types of protected areas, conservation and management of tourism resources both in and outside protected areas, environmental impact assessment, and field trips.	1. Assess case study of ecotourism program; 2. Develop the ecotourism guildline information for interested natural area.
Seminar Special Problems Secial Topic Thesis					

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104791	Seminar in Environmental Biology 1	1(1-0-2)	None	Review of literature and seminar presentation on specific topics in environmental biology.	1. Able to debate and critticize the resukts using environmental biology knowledge; 2. Have skills in environmental biology communication and presentation; 3. Have skills in using information technology for searching data and presentation; 4. Able to relate environmental biology knowledge to daily life phenomena.
104792	Seminar in Environmental Biology 2	1(1-0-2)	None	Review of literature and seminar presentation on specific topics in environmental biology.	1. Able to debate and critticize the resukts using environmental biology knowledge; 2. Have skills in environmental biology communication and presentation; 3. Have skills in using information technology for searching data and presentation; 4. Able to relate environmental biology knowledge to daily life phenomena.
104793	Seminar in Environmental Biology 3	1(1-0-2)	None	Review of literature and seminar presentation on specific topics in environmental biology.	1. Able to debate and critticize the resukts using environmental biology knowledge; 2. Have skills in environmental biology communication and presentation; 3. Have skills in using information technology for searching data and presentation; 4. Able to relate environmental biology knowledge to daily life phenomena.
104794	Special Problems in Environmental Biology 1	4(0-12-12)	None	Research work which can be finished within one academic year on a specific topic in environmental biology.	1. Have skills in using information technology for searching data; 2. Able to design and carry out experiment; 3. Have skills to debate and criticize the results from experiment; 4. Have skills to present and write report.

Courses		Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104795	Special Problems in Environmental Biology 2	4(0-12-12)	None	Research work which can be finished within one academic year on a specific topic in environmental biology.	1. Have skills in using information technology for searching data; 2. Able to design and carry out experiment; 3. Have skills to debate and criticize the results from experiment; 4. Have skills to present and write report.
104796	Special Topics in Environmental Biology 1	4(4-0-8)	None	Lecture and discussion on special topics or recent developments in environmental biology.	1. Have skills in using information technology for searching data; 2. Have skills to debate and criticize the results using environmental biology knowledge; 3. Able to relate environmental biology knowledge to daily life phenomena.
104797	Special Topics in Environmental Biology 2	4(4-0-8)	None	Lecture and discussion on special topics or recent developments in environmental biology.	1. Have skills in using information technology for searching data; 2. Have skills to debate and criticize the results using environmental biology knowledge; 3. Able to relate environmental biology knowledge to daily life phenomena.

Courses	Credit (Lect.-Lab-Self stud.)	Prerequisite	Course Description	Expected Learning Outcomes
104798 M.Sc. Thesis Scheme A2	16	None	M.Sc.Thesis Scheme A2	1. Have skills in using information technology for searching data; 2. Have discipline, faithfulness, respect to comments of others; 3. Describe the environmental biology concepts related to the thesis; 4. Design and carry out the experiment to test the hypothesis; 5. Able to analyze the knowledge from various sources for applying to the thesis; 6. Have skills to debate and criticize the results using environmental biology knowledge; 7. Have skills to communicate the knoledge in environmental biology using oral presentation and writing.
104799 M.Sc. Thesis Scheme A1	48	None	M.Sc.Thesis Scheme A1	1. Have skills in using information technology for searching data; 2. Have discipline, faithfulness, respect to comments of others; 3. Describe the environmental biology concepts related to the thesis; 4. Design and carry out the experiment to test the hypothesis; 5. Able to analyze the knowledge from various sources for applying to the thesis; 6. Have skills to debate and criticize the results using environmental biology knowledge; 7. Have skills to communicate the knoledge in environmental biology using oral presentation and writing.