North South University

Department of Biochemistry & Microbiology

Curriculum

For

Bachelor of Science in Biochemistry and Biotechnology
(120 credits)

Bachelor of Science in Biochemistry and Biotechnology (BS BBT)
Department of Biology and Chemistry
School of Health & Life Sciences
North South University
Bashundhara, Dhaka 1229

Minimum credit requirement: 120 CREDITS

About the program:

Biochemistry is the study of the molecular reactions of life, whereas Biotechnology focuses on the application of this knowledge. Biochemistry has taken the forefront in defining broadly based opportunities in Biotechnology applications that indicate the path for biologically based future of the twenty-first century. The two disciplines go hand in hand and now-a-days there is little distinction between the two. The Bachelor of Science in Biochemistry and Biotechnology program at NSU is a merger of the above two disciplines, first of its kind in Bangladesh. The program integrates the molecular life sciences from the most basic biology-chemistry interface to advanced molecular biology, molecular genetics, bioinformatics and genetic engineering.

The program provides a 4-year academic program leading to the undergraduate BS degree in Biochemistry and Biotechnology. Majors have the opportunity through extensive coursework, laboratories, seminars and diverse range of general education courses to develop the knowledge and skills necessary to enter the workforce or to go on with further higher education in Biochemistry and Biotechnology or related subjects at home and abroad.

Curriculum:

BS in Biochemistry and Biotechnology degree program requires minimum of 120 CREDITS in about 4 years/12 semesters to complete. The breakdown of the 120 CREDITS are given below:

Category	**CREDITS**
University Core	37
School of Health & Life Sciences Core	36
BBT Major Core	29
BBT Major Electives	9
Open Electives	9
Project work/Intern	Non-credit
Total	**120 CREDITS**

BIOCHEMISTRY AND BIOTECHNOLOGY (BBT) (120 CREDITS)

UNIVERSITY CORE			**(37 CREDITS**
Languages			(12 CREDITS)
ENG102/ENG103, ENG105	English composition		6
ENG111	English speech/Professional Communication		3
ENG115	Literature		3
Humanities			(9 CREDITS)
PHI101	Philosophy/Ethics		3
LBA101/LBA102	History (World/Indo-Bangladesh/Islamic)		6
Social Sciences			(9 CREDITS)
POL101/POL104	Political Science/Government		3
ECO101/ECO104	Economics (Micro/Macro Principles)		3
SOC101/GEO205/ANT101	Soc./Geog./Anthropology		3
Computer & Math skills			(3 CREDITS)
MIS105	Introduction to Computers		3
MAT112/MAT116	College Algebra/Pre-calculus	in SHLS core	3
BUS172	Statistics I	in SHLS core	3
Sciences (*with Lab)*			(4 CREDITS)
BIO103	Biology I	in SHLS core	4
CHE101	Chemistry I	in SHLS core	4
PHY107L	Physics I		4
Science/Credit School of Health & Life Sciences core			**(36 CREDITS)**
MAT112/MAT116	College Algebra/Pre-calculus	GE	3
BUS172	Statistics I	GE	3
MAT120	Survey of Calculus		3
BBT230	Statistics II (Biostatistics)		3
With Lab			
BIO103	Biology I	GE	4
BIO201	Biology II		4
CHE101	Chemistry I	GE	4
CHE201	General Chemistry II		4
CHE202	Organic Chemistry I		4
CHE301	Organic Chemistry II		4

Major Required Courses		**(29 CREDITS)**
BBT313	Human Physiology	3
BBT315	Metabolism	3
BBT314	Chemistry & Application of Enzymes	3
BBT413	Plant Biochemistry & Biotechnology	3
BBT317	Molecular Genetics	3
BBT318	Cell Biology	3
BBT422	Senior Seminar	3
With Lab		
BBT312	Molecular Biology	4
BBT316	Immunology	4

ELECTIVE COURSES		**(9 CREDITS)**
BBT415	Molecular Biotechnology	3
BBT416	Bioinformatics	3
BBT417	Neurochemistry & Endocrinology	3
BBT418	Pharmaceutical Biotechnology	3
BBT419	Clinical Biochemistry	3
BBT421	Applied Immunology & Immunogenetics	3

FREE ELECTIVE COURSES **(9 CREDITS)**

Course Syllabus:

UNIVERSITY CORE (37 CREDITS)

Languages	**(12 CREDITS)**
English composition	6
English speech/Professional Communication	3
Literature	3

ENG102 **Introduction to Composition**: Development of integrated language skills with special focus on the mechanics of the writing process and the study of grammar with an emphasis on syntax. Writing unified, coherent paragraphs with topic sentences and controlling ideas. 3 CREDITS

ENG103 **Intermediate Composition:** The practice of academic reading and especially writing, focusing on expository essays. Emphasis will be placed on essay structure and editing. Essay types include narrative, descriptive, process, cause and effect, and comparison and contrast. Prerequisite: ENG 102/Waiver. 3 CREDITS

ENG105 **Advanced Composition:** Continued work on analytic reading and on fluency and control of the writing process. Emphasis on sentence structure, organization, paragraphing, coherence and cohesion. Development of expressive, persuasive and referential writing with emphasis on planning, organization, cohesion and coherence. Participating in small group discussions and seminars. Employing appropriate mechanics of formal speech. Further practice in research techniques. Project work. Considered as GED requirement for students other than students of English. 3 CREDITS

ENG111 **Public Speaking:** This course introduces students to the fundamental principles and practices of rhetoric. They will learn the art of public speaking which involves persuasion, creative analysis and synthesis of topics, organization, language, delivery, audience awareness and adaptation and the use of supporting materials. Types of speeches will include informative, persuasive, impromptu, inspirational, and special occasion speeches. Prerequisite: ENG 103. 3 CREDITS

ENG115 **Literature**: This course introduces students to the rich literary tradition of poetry, drama, and fiction. Drawing on a wide range of writings in English, students will learn to read and respond to literature and learn the fundamentals of literary analysis. Prerequisite: ENG 103. 3 CREDITS

Humanities	**(9 CREDITS)**
Philosophy/Ethics	3
History (World/Indo-Bangladesh/Islamic)	6

PHI101 **Introduction to Philosophy:** An exploration of some basic philosophical topics such as the nature of the mind and its relationship to the brain, knowledge, freewill, justice, the existence of God, and mortality. It focuses specially on the nature and function of philosophy. Part or all of the focus of the course may be on the work of one or two philosophers. 3 CREDITS

LBA101 **Bangladesh Culture and Heritage:** Deals with the cultural and political heritage of Bangladesh from ancient times to the present and familiarizes students with the cultural milieu of the people to make them aware of Bangladesh's national identity. Topics include ethnic origin of the people in Bangladesh, religious faiths, festivals, colonial legacy; baul culture; creativity in the arts and crafts; evolution of nationalism in the pre and post-partition East Bengal, Language Movement, struggle for autonomy, and the independence of Bangladesh. 3 CREDITS

LBA102 **Introduction to World Civilization:** Focuses on the values and importance of the study of the history of human civilization, especially in Egypt, Mesopotamia, and Babylonia; Harappa civilization and the Gandhara civilization, ancient Chinese culture and civilization; ancient Greek civilization, Muslim civilization and their influence over European Renaissance, scientific innovations, cultural progress and religious reformation. The rise of powerful nation states in Europe and North America and the impact of scientific and technological supremacy of the west over the so-called 'backward communities' are also studied here. 3 CREDITS

Social Sciences	**(9 CREDITS)**
Political Science/Government	3
Economics (Micro/Macro Principles)	3
Soc./Geog./Anthropology	3

POL101 **Introduction to Political Science:** Provides students with some of the core concepts of political science, such as state, sovereignty, constitutionality, political culture, democracy, political party, civil society and the functioning of major political systems including Bangladesh. It addresses issues, institutions and structures that correspond to our everyday life and shape our political behavior and perceptions as 'political animal'**.** 3 CREDITS

POL104 **Introduction to Governance:** Introduces students with the concept and various aspects of public governance and their relevance in Bangladesh. Topics include: accountability, transparency, participation, freedom of information, sound judicial system, capacity building; major governance problems of Bangladesh; role of civil society (including media, NGOs etc.); relationship between better governance and the growth of private sector; donor's agenda in governance; public sector corruption; implications of e-governance. 3 CREDITS

ECO101 **Introduction to Microeconomics:** An introduction to the methods and principles of microeconomics. Topics include: markets; theory of consumer behaviour; production theory; costs of production, and market structure; efficiency in allocation and production. 3 CREDITS

ECO104 **Introduction to Macroeconomics:** This course introduces the principles of macroeconomic analysis, its analytical methods with current institutional and empirical issues. Topics include different methods of national income accounting with special emphasis on Bangladesh Economy; issues relating to unemployment, inflation; determination of output, price level, money and banking. It also gives an introductory account of the monetary and fiscal policies; budget and trade deficits; and exchange rate. 3 CREDITS

SOC101 **Introduction to Sociology:** Provides students with an understanding of the primary phenomena, concepts, issues and practices associated with sociology. Topics include explanation of how societies grow and change; reciprocal effects of economic, political, familial, and scientific institutions on each other and on individual life; changes and social conflict, problems of bureaucratic growth and planned and unplanned social change. 3 CREDITS

ENV203/ GEO205 **Introduction to Bangladesh Geography:** Basic geographic concepts and fundamental themes. Geophysical and socio economic characteristics of Bangladesh; introduction to physical geography; landforms; weather and climate; population geography; cultural and political context; natural resources; economic geography and urban - regional concepts; spatial interaction between human and natural environment. 3 CREDITS

ANT101 **Introduction to Anthropology:** Explains the origin of human culture and society and addresses the concepts of fundamental phenomena and procedures of cultural change, impact of culture on personality development, structures of human relationships etc. Students are also introduced to basic research methods that help them develop the primary skills to study human behaviors. 3 CREDITS

Computer, Mathematics and Science

Introduction to Computers	3
College Algebra/Pre-calculus	3
Statistics I	3
Science (with Lab)	
Biology I	4
Chemistry I	4
Physics I	4

MIS105 **Introduction to Computers:** Provides a general understanding of computer applications and functions of the components of a computer system. Topics include components of computer systems; concepts of software; introduction to operating systems; history of computer languages; programming fundamentals; basics such as constant, variables, data type, operators and expressions, pointer; concepts of database; internet technology and World Wide Web. Course is conducted in a lab setting and provides functional orientation to word processing, spreadsheet, presentation, and database and WebPages design. Students also learn some basic skills in searching and evaluating online resources. 3 CREDITS

MAT112 **College Algebra:** Topics include sets, real numbers system, algebraic expressions, systems of equations, functions and relations matrices, determinant applications), exponents and radicals, exponential and logarithmic functions, functions of integers, permutations, combinations, and binomial theorem. Prerequisite: High School Mathematics. 3 CREDITS

MAT116 **Pre-calculus**: Topics includes sets, real number system, algebraic expressions, systems of equations, functions and relations, quadratic functions, synthetic division, the zeros of a polynomial function, exponential and logarithmic functions, trigonometric functions, and graphs of trigonometric functions, analytic trigonometry, and additional applications of trigonometry, mathematical induction, the binomial theorem, and sequences. Prerequisite: High School Mathematics. MAT112/waiver. 3 CREDITS

BIO103 **Biology I:** Introduction to Biology: Scope, Biology, What is life? and Characteristics of living things; Chemistry of life: Atoms & elements, Molecules & bonds, Electronegativity, Polar & non-polar bonds, Diffusion & osmosis, pH; Biological Macromolecules: Carbohydrate, Lipid, Protein and Nucleic acids, Central dogma of molecular biology; Cell structure and function: Organelles description & level of organization; Cellular Reproduction: Cell cycle, Cell Division, Mitosis, Meiosis; Energy of Life: Cellular respiration (anabolism & catabolism); Enzymes definition and characterization; Photosynthesis; Biological Diversity: Evolution and natural selection, the origin and diversification of life on earth; Evolution of microbes & animals, Classification; Human Physiology: Homeostasis, digestive system, circulatory (blood), excretory and respiratory systems; Health and disease: Food & nutrition; diabetics, cancer and heart disease.

Laboratory Work: Determining the pH of given food/juice/beverage samples, Observing a single cell under light microscope and identification of organelles, Observing bacterial growth from microbial plating, Observing antibiotic activity of saliva/tears, Blood grouping, Determination of serum glucose by glucose oxidase method. 4 CREDITS

BUS172 **Statistics I: Introduction to Statistics:** Introduces modern theory and methodology of statistics and their application in economics and business. Topics include descriptive statistics, probability theory, sampling theory and methodology, sampling distributions and hypothesis testing. Computer application is a compulsory component for the course. Cross-listed as BBT203, ECO 172 & ENV 172. 3 CREDITS

CHE101 **Chemistry I:** This course covers fundamental principles of chemistry. Topics include measurement, atomic and molecular structure, periodicity, chemical reactions, chemical bonding, stoichiometry, thermochemistry, Chemical Equilibrium and Kinetics, gas laws and solutions. This course is appropriate as a basic chemistry course or as a science elective for students who have science, engineering, or mathematics majors. Upon completion, students will be able to- Define chemistry as the study of matter, can apply the basic concepts in their future studies and apply safe laboratory skills to solve problems in a cooperative environment.

Laboratory Work: Introducing analytical balance, proving the law of definite proportions, estimation of Avogadro's number, standardization of HCl, acid-base titration, determination of density. 4 CREDITS

PHY107L **Physics I:** Vectors, Kinematics, Newton's Law, Conservation of Energy and Momentum, Rotational Kinematics, Conservation of Angular Momentum, Collision, Compton Effect, Nuclear Theory, DeBrogglie, Oscillations and Waves, Gravitation. *The lab component includes*: Measurement of length area and volume of solids of regular shapes using vernier caliper, micrometer screw gauge and spherometers. This simple experiment will introduce the students to precision in measurements, error and propagation of error. This knowledge is of fundamental importance, which will be applied in all subsequent experiments, Free fall experiment. To find the time of fall through a given distance and to determine the acceleration of free fall. Apparatus required: Light gates and timer, To study equilibrium of a rigid body. Apparatus needed: force table, pulleys, and weights, To study rectilinear motion on an inclined plane. Apparatus: board, electronic timers or ticker tape timers, light gate etc. Plot of v-t and a-t graphs, To find acceleration of free fall using Atwood's machine. Apparatus: pulley, known masses and electronic timer, Measurements of the coefficients of static and dynamic friction. Apparatus: wooden blocks, spring balance, known weights etc, Motion of a ball bearing through a resistive medium. To measure the viscosity of glycerin by Stokes' law. Apparatus: measuring cylinder, stop watch, steel ball bearings, meter rule, and thermometer, Simple harmonic motion 1. Measurement of g by simple pendulum, Simple harmonic motion 2. Vibration of a vertical spring-mass system, measurements of the spring constant and the acceleration of free fall, Study of damped and forced harmonic oscillator. Apparatus: carts, motor, springs, motion sensors etc, Rotational motion. Measurement of moment of inertial of a flywheel, Foucault's pendulum and the effect of Earth's rotation, To study the rotational motion of a cylinder down an incline. The objective of this experiment is to become familiar with the relationships involving angular acceleration and moments of inertia, Conservation of momentum and kinetic energy in elastic collisions. Apparatus: air track, gliders, light gates, timers etc, Study of one-dimensional inelastic collisions. Apparatus: air track. Prerequisite: MAT 120 and Physics in HSC/A Level**.** 4 CREDITS

SCIENCE/SCHOOL OF HEALTH & LIFE SCIENCES CORE (36 CREDITS)

MAT116 College Algebra/Pre-calculus	GE	3
BBT203 Statistics I	GE	3
MAT120 Survey of Calculus (Calculus I)		3
BBT230 Statistics II (Biostatistics)		3
BIO103 Biology I	GE	4
BIO201 Biology II		4
CHE101 Chemistry I	GE	4
CHE201 Chemistry II		4
CHE202 Organic Chemistry I		4
CHE301 Organic Chemistry II		4

MAT120 **Calculus I:** A first course in calculus and analytic geometry. Coordinates, Graphs and Lines; Functions and Limits; Differentiations; Application of Differentiation; Integration; Logarithmic and Exponential Functions. 3 CREDITS

BBT230 **Statistics II (Biostatistics):** This class presents fundamental concepts in data analysis and statistical inference, focusing on one and two independent samples. Students having taken this class should be able to summarize samples, perform relevant hypothesis tests and perform a collection of two sample comparisons. Classical non-parametric methods and discrete data analysis methods are discussed. The topics cover: Hypothesis Testing; Power and sample size and two group tests; Tests for binomial proportions; Two sample binomial tests, delta method; Fisher's exact tests, Chi-squared tests; Simpson's paradox, confounding; Retrospective case-control studies, exact inference for the odds ratio; Methods for matched pairs, McNemar's, conditional versus marginal odds ratios; Non-parametric tests, permutation tests; Inference for Poisson counts; and Multiplicity. 3 CREDITS

BIO201 **Biology II:** This course introduces history, scope and future of Biochemistry and biotechnology. Students learn the basic logics of living organisms, the role of bio-molecules and their interrelationship. The course provides following introductory concepts: i) define and explain the basic concepts in biochemistry; ii) various biochemical pathways; iii) define the biological macromolecules and their subunits; iv) basic applied concepts in biochemistry to biotechnology; v) explain the underlying concepts in biotechnology; and vi) relate the biochemical properties and their principles as tools of biotechnology.

Laboratory work: Main objective of the laboratory section is to bring experience in solving practical problems in biochemistry laboratory, to acquire applicable skills and to teach students to derive conclusions from experiments. Biochemistry part also demonstrates methods of clinical biochemistry and their significance for diagnosis of diseases. 4 CREDITS

CHE201 **Chemistry II** : Thermodynamics - First law, Second law and Introduction, definitions, Thermodynamic terms and basic concepts; Thermochemistry, Exothermic and endothermic reactions, standard enthalpy of formation, thermochemical equations; The nature of chemical equilibrium, law of mass action, equilibrium constant, relationship between ΔG and Keq, effect of temperature and pressure, Le Chatelier's principle,, Chemical Kinetics and it Definition, reaction rate, rate laws, order reactions, molecularity of a reaction, pseudo first order reaction, half-life, Catalysis, Photochemistry and Spetrophotometry, Transmittance and absorbance, Beer-Lambert law, Properties of liquids, Acids and bases.

Laboratory Work: The laboratory section includes following experiments: Calibration of the calorimeter, determining the heat of fusion of ice, determination of specific heat of an unknown metal, determination of heat of solution and heat of neutralization, determination of second order reaction: iodination of aniline by measuring the optical density of reaction medium. 4 CREDITS

CHE202 **Organic Chemistry I:** This course is a comprehensive introduction in fundamental aspects of biological chemistry, for freshmen (first year) students. Knowledge of structure, functionality and reactivity of the organic molecules is vital for understanding the mechanism of numerous biological processes and biochemical reactions. This course provides a foundation of organic chemistry, i.e. the understanding of structure, properties, interactions, transformations and nomenclature of organic compounds. Major topics included: Structure & Properties of the Organic Compounds & Bonding; Saturated Hydrocarbons: Alkanes and Cyclic Alkanes; Unsaturated Hydrocarbons: Alkenes & Alkynes; Introduction to Isomerism; Alkyl Halides; Introduction to Aromaticity: Benzene and its derivatives; Alcohol, Phenols & Ethers (-OH group/derivatives); Chemistry of Carbonyl (-CO-) compounds and carboxylic acid derivatives.

Laboratory Work: The students will get practical experiences on the detection of an unknown organic compound based on their physical and chemical properties. Emphasis will be given on the nature of different laboratory solutions and how to prepare them accurately. Moreover students will also get basic idea how to detect specific organic compound present in biological sample. A number of specific organic reactions will also be demonstrated in this lab. 4 CREDITS

CHE301 **Organic Chemistry II**: The course starts with a review of organic functional group's structure & functions and stereochemistry. Later, the discussion will continue with the structures of small bio-molecules, e.g. carbohydrates, amino acids, nucleotides, and lipids. Next, the formation of large bio-molecules from these building blocks is described with reaction mechanisms in terms of the RNA world hypothesis. The chemistry behind the formation and degradation of these compounds both *in vitro* and *in vivo* will be covered with emphasis on learning about complex biological systems from simpler chemical ones. The curriculum covers: carbohydrate chemistry, amino acids chemistry, lipids, lipoproteins, cholesterol and nucleic acid chemistry, introduction to bioorganic synthesis of secondary metabolites.

Laboratory Work: The organic chemistry laboratory section includes detection of different bio-molecules from various sources, determination of chemical properties of representative organic molecules, and detection of organic contents of representative biological samples. 4 CREDIT

MAJOR REQUIRED COURSES **(29 CREDITS)**

BBT312	Molecular Biology	4
BBT313	Human Physiology	3
BBT314	Chemistry & Application of Enzymes	3
BBT315	Metabolism	3
BBT316	Immunology	4
BBT413	Plant Biochemistry & Biotechnology	3
BBT317	Molecular Genetics	3
BBT318	Cell Biology	3
BBT422	Senior Seminar	3

BBT312 **Molecular Biology:** Molecular biology course deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, transcription, protein synthesis, and gene regulation in different organisms. The topics cover in the courses are Introduction to genetics, Basic principles of Heredity, Chromosomal basis of inheritance, The chemical nature of the gene, DNA replication, RNA molecules, Transcription, Post transcriptional modification, Genetic code, Translation, and Plasmid features (designing of cloning and expression vector).

Laboratory Work: The lab course is designed to introduce the students to the technical world of molecular biology. In this course the students will learn basic techniques used in molecular biology including DNA and RNA isolation, purification and detection, restriction analysis, polymerase chain reaction (PCR), expression cloning, SDS gel electrophoresis and western blotting. 4 CREDIT

BBT313 **Human Physiology:** Physiology is the study of how living organism functions. The main theme of human physiology is the molecular and cellular interactions needed to maintain the constant internal environment, i.e. homeostasis. This course commences with the principles of physiology, which is followed by an elaborate discussion of molecular-cellular physiology with a specific focus on neural and endocrine control and integration of homeostasis. Individual organ systems, including musculoskeletal, circulatory, respiratory, digestive, urinary, and reproductive systems are also given emphasis for a complete understanding of how the human body functions. 3 CREDITS

BBT314 **Chemistry & Application of Enzymes:** The objective of this course is to provide understanding on protein structure, properties and their most important functions. Key concepts related to this course are studying properties of amino acids and peptides, reaction and analysis of amino acids, different structural level of organization of proteins with specific examples, how protein interact with other molecules related to their function, and different analytical techniques use in protein chemistry. Studying enzymes and its classification, enzyme kinetics, enzyme's mechanisms of action, enzyme inhibition, regulation, and reaction mechanism of some enzymes and clinical, diagnostic and industrial application of enzymes are also key notions relation to this course. This course will be useful for future studies in biochemistry, microbiology, molecular and cellular biology, and biotechnology, pharmaceutical and medically related fields. 3 CREDITS

BBT315 **Metabolism:** Major topics include: Bioenergetics and thermodynamics; The glycolytic pathway, pentose phosphate pathway; The citric acid cycle: Steps and reactions; Gluconeogenesis and Reciprocal regulation of gluconeogenesis and glycolysis, Metabolic fates of amino groups, enzymatic degradation of the dietary proteins to amino acids; Oxidative phosphorylation and photophosphorylation and regulation; Nitrogen metabolism, Integration and hormonal regulation of mammalian metabolism. Digestion, mobilization, and transport of Fatty acids: absorption of the dietary fatty acids in the small intestine; Lipid Metabolism I: Utilization and storage of energy in lipid form; Lipid Metabolism II: Pathways of Metabolism of special Lipids such as Phospholipids, Cholesterol, Sphingolipids; Mechanisms involved in switching the metabolism of the liver between the well-fed state and the starved state; Clinical correlations: Obesity, Respiratory distress syndrome, Atherosclerosis. 3 CREDITS

BBT316 **Immunology:** The purpose of this course is to provide a basic knowledge of immunology. This course will provide in-depth understanding of the cells, molecules and organs of the immune system and how they work together to protect us from pathogen. The principal focus of the course is to study structural features of the

components of the immune system and their functions, innate and adaptive branches of both humoral and cellular responses of the immune system. The course will also assign emphasis on learning the major mechanisms by which immune cells protect us from different types of pathogens or from cancer cells, how immune cells detect the presence of pathogens and cancer cells, processes that lead to the elimination of pathogens. Studying the structure and function of key immune recognition molecules including antigens, antibodies, antigen receptors, MHC proteins, and cytokines are covered. The course will introduce some immunological assays to detect antigen-antibody interactions.

Laboratory Work: This laboratory part will concentrate on the immunological methods used to evaluate human disease and will include the theoretical basis for tests of immune function, practical laboratory application of assays based on these principles and case-based study. The learning objectives of this unit are to understand the immunological basis for infection and immunity and how these concepts are applied in the diagnostic pathology laboratory; to understand how the immune system causes and prevents disease, the use and performance of immunological tests. 4 CREDITS

BBT317 **Molecular Genetics:** Molecular genetics is an essential tool for studying biology. This course discusses in details the mechanisms underlying the storage, transmission and expression of heritable information in the genetic and chromosomal level of an organism. The topics that are included in this course are mutation and its repair; recombination and its role in DNA repair and genetic diversity; Transfer of genetic materials in prokaryotes, the concept of regulation of gene expression; developmental biology with model organism *Drosophila melanogaster*. At the end, this course discusses about the principle and application of recombinant DNA technology. 3 CREDITS

BBT318 **Cell Biology:** The cell is a fascinating, complex, and dynamic unit that is constantly interacting with the surrounding environment and making active decisions, by an enormous number of biochemical and biophysical process. A sound knowledge of cell biology is required to understand the diverse cellular components (structure and function) at a molecular level that compose multicellular organisms. Cell biology forms the core of basic scientific investigations and current bio-medical research. Major topics included in this course are: membrane structure and function, intracellular compartments and protein sorting, intracellular vesicular traffic (secretion and endocytosis), mechanism of cellular communications, cytoskeleton, the cell cycle and cell death. Skills and knowledge from this course will be a great advantage for the students' future research carrier. 3 CREDITS

BBT413 **Plant Biochemistry & Biotechnology: T**his course provides a deepening of the subject in areas of plant physiology and plant biochemistry and provides a basic knowledge of plant molecular biology and plant biotechnology. The course deals with the life processes of plants: Seed germination, plant growth, anatomy and differentiation, metabolism, photosynthesis, stress physiology and flowering. The specific characteristics of plants are introduced such as cell wall synthesis, cell extension, the three genomes (chromosomal, mitochondrial and chloroplast), gene regulation, plant growth hormones and natural products. In addition methods of molecular biology used in plant biotechnology such as plant model systems, transformation methods, plant tissue specific expression and use of databases are introduced. 3 CREDITS

BBT422 **Senior Seminar:** The objective of this course is to give students the confidence to make oral presentations before small and large audiences and to train students in basic skills in preparing and delivering audio visual presentations, including audience interaction and effective use of visual aids.

Students will prepare and present on various topics throughout the semester, which will be evaluated by the faculty. They will also be expected to answer questions and tackle problems during the presentation. Through this course, students will be able to make presentations and different of scientific papers compatible with the world class recognized standards and formats. 3 CREDITS

ELECTIVE COURSES **(9 CREDITS)**

BBT415	Molecular Biotechnology	3
BBT416	Bioinformatics	3
BBT417	Neurochemistry & Endocrinology	3
BBT418	Pharmaceutical Biotechnology	3
BBT419	Clinical Biochemistry	3
BBT421	Applied Immunology & Immunogenetics	3

BBT415 **Molecular Biotechnology:** Molecular Biotechnology is an evolving field of science that integrates applications from molecular biology, biochemistry, immunology, genetics and microbiology to create useful products in areas as diverse as human and animal health, agriculture, food and sustainable energy production, and the textile industry. This course will provide sound knowledge regarding transfer of genetic information between organisms to capitalize on existing biological processes to create new and innovative products. Topics include: recombinant DNA technology; chemical synthesis, amplification & sequencing of DNA; manipulation of gene expression in prokaryotes; heterologous protein production in eukaryotes; site directed mutagenesis & protein engineering, development of transgenic animal and use of molecular biotechnology to synthesize commercial products. 3 CREDITS

BBT416 **Bioinformatics:** The course provides a broad overview of bioinformatics and computational biology as applied to biological research. Course material will be geared towards answering specific biological questions ranging from detailed analysis of a single gene through whole-genome analysis. The course include topics: Biological Databases; BLAST and Sequence Alignment; Protein Bioinformatics; Prokaryotic & Eukaryotic Genome analysis, Human variation (SNP) analysis, Phylogenetic tree construction and plasmid (both cloning & expression vector) designing. 3 CREDITS

BBT417 **Neurochemistry & Endocrinology:** The major target of this course is to acquire an understanding of current theories of mechanisms of neural and endocrine functions and their implications for both basic knowledge and its application in modern biology. The neurochemistry part of the course comprises the biochemistry of the nervous system; neurotransmitter synthesis and metabolic mechanisms at the synapse, release and re-uptake/degradation of classical neurotransmitters and peptide transmitters. Receptors for neurotransmitters and their ligands will be discussed from a chemical-pharmacological point of view including the relevance of these molecules and their interactions for development of tolerance, super-sensitivity and long-term potentiation.

The endocrinology part of the course covers the endocrine system and its hormonal products, including the characterization of hormone producing cells, synthesis and modification mechanisms of the hormones, release and transport of the hormones of different chemical nature, various hormone receptors and the mechanisms of hormone action, the effects of hormones on target cells, and physiological processes, as well as the diseases caused by inappropriate hormone functions. This course will cover the general principles of endocrinology, followed by brief discussion of the system-based endocrinology. 3 CREDITS

BBT418 **Pharmaceutical Biotechnology:** The course is designed to equip students with a basic knowledge of concepts directly relevant to working in the biopharmaceutical industry. The course topics include five sections: 1) Introduction (definition of traditional pharmaceutical, biologic and biotechnological product; advantages of producing biotechnological products by recombinant means); 2) Biotechnological drug development (introductory xenobiotics, preclinical studies and clinical trials, developing recombinant therapeutic protein); 3) The biotechnological products manufacturing process (Overview of cell banking systems, typical upstream and downstream processes, Fermentation, Product recovery, stabilization and formulation); 4) Biotechnological product regulation; 5) Practical aspect of pharmaceutical manufacture (Overview of QA and QC); 6) The biochemistry, production and medical uses of selected biotechnology products (Insulin, hormone, monoclonal antibodies, recombinant vaccines, gene therapy, cancer therapy). 3 CREDITS

BBT419 **Clinical Biochemistry:** This course will introduce diagnostic enzymology and the role of clinical biochemistry in evaluating diseases related to hepatic, renal, respiratory, and thyroid function and genetic disorder. An overview of the biochemistry of various diseases such as atherosclerosis, hepatitis, diabetes, rheumatoid arthritis, obesity, gout, mal-absorption syndromes, acidosis and alkalosis will be given. 3 CREDITS

BBT421 **Applied Immunology & Immunogenetics:** This course will enable understanding of the genetic aspects of the immune response and the role of the immune system in health and disease. Genetics of immune recognition molecules and its knowledge in research and therapy will be discussed. Current experimental approaches in immunology, including production of monoclonal antibodies, antibody engineering and their application are covered. This course will provide understanding of how excessive, inappropriate and defective immune responses can lead to hypersensitivity reactions, autoimmune and immunodeficiency diseases. Topics of current immunological interest, including immune tolerance, transplantation, vaccines and tumor immunology will be studied. 3 CREDITS

FREE ELECTIVE COURSES (9 CREDITS)