

## Descriptions of Courses

### BS200 Biochemistry Experiment

Selected experiments covering the study of the properties of biomolecules are performed in order to expose the students to techniques commonly used in a biochemistry lab, introducing them to modern experimental methods in biochemistry including separation, identification, and characterization of biomolecules.

### BS202 Cell Biology

A series of lectures on cell biological subjects; Cell composition, cell structure, Cell cycle regulation, cytoskeleton, Membrane, Transport, Protein Sorting are given in this course.

### BS205 Biochemistry I

This course is designed for junior students to have an ability to understand life science in molecular and chemical level and to apply biochemical principle to real life by both theoretical, hypothetical and experimental techniques. This course covers the Molecular design of life, Protein conformations, Dynamics and function including enzyme reaction cinchonism and kinetics, Generation and storage of metabolic energy including photosynthesis, iosynthesis of lipids and steroid hormones, and Integration of metabolism.

### BS208 Biochemistry II

This course is a continuation of Biochemistry I and begins with photosynthesis and the synthesis of biological macromolecules and their components. It focuses on DNA replication, recombination, and repair, RNA synthesis and splicing, and protein synthesis and activation, and also looks at how cells sense and adapt to environmental changes.

### BS209 Molecular Biology

This course will cover the integrated introduction to the studies of genes and their activities at the molecular levels including: Mechanisms of gene regulation at the level of transcription, Translation, Replication, and Recombination. One of key features of this course will be the layering various approaches to the detailed mechanisms.

### BS223 Introductory Biotechnology

This course consists of two parts. The first part is to define and explain about the biotechnology inductively based on the people who contributed to the development of the "Biotechnology" which will help students understand the allure of the scientific enterprise and the passion with which the best researchers approach their work. The second part is to discuss with students how the biotechnology is applied in health care, agriculture, and environment and its relationship with nanotechnology and information technology.

### BS232 Microbiology

This course provides basic concepts on the fundamental aspects of microbiology, including genetics, physiology, and classification. Based on these background, various applications to microbial industries will be discussed.

### BS305 Physical Chemistry for Life Science

This course is designed to instruct basic concepts of physical chemistry for life scientists. Thermodynamics kinetics and emphasized for understanding biological structure and function.

### BS312 Evolution and Ecology

This course will cover general knowledge of evolution and ecology : Darwinism, evidence of evolution, processes and patterns of evolution, and interactions and homeostasis in ecosystems. The goal of this course is to provide students with macroscopic insight for the life sciences through understanding how evolution proceeds by interactions of organisms with their environment.

### BS315 Genetics

The course deals with the rules of inheritance underlying the phenotypic consistency of an organism. Detailed topics include the transfer of genetic information, recombination, mutagenesis, genetic regulatory mechanism, and genes associated with disease and development. The quantitative approaches to population and evolutionary genetics will also be introduced.

### BS318 Developmental Biology

In this lecture course, we will deal with the developmental processes by which the genes control cell differentiation and determine pattern from fertilized eggs to adults. In particular, we will emphasize developmental principles and concepts of developmental biology by understanding how genes control the developmental processes in *Drosophila* and in vertebrates.

### BS319 Laboratory in Cell Biology & Genetics

This laboratory course provides practical experience with selected, but broad-ranging methods in cell and organism-level researches, and also demonstrate the application of those methods to contemporary problems in genetics and cell biology. Experiments include a variety of organisms (bacteria, plants, and animals) and a variety of techniques

(cell culture, spectrophotometry, genetic complementation, genetic transposition, histochemical staining, etc.).

### BS322 Biological Engineering I

This course intends to introduce all aspects of introductory biochemical engineering such as mass balance, energy balance, and fundamental engineering calculations.

### BS325 Microbial and Cell Biotechnology

This course introduces the basic principles related to the cultures of microorganisms plant, and animal cells in bioreactor to exploit cellular activities. Subjects include Cell growth kinetics, Metabolic regulation, Medium design, Environmental factors, and Bioreactor design and operation.

### BS326 Biotechnology Experiment

This course is designed to gave students understand the principles of biological engineering related to various bioprocesses using microbes and enzymes. In addition, the part of laboratory course is designed to train students basics biological engineering experimental techniques and practice.

### BS332 Microbial Chemistry

This course deals with biosynthesis and biological functions of important secondary metabolites of living microorganism. Topics covered include Antibiotics, Industrially important secondary metabolites, Biosynthesis of polypeptides, Shikimates, Terpenes, and Molecular biological aspects of antibiotic biosynthesis and development.

### BS342 Enzymology

In this lecture we have tried to give a broad account of enzymology and have aimed to put current knowledge into prospective. To study enzymes will be helpful to understand a crucial role of catalysis in metabolic process of living organism. Because of the complexity of such processes, it is necessary to gain

an insight into the properties of enzymes in simpler systems such as isolated entities in the test tube. Next we followed a progression from the properties of isolated enzymes to the behavior of enzymes in complex systems, leading up to cells. We include discussion of the importance of enzymes in medicine and industry to emphasize that enzymology is not purely academic but has increasingly wide applications.

#### BS351 Physiology

Topics include: permeability and transport, ions and excitation, propagation and transmission of signals, sensory mechanisms, neural processing and behaviour, chemical messengers, and regulators, muscle and movement, osmoregulation and excretion, circulation of the blood, exchange of gases, feeding, digestion and absorption, animal energetics and temperature relations.

#### BS355 Pharmacology

Students taking this class will gain the necessary understanding of fundamental principles of pharmacology, emphasizing molecular mechanisms of drug action and principles of drug-receptor interactions, drug absorption/pharmacokinetics, drug metabolism, etc.

#### BS365 Environmental Microbiology

This course deals with the characteristics of fundamental physiology, taxonomy and ecology of microorganisms in the clinic, environment, and industry.

#### BS431 Virology

This course is designed to provide students with basic and medical characteristics of viruses. It deals with classification, replication, and transcription of viruses. Viral structure and functions are also covered.

#### BS433 Molecular Biology of Gene Regulation

This course will cover the integrated introduction to the studies of genes and their activities at the molecular levels including: mechanisms of gene regulation at the level of transcription, chromatin structure, DNA methylation, RNA processing, mRNA localization, protein synthesis and degradation, and DNA replication. One of key features of this course will be layering various approaches to the detailed mechanisms.

#### BS452 Immunology

The course deals with the basic concept of immune system including immune cells, diverse cytokines and their interactions both at cellular molecular levels.

#### BS462 Environmental Biotechnology

The course deals with the role of microorganisms in the maintaining of balanced ecosystems in the biosphere. Students will then be encouraged to discuss how to use microorganisms to re-organize an ecosystem destroyed by pollution. Because microorganisms act mainly in water, methods for effectively taking care of polluted water will be the focus of this course. The students will learn to measure the amount of pollution of water; to calculate various parameters for designing effective mechanisms to eliminate polluted water; to use the obtained parameters to create systems of activated sludge treatment, effluent treatment, lagoons, water filtration, and anaerobic fertilization.

#### BS463 Genetic Engineering

Purpose of the course; To get senior students acquainted with advanced recombinant technology and its application in basic and applied sciences. In addition, genome engineering and functional genomics of living organisms will be discussed with the emphasis on the creation of new metabolic pathways and restructuring of microbial genomes. Knowledge of general microbiology and biochemistry is strongly required.

#### BS465 Biological Engineering II

This course introduces fundamental aspects of biochemical engineering such as fluid dynamics, heat transfer, mass transfer, unit operation, and bioreactors and discusses the application of these principles.

#### BS480 Selected Topics

This course selects a topic that has drawn the particular attention of biological scientists. Discussion will be concentrated on how original discoveries were made, what progress was achieved later on, and what major controversies currently exist, as well as future directions.

#### BS490 B.S. Thesis Research

Each student is required either to perform an original research or to write an extensive review article for a M.S. thesis.

#### BS495 Specified Research

This listing is for participation in advanced research under direction of a selected faculty member.

#### BS496 Seminar

This selection is offered to all students as part of the core curriculum. Recent and interesting work regarding selected issues in modern biological studies is included.

#### BS512 Biostatistics

The course deals with descriptive and analytical method of biological phenomena, and the topics treated include distributions of statistical tests, analysis of variance, regression and correlation.

#### BS516 Advanced Genetics

Genes of the higher eucaryote are characterized by complex structures and their activation is restricted by various methods. This course examines the biological significance of such structures and functions and helps students create insight into the activation of genes through post-transcriptional modification by methylation. Moreover, it will cover specific examples of medical applications concerning the unique regulation mechanism of sex chromosomes.

#### BS518 Chemical Genomics & Medicinal Systems Biology

With advances in determining the entire DNA sequence of the human genome, it is now critical to identify and catalog genes for specific cellular pathways, and ultimately to formulate and modulate genomic networks in complex biological systems. This course will focus on the recent development of such genomic approaches, including chemical genomics that uses small molecules to probe and control human genomic networks. These multi-disciplinary approaches with medicinal systems biology approach will provide the relevant and creative directions for efficient discovery of drugs, therapeutic disease genes and disease networks in human bio-systems. Thus, the importance of these genome studies will be highlighted to perform basic and clinical research for diagnosis, drug discovery and development.

#### BS524 Advanced Molecular Biology

This course is designed to give students a basic understanding and history of molecular biology. Topics include: structure and function of nucleic acids, enzymes involved in DNA replication, *in vivo* DNA replication, transcription and translation in general.

#### BS525 Gene Expression

This course provides students with an understanding of fundamental principles underlying various steps of gene expression with an emphasis on molecular mechanism of transcription regulation. Topics include the mechanistic steps of transcription, the roles of transcription factors, regulation of gene transcription, RNA

processing and editing, translational post-translational control.

#### BS526 Molecular Virology

This course deals with the structure, replication and functions of viral genes in molecular level and emphasizes the understanding of the molecular characteristics of animal viruses

#### BS531 Advanced Microbiology

This course covers chemistry, synthesis, and functions of structural components of bacteria, diversity of morphology, physiological and ecology of bacteria and other microorganisms. Interrelationships between microorganisms and their environment are also covered.

#### BS532 Applied and Environmental Microbiology

This course deals with the roles of microorganisms in the environment and industry: the characteristics of microorganisms in applications are discussed.

#### BS536 Environmental Toxicology

This course covers the absorption, distribution, metabolism and excretion of toxic substances. Topics include: Target organ toxicity and toxic mechanisms of drugs, Pesticides, Food additives and air pollutants. Regulation and risk assessment.

#### BS538 Microbial Genomics

This course is intended to give graduate students familiarity with microbial sequencing, microbial functional and comparative genomics and microbial evolution.

#### BS541 Advanced Cell Biology

This course emphasizes the molecular structure/function relationship at the cells. Focus is given on cell membrane permeability, cellular interaction, cytoskeleton/motility, function of ER. Golgi complex, mitochondria, ribosome, etc.

#### BS543 Advanced Neurobiology

This course will study basic aspects of neurons (development, synaptic transmission and synaptic plasticity) and molecular mechanisms underlying various brain functions (i.e., sensory-motor system, sleep and memory) and dysfunctions (i.e., schizophrenia)

#### BS551 Advanced Biological Engineering

This course deals with the handling of the bioreaction of enzymes and microbial cells in the various types of bioreactors, in order to make the bioreactors, in order to make the bioprocesses more economically feasible. It covers the following topics: Interpretation of principal ideal reactions, Kinetics of biocatalytic reactions, Design and analysis of bioreactors, Control and optimization of bioreactors. Certain segments of BS324 are discussed here in more depth.

#### BS552 Advanced Fermentation Technology

This course covers the application of microbial physiology and biochemical engineering principles to fermentation processes of practical importance to exploit the activity of microorganisms to the greatest extent. Selected topics include fermentations of primary and secondary metabolites and other biologically active substances. In addition, a recombinant DNA fermentation system are introduced and discussed on fermentation technology.

#### BS561 Design and Molecular Evolution of Enzyme

With the expansion of the use of enzymes, designing enzymes at the molecular-level and inducing their evolution in-vitro on the basis of their structure is the focus of much research. This lecture deals with designing enzymes fit

for the purpose of application and also with studying recent researches on the principles and application of enzyme evolution.

#### BS582 Food Engineering I

This course deals with engineering principles related to mass transfer, heat transfer and momentum transfer in food processing. Principles of a panel test and physics-chemical properties of food materials are also discussed.

#### BS583 Structural Biology

This lecture elaborates on how biological functions of organisms at the molecular level operate, by understanding the 3-D structure of large biomolecules such as proteins.

#### BS584 Novel Drug Delivery Systems

This is a general education course of novel drug delivery systems (DDS), introducing sustained-release DDS formulation and targeted drug delivery systems. The importance and current problems concerning stabilization and formulation of DDS and gene delivery systems are the major topics of discussion in this course, as well as the design of polymeric scaffold systems for effective drug delivery.

#### BS586 Plant Developmental Biology

The plant, an important group of living organisms which provides not only foods but also many medicinal drugs, perfumes, and construction materials, has evolved separately from the animal, thus the extrapolation of knowledge gained from the animal has the limited use. Since our existence on Earth depends so much on plants, however, it is necessary to understand how plants develop themselves and maintain the integrity as multicellular organisms. This lecture will cover how plants develop themselves and how plants maintain the integrity at the molecular levels.

#### BS611 Advanced Molecular Cell Biology I

This course covers recent advances in most areas of modern life sciences which graduate students should be acquainted with for their own thesis researches. The course will place a particular emphasis on basic processes of cell biology.

#### BS612 Advanced Molecular Cell Biology II

This course is the continuation of Molecular Cell Biology I, which will cover the recent advances in several fundamental biological phenomena occurring at the level of cells with a particular emphasis on their molecular and mechanistic aspects.

#### BS620 Physical Biochemistry

This course deals with the principles of physical chemical methods in biochemistry and molecular biology. Hydrodynamic as well as spectroscopic methods for separation, characterization and structure determination of biopolymers such as proteins and nucleic acids are discussed.

#### BS622 Enzyme Chemistry

This lecture course deals with a comprehensive discussion of enzyme catalysis: principles of catalytic mechanisms, kinetics of enzyme and nonenzyme catalyzed reactions allosteric interactions between subunits and the mechanisms of coenzyme catalyzed reactions.

#### BS624 Protein Chemistry and Engineering

This course provides seniors with an ability to understand modern protein folding and protein structure analysis. Topics include methods for determining protein structure, biological and biochemical methods in protein design, purposely modified proteins and their properties. Design of mutant proteins, structural analysis

of mutant protein by NMR and X-ray crystallography, and applications to science medicine and industry are also included.

#### BS626 Nucleic Acid Biochemistry

This graduate course provides students with the current advancements in nucleic acid research. Focus is given on new unusual structures of DNA and RNA, and newly discovered functions of RNA ribozymes, telomerase RNA, guide RNA and anti-sense RNA, etc.

#### BS628 Biological Membranes

The course focuses on the relationship between the structure and function of biological membranes. The lectures will also provide insight to the characteristics of the liposome, the mutual relationship between liposomes and proteins, the transport of molecules through the membrane, the electrical phenomenon in organisms, the effect of hormones, and the mechanism of energy transduction and membrane fusion.

#### BS631 Microbial Genetics

Provides graduate students in biological sciences with an ability to apply microbial genetics methodology and reasoning to specific biological problems. Topics include mutation and metagenesis, gene theory, mapping and strain construction, genetic manipulation in vivo, plasmid and genetic manipulation in vitro, physical characterization of the whole genome, repair and recombination. mobile genetic elements, control of gene expression, fungi as a genetic system, lambda bacteriophages, and a genetic approach to morphogenesis and behavior.

#### BS633 Microbial Physiology

Advanced topics related to microbial physiology at the graduate level are discussed with a particular emphasis on the methodology of approaching a problem. This course covers protein localization, cell division sensory response/signal transduction, stress response, and various global regulatory networks.

#### BS662 Bioseparation Technology

Basic principles for the economical purification of valuable bio-materials are provided in this course. Issues with regard to scale-up purification processes from bench- to plant-scale are also dealt with.

#### BS664 Numerical Methods for Biochemical Engineering

This course is focused on mathematical methods which are basically required to understand and solve biochemical engineering problems. The numerical methods to solve linear algebraic equations, ordinary and partial differential equations are provided. Matrix operations and the Runge-Kutta method for numerical integration are included.

#### BS672 Animal Cell Biotechnology

The course will provide the students with basic knowledge on cell functions needed for cultivation of animal cells. In addition, the students will be informed about monoclonal antibodies of these cells, as well as about vaccines and the production of other useful proteins. Discussions will be held on recent trends concerning the tissue engineering of creating human bone marrow, epidermal, and liver cells.

#### BS685 Advanced Developmental Biology

The primary goal of the course is to present a comparative view of cellular and molecular mechanisms of animal development. This includes induction mechanisms, cell adhesion and migration, cell-matrix interactions and protein-protein interactions (*i.e.*, interactions between Hox and transcriptional cofactors) during body axis formation, neurulation, and organogenesis. The development of complex systems, such as the nervous system and limbs is emphasized. Model organisms and evolutionary aspects are especially emphasized. Another

important aim of the course is to teach the students how actual developmental research is carried out. Various state-of-art research techniques used in modern developmental biological researches are introduced.

#### BS710 Selected Topics in Life Science

The course provides graduate students with an overview of the characteristics of biological information, organization, and processing mechanism, and introduces various approaches to simulate those systems.

#### BS711 Bioinformatics

The course provides graduate students with an overview of the characteristics of biological information, organization, and processing mechanism, and introduces various approaches to simulate those systems.

#### BS713 Human Genomics

The course provides the student with an ability to apply the concept of DNA, chromosome and cell in classical genetics to very real situation on human genome, genetic engineering, gene therapy, along with biomedical application in human health care.

#### BS720 Selected Topics in Biochemistry

This course is designed to provide doctoral degree candidates with the current advancements of biochemical research with a focus on a few specific topics of contemporary interest. Different topics are discussed every year.

#### BS722 Biochemistry of Carcinogenesis

This course is designed for graduate students to understand the basic biochemistry of chemical carcinogens. These include metabolism of chemical carcinogen, interactions between the carcinogens and oncogenes, inhibition of chemical carcinogenesis, chemoprevention and reduction of cancer risks, and finally influence of dietary constituents in chemical carcinogenesis.

#### BS730 Selected Topics in Microbiology

This course deals with the most up to date information about microbiology with an emphasis on the applications to production of industrially useful products.

#### BS740 Selected Topics in Cell Biology

This course is designed to provide doctoral degree candidates with the current advancements of cell biology research with a few specific topics of contemporary interest.

#### BS742 Molecular Cell Biology

Details of the cell's delicate structure, functions and their interrelationships are presented. Topics include: plasma membrane, cell nucleus, cytoskeleton, cell signalling, cell growth and division, cell adhesion, cell junctions and the extracellular matrix.

#### BS750 Selected Topics in Biotechnology

The purpose of this course is to give graduate students the most up-to-date information about biotechnology. Topics are decided by instructors. Covered topics are as follows: molecular biology, industrial microbiology, biochemical engineering, biomedical technology, and cell cultures.

#### BS760 Selected Topics in Environmental Biotechnology

The purpose of this course is to give graduate students the most up-to-date information about environmental biotechnology.



#### BS781 Special Topics in Food Science & Technology

This course is designed to expose graduate students in biotechnology to the research topics of current interests in food sciences and technology. It covers the following topics: food biotechnology, novel bioseparation, food additives, and food packaging. Covered topics are as follows: Physical chemistry, food engineering, food chemistry and biochemistry.

#### BS782 Cell Signal Transduction

This course explores advanced topics in signal transduction related to cell proliferation and differentiation. Some topics covered include the following: protein kinases and their function, phosphatases and their role in regulation, growth factor receptors and G-proteins, calcium and other second messengers, cell cycle and immune system signal transduction events, etc. A basic review of overall related researches will be provided, and current findings from the scientific literature will be discussed.

#### BS791 Scientific Writing in English

The course is intended to improve graduate students ability to present their research results at international scientific meetings and to write manuscripts for international scientific journals. Students taking this course are to learn structural management and technical pitfalls in scientific writing. They will also practice writing and proofreading of scientific papers.

#### BS960 M.S. Thesis Research

This listing is for participation in advanced research under the direction of a faculty member.

#### BS965 Independent Study in M.S.

This listing is for participation advanced research under the direction of a faculty member.

#### BS966 M.S. Seminar

This selection is offered to all students in biological sciences as a core curriculum course. The course covers recent relevant and interesting research in modern biology.

#### BS980 Ph.D. Thesis Research

This is advanced research under the direction of a faculty member.

#### BS986 Ph.D. Seminar

This is offered to all students in biological sciences as a core curriculum course. The course covers recent research works in which topics include selected issues of modern biological studies interesting to members of discipline.

#### BS990 Graduate Student Seminar

This course intends to enhance the skill of presentation and communication of the predoctoral students by providing them with an opportunity to present their own results obtained during their doctoral training. In this course, it is mandatory for students to present twice before they finish the Ph. D. program.