1st Year 1st Semester

Course Code	Course Title	Class Hours/Week		Credits
		Theory	Sessional	
BGE 1101	Introduction to Biotechnology	3		3
BGE 1103	Biomolecules I	2		2
BGE 1105	Basic Biology	3		3
BGE 1107	Chemistry for Biotechnology	3		3
BGE 1108	Chemistry for Biotechnology (Sessional)		2	1
BGE 1109	Physics for Biology	3		3
BGE 1111	Introduction to Computer Science	3		3
BGE 1112	Introduction to Computer Science (Sessional)		2	1
	Total	**17**	**4**	**19**

BGE 1101 Introduction to Biotechnology 3 Credits

Course objective:

After completing this course students should be able to follow developments in different areas of biotechnology; recognize principle methods of biotechnology and genetic engineering; detect problems in the areas of agriculture, industries, healthcare and environment that can be solved by biotechnology and genetic engineering; identify potential research problems for future research activities; and identify a potential future career as a biotechnologists. To achieve the above objectives, the course will discuss the following subjects.

1. **Introduction:** Definition, history and multidisciplinary nature of biotechnology, scopes of biotechnology in developing countries, careers in biotechnology, traditional & modern biotechnology.
2. **Recombinant DNA technology:** Scope of gene cloning – concept and basic steps, application of bacteria and viruses in genetic engineering; molecular biology of E. coli and bacteriophages, restriction endonuclease, DNA ligase, usages of plasmid and phage as vector, use of Agrobacterium for genetic engineering in plant, marker gene, genetic transformation and selection, creating and screening a gene library.
3. **Potential Areas of Biotechnology**

   i. Agricultural biotechnology:

   Applications; scope and opportunities of agricultural biotechnology in Bangladesh.

   -Genetic manipulation in plants; seed quality improvement, nitrogen fixation and bio-fertilizers.

   -Genetically Modified (GM) crops: implications & concerns.

   -Biocontrol of plant pathogens, insects, pests and weeds.

   -Livestock and fish biotechnology:

   -Improving dairy and meat animals.

   -Improvement of culturable fish species.

   -Feed improvement.

   ii. Medical biotechnology:

   -Medical products and applications of biotechnology.

-Commercial production of hormones, vaccines etc.
-Gene therapy.
-Disease diagnosis.
-Monoclonal antibodies and their applications.
-Forensic applications: DNA fingerprinting.

iii. Environmental Biotechnology:

-Applications of biotechnology in the environment.
-Pollution control; Recalcitrant molecules and xenobiotics, use of specialized microorganisms to detoxify chemicals.
-Bioremediation of water, soil; waste disposal.

iv. Industrial Biotechnology

-Applications of biotechnology in the industry.
-Industrial fermentation.

Text Books:

1. An Introduction to Genetic Engineering, T. Nicholl, 3rd edition.
2. Dubey, R.C. Introduction to Biotechnology. 7th ed. S. Chand & Co. Pvt. Ltd. India.
3. Natesh, S. Biotechnology in Agriculture. Oxford & IBM Pvt Ltd. India. (1993).
4. Smith, J.E. Biotechnology, 2nd Ed, Edward Arnold Pub NY, UK. (1988).
5. Antebi, E. and Fishlock, D. Biotechnology, The MIT Press, USA. 1986.
5.Thieman WJ, Palladino MJ. Introduction to Biotechnology. Pearson (3rd edition 2012 or a later editi on).
6.Ratledge C, Kristiansen B. Basic Biotechnology. Cambridge Univ. Press (1st edition 2001 or a later edition).
7. Gupta PK. Biotechnology and Genomics. Rastogi Publications (2005 or a later edition).
8.Watson JD, Myers RM, Caudy AA, Witkowski JA. Recombinant DNA: Genes and Genomes- A Sh ort Course.
W. H. Freeman (3rd edition 2006 or a later edition).

BGE 1103 Biomolecules I 2 Credits

Course objectives: Biomolecules are molecules that are present in living organisms, including large macromolecules such as carbohydrates, proteins, and nucleic acids, as well as small molecules such as primary, and secondary metabolites. The aim of this course is to familiarize students with biomolecules in both chemical and biological contexts by introducing the central types of biological macromolecules, demonstrating their fundamental organic chemistry, defining the structures and functions. To achieve the above objectives, following topics will be extensively discussed.

1. Carbohydrates

(a) *Monosaccharide*: Nomenclature, optical and chemical properties, ring structure of common monosaccharides, proof of ring structure of glucose, mutarotation of glucose, general properties of sugars, important derivatives of monosaccharides, sugar acids.
(b) *Disaccharides:* Maltose, lactose, sucrose and other disaccharides.
(c) *Polysaccharides:* Storage and structural polysaccharides, occurrence, composition, structures and properties of starch, glycogen, cellulose, other polysaccharides of biological interest, their chemical tests and biological importance.
(d) *Glycoconjugates:* Proteoglycans, glycoprotein and glycolipids.
(e) Carbohydrate as informational molecule; The sugar code.

2. **Amino acids and peptides:** Definition, source, classification, structure, physicochemical and optical properties of amino acids and peptides, essential and non-essential amino acids, concept of residue, peptide bonds, oligopeptide, and polypeptide. Identification of N terminal and C terminal residue of peptide, general methods of preparation of amino acids, analysis of amino acids from protein hydrolysate, synthesis of peptides.
3. **Nucleic Acids:**
   a) *DNA:* Structure, molecular properties, physico-chemical properties – such as T_m value, Cot value. Different conformations of DNA, hybridisation kinetics, DNA-DNA & DNA-RNA hybridization. Sequence complexity, tandem sequence, palindromic sequence, cruciform structure.
   b) *RNA:* Types, structures, properties, primary, secondary, tertiary structure of RNAs and sequences.

Text Books:

1. Nelson and Cox. Lehninger's Principles of Biochemistry.
2. Voet and Voet, Biochemistry. 4th edition.
3. Stryer, L. Biochemistry, Latest Ed.
4. Thomas M. Devlin, Text Book of Biochemistry with Clinical Correlations
5. Robert K. Murray, Daryl K. Granner, Peter A. Mayer, Victor W. Rodwell, Harper's Biochemistry

BGE 1105 Basic Biology 3 Credits

Course objectives

Biology is the mother subject of biotechnology. Molecular manipulation in cell level is becoming crucial for sustainable biotechnology. This course helps the students to acquaint knowledge about cell, its manipulation, organic evaluation, formation of molecules to cell, cell chemistry and origin of eukaryotic cells. This course will also make a prime base for students to acquire knowledge about plant and animal, their differences and advantages for mankind.

1. **Origin of life:** Definition of life, properties of life, origin of life, origin of earth, age of earth, the geologic time scale, pre-biological formation of macromolecules, spontaneous generation of life, from molecules to cells, microfossils of unicellular organisms, origin of eukaryotic cells, origin of organelles, diversity of life.
2. **Biology of the Cell:** A brief introduction to cell**,** historical background, cell theory, modern techniques of study e. g. cell fractionation.

   Cellular organelles: Mitochondrion, Endoplasmic reticulum, Chloroplast, Golgi apparatus, Ribosome, Nucleus, Lysosome, Peroxisome, Vacuole, etc.

   Biological membrane: Chemical composition of membrane, major classes of membrane lipid, lipid bilayers and their common structural theme, membrane proteins, membrane models, membrane carbohydrates.

   Cell Cycle: Stages of cell cycle, control of the cell cycle.

   Cell Division: Types: amitosis, mitosis and meiosis, Stages of mitosis and meiosis, karyokinesis and cytokinesis, biological significance of cell division.

   Microscopy: Advent of microscopy, development of electron microscope, importance of microscope in cell study.

3. **The simpler plants** (Introduction, salient features, structure, reproduction and economic importance):
   Algae – The green, brown and red algae.
   Fungi – Slime molds, water molds, zygospore forming fungi, sac fungi, club fungi, imperfect fungi, mycorrhizae and lichens.
   Bryophytes – Liverworts and mosses.
4. **The simpler animals** (Introduction, salient features, structure, reproduction, economic importance)**:**
   Protista – Amoeba, protozoa, plasmodium, paramecium.
   Cnidaria – Hydra, jellyfish, corals.
   Platyhelminthes – Tape worm.
   Nematodes – Ascaris and other parasitic round worms.
5. **Evolution:** Definition, evolution and genetic variation, Evidence, Overview of major phylogenic and evolutionary trends among the simpler plants and animals.

Text Books:

1. Gerald Karp. Cell and Molecular Biology.
2. Raven, P.H. and Johnson, G.B. Biology, Times Mirror/Mopsby College Pub. Ltd. USA.1986.
3. Starr, C. and Taggart, R., Biology – The unity and Diversity of Life, Wards worth Pub. Company USA. 1989.
4. Attenborough, D. Life on Earth. 1979.
5. Pelczer and Reid, Microbiology

BGE 1107 Chemistry for Biotechnology 3 Credits

Course Objectives:

The main objective of this course is to explain the basics of chemistry to understand the biological phenomena. After successful completion of this course, students will be able to elucidate the thermodynamic processes and energy flow in biological systems; pH and its measurement; buffering system and their role in maintaining pH; nature of chemical equilibrium; Different types of bonds especially covalent bonds and weak bonds important for biological functions; different types of stereoisomer and their identification; Different types of chemical reactions exist in biological system and the involvement of enzymes in these reactions. To accomplish the above objective, the course will discuss the following topics:

1. **Thermodynamics:** Thermodynamic terms and basic concepts. Thermodynamic systems. State of a system. Thermodynamic processes.
   First law: Definitions and Statements. Enthalpy. Enthalpy of a system.
   Second law: Spontaneity. Entropy – definitions, units and significance. Statements of second law. Statements of third law.
2. **Bioenergetics:** Free energy, Cells require sources of free energy, Gibbs free energy, Standard free energy change, ATP as fundamental biological energy, Activation barrier, Activation energy, Role of Enzymes.
3. **Acids and Bases:** Arrhenius concept, Bronsted-Lowry concept, Lewis concept, strength of acids, pH of solutions, pH scale, buffer solution, Henderson-Hasselbalch equation, Importance of pH in biological system, Acidosis in Type II diabetes mellitus. Buffering against pH changes in biological system, acid- base indicator, and acid-base titration, choice of a suitable indicator and theories of acid - base indicators.

4. **Chemical equilibrium:** Nature of chemical equilibrium, law of mass of action, equilibrium constant, relationship between ΔG & K_{eq}, Effect of temperature and pressure, ionization of water, Le-chatteliar principle, equilibrium reaction involving protons, coupling of reactions.
5. **Chemical bonding:** Covalent bond, ionic bond, hybrid orbital, polarity of bonds, electronegativity, dipole movement, weak bonds, Non-covalent interactions in Biological system, hydrogen bond, Significance of Hydrogen bond in biology, hydrophobic interactions, intra-molecular forces.
6. **Stereochemistry:** Stereochemistry and stereoisomers, plane –polarized light and the polarimeter, Enantiomerism, the chiral center, Optical purity.
7. **Reaction Mechanisms:** Different biochemical reactions – oxidation and reduction, movement of functional group within or between molecules, addition and removal of water. Nucleophiles and electrophiles; Substitution reaction, addition reaction, elimination reaction. Chemical reactions in living cells: major types of reactions and examples.

Text Books:

1. K. K. Sharma and L. K. Sharma, A text book of Physical Chemistry
2. B.S. Bahl and G.D. Tuli, Essential of Physical Chemistry, S. Chand and Company Ltd.2006
3. Morrison and Boyed, Organic Chemistry.
4. I. L. Finer, Organic Chemistry (Volume: 1 and 2).
5. V.M. Khanna, M.M. Kapur, and V.P. Sharma, Physical Chemistry
6. Morris, J. G. A, Biologist's Physical Chemistry

BGE 1108 Chemistry for Biotechnology (Sessional) 1 Credit

1. Preparation of standard solutions (e.g. Normal, Molar, Percent solutions).
2. Determination of the strength of unknown solution by Titration (e.g. HCl).
3. Preparation of buffer and determination of pK of Acetic acid.
4. Identification of organic compounds: detection of elements (N, S, C, H, O and X in organic compounds)

BGE 1109 Physics for Biology 3 Credits

Course objectives

Physics and Biology are two interdisciplinary fields that are merged together in this course to acquaint students with the key aspects of the physics used to solve the biological problems. After completing this course students will be able to discern different dimensions and units, coordinate systems, vector dynamics, friction and drag, human cardiovascular system, the nature of fluids, blood velocity and turbulence, membrane potentials, circuit topology, cable model of the axons, magnetic field, mass spectroscopy, imaging problems, electromagnetic radiation, nuclear reactions, biological applications of diffusion and friction in fluids and nanotechnology. To accomplish the above objectives, following topics will be discussed.

1. **Introduction:** Dimensions and units, coordinate systems, idealization, approximation and precision, problems.
2. **Mechanics:** Kinematics, vector dynamics, friction and drag, conservation, stress and strain, angular quantities, static equilibrium, problems.
3. **Fluids:** The human cardiovascular system, the nature of fluids, Poiseuille's equation, pulsatile flow, blood velocity and turbulence, problems.
4. **Electricity:** Coulomb force, electric potential, membrane potentials, the action potentials, circuit topology, circuits, capacitors, and RC circuits, cable model of the axons.

5. **Magnetisms:** Magnetic field, mass spectroscopy, current loops and spin magnetic resonance, imaging problems.
6. **Atomic physics:** Rutherford atom model, Bhor atom model, hydrogen spectrum, quantum number and periodic table, electromagnetic radiation, spectral sensitivity of the eye, degrees of freedom, problems.
7. **Nuclear Physics:** Nucleus, binding energy, mass defect, nuclear reactions, threshold energy, nuclear decay and radioactive series, biological effect of radiations, problems.
8. **Heat:** How life generates order, the probabilistic facts of life, biological applications of diffusion and friction in fluids.
9. **Nanotechnology and its Application in Biological Science.**

Text Books:

1. Philip Nelson. Biological Physics.W.H. Freeman and Company, New York, 2004
2. Gr. Gias Uddin Ahmed, Physics for Engineers, Part 1, Habib Book Center, Dhaka, Bangladesh. 20(
3. R. Murageshan, Electricity and Magnetism, S. Chand and Co. Ltd., New Delhi, India.
4. R. Murageshan, Modern Physics, S. Chand and Co. Ltd., New Delhi, India.
5. B. L. Theraja, Modern Physics.

BGE 1111 Introduction to Computer Science 3 Credits

Course Objectives

This course will describe the basic education on hardware, software and applications in computer system to the Biotechnology students. Student will be able to operate computer and prepare documents using MS word, excel and power point application to aware about the use of computer in their entire study period.

1. **Introduction:** Brief history and types of computers, application areas. Working principle of a computer system, single and multi-user systems.
2. **Hardware:** Organization and architecture, motherboards and microprocessors, memory units; primary memory, secondary memory, I/O devices, peripheral devices, AT/XT, ISA, EISA. PCI Bus architecture.
3. **Software:** Classification, system software, operating system concepts, importance, components and basic functions of DOS, Windows and UNIX operating system. Application software, database, spreadsheet and word-processing software.
4. **Applications:** Multimedia systems, computer networks; basic concepts on LAN and WAN and Internet systems, internet services, on-line and off-line E-mail and WWW.
5. **Selection of computers:** Hardware, software and cost consideration.
6. **Maintenance:** Power supply stability, grounding. Effect of surge, sag current and its protection. Effect of static charge on computer devices, handling of computers cards and chips, computer viruses and protections, software troubleshooting and maintenance

BGE 1112 Introduction to Computer Science (Sessional) 1 Credit

1. MS Word: Basic applications.
2. MS Powerpoint: Preparing presentation slides, master slide.
3. MS Excel: Spreadsheet analysis, plotting graphs and charts.
4. Programming: Writing basic programs using C.

1st Year 2nd Semester

Course Code	Course Title	Class Hours/Week		Credit
		Theory	Sessional	
BGE 1201	Biomolecules II	3		3
BGE 1202	Biomolecules II (Sessional)		2	1
BGE 1203	Human Physiology I	3		3
BGE 1205	Molecular Biology I	3		3
BGE 1207	Plant Tissue Culture	3		3
BGE 1208	Plant Tissue Culture (Sessional)		2	1
BGE 1209	Mathematics I	2		2
BGE 1211	Functional and Communicative English	2		2
BGE 1213	Course Viva			1
Total		**16**	**4**	**19**

BGE 1201 Biomolecules II **3 Credits**

Course objectives: Biomolecules are present in living organisms that are important for structural and cellular functions. This course covers structures of the biomolecules at the cutting edge of current research. The course is broadly based and devoted to the molecular structure, characteristics, classification and function of proteins and lipids followed by different techniques of purification and characterization of major biomolecules. After completing this course students will be able to extrapolate the relation between structure and function of biomolecules. To achieve the above objectives, following topics will be extensively discussed.

1. **Proteins:** General introduction, classification based on biological function, shape and structure, isolation and purification, primary, secondary, tertiary and quaternary structure of proteins, protein domains and subunits, denaturation and renaturation of proteins
   Fibrous proteins: Secondary structures of proteins, protein conformation, alpha-keratins, X-ray analysis of keratin, planar peptide bonds, alpha helix, helix forming and destabilizing amino acids, the insolubility of alpha-keratins, beta-keratin: conformation and structure, structures of collagen and elastin, filamentous proteins: actin, myosin and microtubules.
   Globular proteins: Tertiary structures of proteins : distinctive tertiary structures of myoglobin and ribonuclease, renaturation of unfolded and denatured ribonucleases, factors maintaining the tertiary structure of globular proteins, oxygen-binding curves of haemoglobin and myoglobin, the cooperative binding of oxygen by haemoglobin, factors contributing to oxygen saturation curve of haemoglobin, sickle-cell anaemia and its relation to haemoglobin.
2. **Lipids:** Definition, nomenclature, classification, general reaction of fats, fatty acids and sterol, structure and biological importance of different classes of lipids, isolation of cholesterol and phospholipids from natural sources. Storage lipid, structural lipids in membrane.
3. **Biomolecules purification and characterization:**
   Principles and Applications of
   - Paper chromatography
   - Thin layer chromatography
   - Gel Exclusion Chromatography
   - Ion exchange chromatography

- Liquid chromatography: HPLC, FPLC, and GLC
- Affinity and covalent chromatography
- Hydrophobic chromatography
- Electrophoresis
- Ultra-centrifugation

Text Books:

1. Nelson and Cox. Lehninger's Principles of Biochemistry.
2. Voet and Voet, Biochemistry. 4th edition.
3. Stryer, L. Biochemistry, Latest Ed.
4. Thomas M. Devlin, Text Book of Biochemistry with Clinical Correlations
5. Robert K. Murray, Daryl K. Granner, Peter A. Mayer, Victor W. Rodwell, Harper's Biochemistry

BGE 1202 Biomolecules II (Sessional) 1 Credit

1. Qualitative tests for carbohydrates.
2. Qualitative tests for proteins.
3. Qualitative tests for lipids.
4. Paper chromatography.

BGE 1203 Human Physiology I 3 Credits

Course objectives: The course named of Human physiology I is broadly based on blood, skeletal, muscular, lymphatic, cardiovascular, and excretory system. After completing this course, students should be able to know about growth, development, function and disorder of skeletal and muscular system. Origin, composition and function and disorders of blood. Origin, development and processing, proliferation and inhibition of B and T cells. Anatomy and histology of heart, ECG, regulation of BP. Kidney as an endocrine organ, urine formation, acid base balance and haemodialysis. To accomplish the above objectives, the course will discuss the following subjects.

1. **Skeletal System:** Cartilage and bones, bone cells, bone anatomy, bone marrow, bone development, bone growth, functions of skeletal system, calcium homeostasis, bone disorders.
2. **Muscular system:** Types of muscle tissues, comparison of muscle types, structural features of muscle, muscle fibres, function of muscular system, neuromuscular junction, muscle contraction and relaxation, muscle twitch, summation, tetanus and recruitment, fate of ATP and types of muscle contraction. Disorders (Cramps, hypertrophy and atrophy, muscular dystrophy).
3. **Circulatory system:**

   Blood: Composition of blood and its functions, blood cells, lymph, serum, plasma. Total count (TC), differential count (DC), haematopoiesis, origin of blood cells and macrophage system, biochemistry of blood clotting, blood grouping (types), Rh factor and cross matching, homeostasis. Haemoglobin (Structure, function and reaction). ESR (Definition, Measurement and significance), agglutination and transfusing reaction, anticlotting mechanism, sickle-cell anaemia, thalassemia and other disorders of blood cell formation.

   Lymphatic and Lymphoid System: Lymph and lymph vessels, lymphatic circulation, primary and secondary lymphoid organs and their functions, structure and function of lymph nodes, spleen, thymus, and bone marrow in immunity. Origin, development and processing of B and T cells. Proliferation and inhibition of lymphocytes. Different kind of disorders.

4. **Cardiovascular system:** Anatomy of heart, origin, conduction and regulation of heart beat, cardiac cycle; electrocardiogram, blood pressure, capillary pressure, regulation of blood pressure, cardiovascular disorders, renin-angiotensin system, atherosclerosis, myocardial infarction.
5. **Hepatic System:** Structure and function of liver, storage, metabolic, synthetic and secretory function, liver function test, liver diseases (cirrhosis and jaundice).
6. **Digestive System:** Anatomy and function of digestive system, composition, function and regulation of salivary, gastric, pancreatic, bile and intestinal juices, mechanism of secretion of gastric acid, physiology of digestion and absorption of foods, digestive disorders (e.g. Diarrhoea, gastritis etc.), gastrointestinal hormones.
7. **Excretory System:** Structure and function of nephron, glomerular filtration rate, selective reabsorption & secretion, mechanism of urine formation, endocrine function of the kidney, the role of kidney in water, electrolyte and acid base balance of the body, renal disorders, relationship between kidney function and BP, haemodialysis, hormones secreted by kidney.

Text Books:

1. Gyton, M.D. Test Book of Medical Physiology. W.B. Saunders Com., London. 1986.
2. Smith, E., Pateson, C.R. Scratcherd, T. and Read, N.W. Text Book of Physiology,
3. C.C. Chatterjee, Human Physiology. Vol. 1 and 2.
4. Chakrabarti, Ghosh and Sahana, Human Physiology.
5. William F. Ganong, Review of Medical Physiology.

BGE 1205 Molecular Biology I 3 Credits

Course objective:

The objective of this course to learn the central dogma: The central dogma of molecular biology describes the flow of genetic information in cells from DNA to messenger RNA (mRNA) to protein. It states that genes specify the sequence of mRNA molecules, which in turn specify the sequence of proteins. The course also describes how DNA con be copied to DNA (DNA replication).

1. **Replication**: Semi-conservative replication, bidirectional replication, semidiscontinuous replication, DNA polymerases, enzymes and proteins involved in replication, stages of replication – initiation, elongation, termination.
2. **Transcription**: DNA-dependent synthesis of RNA, stages of transcription – initiation, elongation, termination, promoter sequence, termination signal. RNA polymerase – core enzyme, sigma factors, different RNA polymerases, selective inhibition of RNA polymerases – actinomycin D, rifampicin, α-amanitin.
   Non-coding RNA: Definition, types, biological role of non-coding RNA.
   Reverse transcription: significance in biological system.
3. **Translation**: Codons, open reading frames (ORFs), degeneracy of genetic codons, stages of translation – initiation, elongation, termination. tRNAs and activation of amino acids, initiation codon and Shine-Dalgarno sequence, initiation factor proteins, translocation reaction, elongation factors, termination codon and termination factors, inhibition of protein synthesis by antibiotics and toxins.

Text Books:

1. Benjamin and Lewin, Genes VI and VII, Oxford University Press, sixth Edition.
2. Watson, J.D. and Hopkins, A.M., Roberts, J.W., Steitz, J.A. and Weiner, A.M. Molecular Biology of the Gene, Benjamin/Cummings Scientific Publishing.
3. Nelson and Cox. Lehninger's Principles of Biochemistry.

4. Brown, T. A. Genomes, Second Edition. BIOS Scientific Publishers Ltd. 2002.
5. Snustad, D.P. Simmons, M.J. and Jenkins, J.B. Principles of Genetics, Jacaranda/Wiely pub.
6. Klung, W.S. and Cummings, M.R. Concepts of Genetics, Scott, Foresman and Co. USA

BGE 1207 Plant Tissue Culture 3 Credits

Course objectives

Plant Tissue Culture is a basic tool of Plant Biotechnology. The objective of this course is to introduce students to the principles, practices and application of plant tissue culture in science, agriculture and industry. Moreover, to give students hands-on experience to learn the techniques for *in vitro* rapid clonal propagation, learn the techniques for production of disease-free plants, understand the *in vitro* techniques on the application of seedling production and breeding in horticultural and agronomic plants.

1. **Introduction to Plant Tissue Culture:** Definition, concept, history and development, totipotency, macropropagation and micropropagation, botanical basis for tissue culture, clone, importance of cell, tissue and organ culture.
2. **Laboratory Organization:** Facilities, design, requirements, basic laboratory procedures, laboratory safety and daily maintenance operation.
3. **Aseptic techniques:** Definition, sterilization of glassware, instrument, culture room and transfer areas, sterilization of nutrient media, surface sterilization of plant materials, maintenance of aseptic environment, microbial contamination and prevention procedures.
4. **Media:** Components, composition, functions of components, preparation and media selection, media solidification, sterilization of media and maintenance, types of media.
5. **Culture Types and Applications:** Types of culture e.g. tissue/callus culture, suspension/cell culture, embryo culture, organ culture, anther culture, protoplast culture, plant culture applications of culture, explant, explant types, selection, collection and preparation of explants, transfer of cultures and subculture, storage of culture and germplasm (cryopreservation), culture conditions, effects of culture conditions.
6. **Plant Regeneration and Techniques:** Micropropagation, stages of micropropagation, organogenesis, somatic embryogenesis, morphogenesis.
7. **Clone and Variation:** Definition, types of clone, variation in clone, *in vitro* mutagenesis, screening of somaclone and somaclonal variants.
8. **Synthetic Seed:** Concepts, formation of synthetic seed (somatic embryo), automation of somatic embryo production, preservation, merits and demerits.
9. **Protoplast culture:** Isolation of protoplast, fusion and production of hybrid and cybrid, somatic hybridization. Factors affecting hybridization. Importance.
10. **Anther/ Pollen Culture:** Androgenesis, gynogenesis, production of haploid and double haploid plants, technique of anther culture, importance.
11. **Application of Plant Tissue Culture:** Application in agriculture, horticulture and forestry, and industries. Secondary metabolites in pharmaceuticals, natural products, pigments, commercialization of tissue culture product.

Text Books:

1. Jack G. Chirikjian Biotechnology: Theory and Techniques. Volume I. Jones and Bartlett Publishers, Boston, London, Singapore. (1995).

2. Kenneth C. Torres, Tissue Culture Techniques for Horticultural Crops. Van Nostrand Reinhold, New York. (1989).
3. Razdan, M.K. An Introduction to Plant Tissue Culture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta. India. (1993).
4. Vasil, I.K. and Thorpe. T.A. Plant Cell and Tissue Culture. Kluwer Academic Publishers.
5. Dodds L.H. and Roberts L.R. Experiments in Plant Tissue Culture, Cambridge University Press.
6. Bhojwani S.S. and Razdan M.K. Plant Tissue Culture-Theory and Practice. Elsevier Sci Publishers.
7. Lindsey, K. Plant Tissue Culture. Manual, Kluwer Academic Publishers. The Netherlands.
8. R. C. Dubey A Text Book of Biotechnology. S. Chand & Company Ltd., New Delhi.

BGE 1208 Plant Tissue Culture (Sessional) 1 Credit

1. Techniques of media preparation and their stock solutions.
2. Selection and pre-treatment of different kinds of explants.
3. Sterilization techniques of media, instruments and surface sterilization of explants.
4. Culture of explants, transfer of culture and subculture.
5. Detection of contamination of media and cultures.
6. Initiation of callus and regeneration
7. Detection of appropriate stages of anther and pollen, anther culture.
8. Protoplast isolation and culture

BGE 1209 Mathematics I 2 Credits

Course objective:

After finishing this course students should be able to make scientific calculations accurately and confidently, derive data from both qualitative a quantitative outputs; manage large data sets; convert large numbers in to manageable ones for more effective analyses; infer trends in data sets; derive mathematical models based on the trends of reference data sets and use the model to explain experimental data sets; present trends of data set graphically; and interpolate and extrapolate data points logically. To accomplish the above objectives, the course will discuss the following subject.

1. **Basic Concepts:** Concepts of number system, equation, polynomials, relation, functions, types of function, graph of function.
2. **Set Theory:** Sets, set notation, operation with sets, laws of set operations, venn diagram and application of set theory.
3. **Equation System:** Solution of equation, simultaneous equation system, solution of simultaneous equation.
4. **Determinant and Matrix:** Definition of determinant, minor and co-factors, application of determinants to linear equations, definition of matrix, addition, scalar multiplication and matrix multiplications, adjoint and inverse matrices, solution of linear equations by applying matrices.
5. **Differentiation:** Limit, continuity, differentiability, differentiation, general theorem, partial differentiation, maxima, minima.

Text Books:

1. Differential Calculus. B.C. Das and B.N. Mukherjee
2. Calculus. Howard Anton, Irl. Bivens Stephen Davis
3. Linear Algebra. Abdur Rahman
4. Set Theory. Abdur Rahman

BGE 1211 Functional and Communicative English 2 Credits

Course Objectives:

The main aim of this course is to improve the English reading and writing skill of the students that will help them to well prepare for the English medium study in the Department of Biotechnology and Genetic Engineering.

1. **Grammar:** Tenses, prepositions, subject-verb agreement clauses, transformation of sentences: active passive transformations, reported speech.
2. **Phonetics:** How to use a dictionary, IPA symbols, word transcriptions.
3. **Vocabulary building:** Importance of vocabulary, correct and proper diction: affixes, practice in vocabulary.
4. **Developing writing skill:** Sentences: sentence variety, paragraph structures: topic sentences, developing paragraphs with specific details and examples.
   Essays: Essay structure, strategies for development, letter writings, informal and formal letters.
5. **Developing reading skill:** Strategies of readings, skimming, scanning, predicting and interfacing.
6. **Listening and note taking:** Listening to class text and lectures, and learning to take useful notes based on the listening.
7. **Writing Research paper:** Planning the research paper, doing the research, organizing the information, drafting and documenting the papers.

Text Books:

1. S.M. Zakir Hossain. A Passage to the English Language, 3rd impression, December 2001. Rohel Publication, Dhaka.
2. Moniruzzaman. Basic English Language Skills, 2002, Friends Book Corner.
3. S.M. Amanullah. A Guide to Correct Speech. 2007, Albatross Publication.
4. C.R. Kothari. Research Methodology, 2005, New Age International (r) Limited Publishers.

BGE 1213 Course Viva 1 Credit

Viva-voce on all courses belonging to the respective year.

2nd Year 1st Semester

Course Code	Course Title	Class Hours/Week		Credit
		Theory	Sessional	
BGE 2101	Molecular Biology II	3		3
BGE 2103	Basic Concepts of Genetics	3		3
BGE 2105	Metabolism I	3		3
BGE 2107	Human Physiology II	3		3
BGE 2109	Basic Microbiology	3		3
BGE 2110	Basic Microbiology (Sessional)		2	1
BGE 2111	Breeding	**3**		3
BGE 2112	Breeding (Sessional)		**2**	1
BGE 2113	Mathematics II	**2**		2
	Total	**20**	**4**	**22**

BGE 2101 Molecular Biology II **3 Credits**

Course objective:

From this course students should be able to learn structural and functional organization of genome. The students also get idea how mRNA is being processed and protein is modified after transcription and translation respectively.

1. **Structural Organization of Genome:** Viral genome, bacterial genome, organelle genome of eukaryotes, eukaryotic nuclear genome, chromosome and chromatin, nucleosomes, chromatin fibers, histone octamer, nucleosome assembly.
2. **Accessing the Genome:** Internal architecture of eukaryotic nucleus, chromatin domains, locus control regions, histone modifications, chromatin remodelling.
3. **Processing of RNAs:** *Processing of bacterial RNAs* – nucleotide modification. *Processing of eukaryotic RNAs* – splicing, splicing mechanisms, structural features of mature mRNAs, differential RNA processing, processing of rRNAs and tRNAs.
4. **Post-Translational Modification:** Protein folding, proteolytic cleavage, chemical modifications of proteins.
5. **Genome Mapping:** Genetic and physical maps, DNA markers for genetic mapping, methods of DNA sequencing.
6. **Chemical Synthesis of DNA:** Methods of synthesis of small DNA fragments.

Text Books:

1. Benjamin and Lewin, Genes VI and VII, Oxford University Press, Sixth Edition.
2. Watson, J.D. *et al*. Molecular Biology of the Gene.
3. Nelson and Cox. Lehninger's Principles of Biochemistry.
4. Bruce Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, J. D. Watson. Molecular Biology of Cell.

BGE 2103 Basic Concepts of Genetics 3 Credits

Course objectives: Genes are the heritable messengers of our ancestral traits and causative agents of most of the diseases. This course covers both Mendelian (classical or transmission), and molecular genetics which are very crucial to explore all branches of biotechnology. After completing this course students should be able to explain basic concepts in genetics including Mendelian genetics and its variations; heredity; genetically important organisms; chromosomal theory of inheritance; linkage studies; sex determination; chromosomal aberration; mutation; eugenics and euphenics. Furthermore, students will also be able to critically interpret and evaluate the results in context of Mendelian's law and its variations. To accomplish the above objectives, following topics will be discussed.

1. **Introduction:** Definition, scope and branches of genetics, importance of genetics in human society, brief account of the structure and function of gene, pangenesis theory, the evolution of science of genetics leading to the modern biotechnology and genetic engineering. Reproduction as the basis of heredity: the cell as a basic unit of life, cell division: meiosis, The formation and unit of gametes, the life cycle of some genetically important organism.
2. **Mendelian Principle:** Mendel and his experiments and the laws of inheritance; back cross, test cross, rediscovery of Mendelism.
3. **Variation on Mendel's Theme:** Variation of first law (incomplete dominance, co-dominance and lethal gene), variation of second law (epistasis, duplicate gene, complementary gene, and suppressor gene), gene interactions.
4. **The chromosomal theory of inheritance:** Clues from inheritance of sex, linkage and crossing over, gene mapping, genetic recombination in prokaryotes and eukaryotes.
5. **Sex determination:** Sex Chromosome, discovery of sex chromosome, sex determination system.
6. **Chromosomal Aberration:** Definition, types of chromosomal aberration, structural and numerical changes of chromosomes and their type, importance of polyploidy.
7. **Mutation:** Definition, types of mutation and its identification, causes and effect of gene mutation, reverse mutation, importance of mutation. Molecular basis of mutations, repair mechanism in mutation, targeted mutagenesis, in-vitro site specific mutagenesis, mutation and carcinogenesis, inherited mutational diseases and its application.
8. **Eugenics and Euphenics:** Historical background, positive and negative eugenic measures for the betterment of human race.

Text Books:

1. Snustad, D.P. Simmons, M.J. and Jenkins, J.B. Principles of Genetics, Jacaranda/Wiely pub.
2. Averse C. J. Genetics. Freeman and Co., NY.
3. Watson, J.D. and Hopkins, A.M., Roberts, J.W., Steitz, J.A. and Weiner, A.M. Molecular Biology of the Gene, Benjamin/Cummings Scientific Pub, Menlo Park, California. 1988
4. Lewin, B. Genes VI, Oxford University Press, sixth Edition.
5. Strickberger. M.W. Genetics. 3rd edition, Prentice Hall Inc. USA. (1996).
6. Klung, W.S. and Cummings, M.R. Concepts of Genetics, Scott, Foresman and Comp.
7. Sinha, U and Sunita Sinha, Cytogenetics, Plant Breeding and Evaluation. Vikas Publishing.
8. Robert Tamarin, Priciple of Genetics; 7th edition, publisher: McGraw Hill.

BGE 2105 Metabolism I 3 Credits

Course objectives

Metabolism is the sum of all chemical transformations that occur in a cell or organism which is highly coordinated and purposeful cellular activity. Living organisms use metabolism to obtain chemical energy, convert nutrient molecules, assemble the precursors into macromolecules and degrade biomolecules required in specialized cellular function. In B.Sc. (Hons) we divided Metabolism in to two integrated courses. In Metabolism I, the course teacher will focus on Introductory metabolism and all aspects of anabolic and catabolic transformations of carbohydrates and their interrelationships in details. This course will also focus on bioenergetics related to the synthesis of chemical energy in oxidative phosphorylation.

1. **General aspects of metabolism:** Experimental approaches to the study of metabolism, metabolic and energy transfer pathways, a survey of intermediary metabolism.
2. **Glycolysis:** The glycolytic pathway, aerobic and anaerobic fate, regulation of glycolytic pathway, metabolism of disaccharides, pentoses and hexoses other than glucose, physiological importance of anaerobic glycolysis, anaerobic glycolysis and tumor cell, anaerobic glycolysis and heart attack, Fructose intolerance, galactosemia, diabetes mellitus, haemolytic anemia, hypoglycemia and premature infants.
3. **Glycogen Metabolism:** Glycogenolysis and glycogenesis, regulation of glycogen metabolism.
4. **The tricarboxylic acid cycle:** Cycle overview, the discovery of the TCA cycle, amphibolic nature of the cycle, anaplerotic reactions, regulation of the TCA cycle, pyruvate dehydrogenase deficiency, mitochondrial myopathies.
5. **Other pathways of carbohydrate degradation:** The pentose phosphate pathway, the glycoxylate pathway, glucose to glucuronic acid and ascorbic acid.
6. **Biosynthesis of carbohydrates:** Gluconeogenesis and its regulation, biosynthesis of di-oligo- and polysaccharides, glycoproteins, proteoglycans, sugar interconversons and nucleotide sugar formation.
7. **Electron transport and oxidative phosphorylation:** The evolution of electron transport chain, oxidation reduction enzymes and electron transport, oxidative phosphorylation, uncouplers and inhibitors of oxidative phosphorylation, mitochondrial structure and the compartmentation of respiratory metabolism, disorders due to deficiencies of mitochondrial proteins, Lufts syndrome, deficiencies of electron transfer proteins, brown adipose tissue and thermogenesis, mechanism of thermogenesis, diet induced thermogenesis.

Text Books:

1. Nelson and Cox. Lehninger's Principles of Biochemistry.
2. Alberts, B. Bray, D. Lewis, J., Molecular Biology of the Cell. Garland Publishing, Inc.
3. Lubert Stryer, Biochemistry, 3rd edition, W.H. Freeman and Company, New York.
4. Dr. A. C. Dev, Fundamental of Biochemistry.
5. Voet & Voet, Biochemistry. 1991.
6. Darn ell, J., Lodesh, H. and Baltimore, D. Molecular Cell Biology, W.H. Freeman and Company, New York. 1986.
7. Stryer, L. Molecular Design of Life. W.H. Freeman and Company, New York. 1989.
8. Goodman and Gilman, The Pharmacological Basis of Therapeutics.

BGE 2107 Human Physiology II 3 Credits

Course objectives:

Human physiology is the science of the mechanical, physical, and biochemical functions of normal humans or human tissues or organs. The course is broadly based and is devoted about respiratory, reproductive, nervous and endocrine system. After completing this course, students should be able to know about the anatomy, control mechanism and disease condition of respiratory, reproductive, nervous and endocrine system. To accomplish the above objectives, the course will discuss the following subjects.

1. **Respiratory system:** Anatomy of the respiratory tract and lungs, physiology of respiration, lungs volume and lungs capacity, transport of oxygen and carbon dioxide, oxygen dissociation curve of haemoglobin and myoglobin, Bohr effect; chloride shift, mechanism of breathing and common respiratory diseases (bronchitis, asthma, common cold, tuberculosis).
2. **Reproductive System:**
   Male: Spermatogenesis, hormonal factors that stimulate spermatogenesis, regulation of male reproductive function by various hormones, fertility and impotency. Hormonal regulation of male hormone secretion
   Female: Ovulation, monthly ovarian and uterine cycle and function of gonadotropic hormones, function of the placenta, fertility, impotency, pregnancy, hormonal factors in pregnancy, lactation and menopause. Hormonal control of ovulation, hormonal regulations of uterine and menstruation cycle, contraceptive pills.
3. **Nervous System:** Definition and classification of nervous system, structure and function of neuron, synapse, neurotransmitter, membrane potential, action potential; the sense, sense receptors, and transmission of nerve impulse, control of sensory and motor function, reflex. Neural regulation of temperature, neural control of pituitary, adrenal, cortical and other systems. Major neurophysiological disorders in humans (Parkinson's diseases, Alzheimer's diseases, Epilepsy).
4. **Endocrine system:** Functions, chemical signals, functional classification of intercellular chemical signals, receptors and its types, hormones, hormone chemistry, regulation of hormone secretion, endocrine glands (pituitary, hypothalamus, thyroid, parathyroid, adrenal) and their hormones, pancreatic hormones, gonad hormones, hormone producing/ releasing cells, inhibitory hormones, consequence of endocrine malfunction, environmental signals.

Text Books:

1. Gyton, M.D. Test Book of Medical Physiology. W.B. Saunders Company, London. 1986.
2. Smith, E., Pateson, C.R. Scratcherd, T. and Read, N.W. 1988. Text Book of Physiology, Longman Group Ltd., Hongkong.
3. C.C. Chatterjee, Human Physiology. Vol. 1 and 2.
4. Chakrabarti, Ghosh and Sahana, Human Physiology.
5. William F. Ganong, Review of Medical Physiology.

BGE 2109 Basic Microbiology 3 Credits

Course Objectives

After completing this course, students will have been introduced to a working knowledge of basic bacterial laboratory techniques, conceptualize the nature and origin of life - the concepts of classification, explain the similarities and differences among different groups of living things; Investigate diverse species of microbes, protists, plants and animals; Observe the interactions of different species among themselves, other species and the environment; And evaluate the effects of human activities on biodiversity and the ecosystem evolution and growth of microorganisms, as well

as a factual and laboratory knowledge of specific microorganism types - In addition, they should have developed an understanding of microbial ecology and of medical and practical uses for microorganisms, and how they relate to basic biological concepts. To achieve the above objectives, the course will discuss the following aspect of general biology.

1. **Historical development of microbiology:** Spontaneous generation versus biogenesis; germ theory of disease; contributions of Louis Pasture, Robert Koch, Alexander Fleming, S.A. Waksman and others in the development of microbiology and their early discoveries.
2. **The scope of microbiology:** The place of microorganisms in the living world; major scheme of classification of living organisms by Carolus Linnaeus, Haecke, Whittakcr and Carl Woose; distinctive characteristics of the major groups of microorganisms; major applied areas of microbiology.
3. **The characterization, classification, and identification of microorganism:** Major characteristics of microorganism, microbial classification, nomenclature and identification. eukaryotic and prokaryotic microorganisms and their differentiation,
4. **Microscope:** Units of measurement, different types of microscope, preparation of specimen for light microscopy.
5. **Bacteria:** Morphology, size, shape, and arrangement of bacterial cell, external structure; flagella, pilli, capsules, sheaths, cell wall, internal structure; cytoplasmic membrane, cytoplasm and nuclear material.
   Normal growth cycle (growth curve) of bacteria. Generation time, quantitative measurement of bacterial growth: direct microscopic count, the plate count method, membrane-filter count, electronic enumeration of cell numbers, turbidometric method. Methods of maintenance and preservation of bacteria; periodic transfer, overlaying with mineral oil, freeze-drying (lyophilization) and storage at low temperature.
6. **Control of Micro-organism**: Effect of physical and chemical agents; evaluation of effectiveness of antimicrobial agents.
7. **Algae and fungi:** Characteristics of algae and fungi; sexual and a sexual reproduction of fungi, fungal diseases; algal and fungal toxins, other economic importance of algae and fungi.
8. **Archaea:** Different types of archaea, methanogenic bacteria, extreme halophiles, thermoacedophiles.
9. **Protozoa:** Ecology of protozoa, importance of protozoa, morphology and reproduction of protozoa, characteristics of some major group of protozoa.

Text Books

1. Pelczar, M. J.; Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw Hill Inc. USA. (1993).
2. Tortora, G.J.; Funke, B.R. and Case, C.L. Microbiology: An Introduction. (1982).
3. Stainer, R.Y. Adelberg and Ingraham, I.J. General Microbiology, MaCmillan USA.
4. Jawetz, E.J., Melnick, J.L. and Adelberg, E. Medical Microbiology (1991).
5. Kenneth J. Ryan and C. George Ray Sherris Medical Microbiology. Fourth Edition, McGraw Hill Inc. USA (1994).

BGE 2110 Basic Microbiology (Sessional) 1 Credit

1. Preparation of culture media.
2. Isolation of different bacteria from environmental source.
3. Spreading and colony counting.
4. Different types of staining.
5. Microscopic examination of bacteria.
6. Susceptibility of microbes to antibiotics.

BGE 2111 Breeding 3 Credits

Course Objectives

The main objectives of this subject is to introduce the students with basics and different methods of breeding utilized in the plant, cattle and fish.

1. Plant Breeding:

i. Introduction to plant breeding: definition, nature, scope and history of plant breeding, objectives and applications, achievements.
ii. Mode of reproduction in relation to breeding methods: method of reproduction, mode of reproduction, pollination and its biological significance, control of pollination and genetic significance.
iii. Methods of crop improvement: selection, hybridization, introduction and acclimatization, mutation breeding.
iv. Selection methods: Mass selection, pure line selection, clonal selection, application, advantages and disadvantages.
v. Hybridization: definition, types, application, objective, prerequisite, procedure, advantages and disadvantages.
vi. Heterosis of hybrid vigour: definition, effects, causes of heterosis, breeding methods and techniques, utilization, limitations.
vii. Mutation breeding: definition, types, procedure, application, achievements, advantages, disadvantages.

2. Animal Breeding:

i. Principles of animal breeding: Selection, methods of selection, variation, traits for selection, breeding efficiency, heritability and repeatability.
ii. Systems of breeding: inbreeding outbreeding, top crossing, grading, cross breeding, intersementing, criss crossing and triple crossing.
iii. Artificial insemination (AI): history, advantages, insemination techniques, significance of AI in animal breeding.
iv. Factors influencing cattle fertility: anatomical, genetical, and environmental.
v. Artifical control of oestrous, ovulation and pregnancy diagnosis of cattle: Synchronisation, super ovulation.
vi. Fish breeding and biotechnological implication in fish production.

Text Books:

1. H. K. Chaudhari. Elementary Principles of Plant Breeding, second edition, Oxford and IBH publishing CO. Pergamon press.
2. B.D. Singh, Plant Breeding: Principles and Methods. Kalyani Pub., India.
3. U. Sinha, Sunita Sinha; Cytogenetics, Plant Breeding and Evolution, Second edition, Vikas Publishing house PVT LTD.

BGE 2112 Breeding (Sessional) 1 Credit

1. Techniques of hybridization: parent selection, emasculation, pollination, bagging and labeling of economic important crops.
2. Production of F1 seeds/ or hybrid seeds, their harvesting and data recording.
3. Handling F1 seeds/ or hybrid seeds, their germination and growth.
4. Morphological study of mother plant and F_1 plants and find out variation and concept of variety development.

5. Pollen viability testing, pollen germination and pollen tube growth testing.
6. Techniques of semen collection from cattle and preservation.
7. Artificial insemination and production of breed.

BGE 2113 Mathematics II 2 Credits

Course objective:

After finishing this course students should be able to make scientific calculations accurately and confidently, derive data from both qualitative a quantitative outputs; manage large data sets; convert large numbers in to manageable ones for more effective analyses; infer trends in data sets; derive mathematical models based on the trends of reference data sets and use the model to explain experimental data sets; present trends of data set graphically; and interpolate and extrapolate data points logically. To accomplish the above objectives, the course will discuss the following subject.

1. **Integration:** Indefinite integrals: method of substitutions, integration by parts, special trigonometric function and rational fraction, definite integrals: fundamental theorem, general properties, integration as the limit of a sum, evaluations of definite integrals, determination of length, area and volume.
2. **Differential equation:** Definition and classification of differential equation, problems and solutions, formation of differential equations, separable and homogenous equations, exact differential equations, linear differential equations, first order and first degree linear differential equation with constant coefficient.

Text Books:

1. Differential Calculus. B.C. Das and B.N. Mukherjee.
2. Calculus. Howard Anton, Irl. Bivens Stephen Davis.
3. Ordinary Differential Equation. B.D. Sharma.
4. Differential Equation. Shepley L. Ross.

2nd Year 2nd Semester

Course Code	Course Title	Class Hours/Week		Credit
		Theory	Sessional	
BGE 2201	Enzymology	3		3
BGE 2203	Metabolism II	3		3
BGE 2205	Nutrition	3		3
BGE 2207	Immunology I	3		3
BGE 2208	Immunology I (Sessional)		2	1
BGE 2209	Economics	2		2
BGE 2211	Biostatistics	3		3
BGE 2212	Biostatistics (Sessional)		2	1
BGE 2213	Course Viva			1
Total		**17**	**4**	**20**

BGE 2201 Enzymology 3 Credits

Course Objectives:

Enzymes are Biological molecules that have catalytic activity. The subject Enzymology deals with the properties, activity, and significance of enzymes. This course is designed to introduce about the basic characteristics of Enzymes, mechanism of its action, inhibition and regulation.

1. **Introduction:** Brief history, enzymes as biological catalysts, classification and nomenclature of enzyme, enzyme assay, specific activity and enzyme activity units.
   Factors affecting the rate of enzymatic reactions: substrate concentration, enzyme concentration, pH, temperature, coenzyme and cofactors.
2. **Active site of enzyme:** Active site of an enzyme and its characteristics, structural feature and identification, enzyme substrate complex formation, evidences.
   Isoenzymes: characteristics and importance; ribozymes.
3. **Enzyme kinetics:** Relation between substrate concentration and enzymatic reaction rate (Michaelis Menten equation), double reciprocal plot or Lineweaver - Burk equation kinetics of enzymatic reaction having two or more substrates.
4. **Mechanism of enzyme action:** Mechanism of action of enzyme, specific examples; chymotrypsin, lysozyme, ribonuclease A, carboxypeptidase.
5. **Enzyme inhibition:** Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibition with specific examples.
6. **Enzyme regulation:** Allosteric enzymes, special characteristics, Monod and Koshland models, mechanism of regulatory activity of allosteric enzyme, covalent modification of enzymes, specific examples to be studied: ATPase, phosphorylase, lactate dehydrogenase, macromolecular enzyme complexes and their regulation, case study: pyruvate dehydrogenase, regulation of pyruvate dehydrogenase in normal and diabetes state.

Text Books:

1. Boyer, The enzymes. 1970.
2. Malcom Dixon and Edwin C. Webb, Enzymes
3. Christopher Walsh, Enzymatic Reaction Mechanisms.

4. Stryer, Lubert. Biochemistry; W.H. Freeman and Company, San Francisco. (1981).
5. Lehninger, A.L. Biochemistry. 1987.
6. Voet & Voet, Biochemistry. 1991.

BGE 2203 Metabolism II 3 Credits

Course objectives

In Metabolism II, the course teacher will focus on all aspects of anabolic and catabolic transformations of Lipids, amino acids and nucleotides and will have a look on clinical implications of theses bio-chemical conversions. This course will also focus on tissue specific metabolism.

1. **Lipid metabolism: F**atty acid oxidation, ketone body formation and utilization, fatty acid biosynthesis: fatty acid biosynthesis regulation of fatty acid metabolism, storage of fatty acids as triglycerides, utilization of fatty acids for energy production, metabolism and functional role of polyunsaturated fatty acids: cholesterol metabolism, arachidonate metabolism: prostaglandins, prostacycline, thromboxane, and leukotrienes, phospholipid and glycolipid metabolism, some disorders of lipid metabolism.
2. **Amino acid metabolism:** Overview, general reactions of amino acids, glucogenic and ketogenic amino acids, oxidative degradation of amino acids to specialized products, amino acid biosynthesis, regulation of amino acid metabolism, metabolism of branched chain amino acids, propionate and methylmalonate metabolism, nitrogen fixation, folic acid and one-carbon metabolism, glutathione metabolism, clinical correlations: phenylketonuria, alkaptonuria, folic acid deficiency, hyperammonemia and hepatic coma, deficiencies of the urea cycle enzymes.
3. **Nucleotide metabolism**: Overview, metabolic functions of nucleotides, synthesis of purine and pyrimidine nucleotides, formation of deoxyribonucleotides, nucleotide degradation, biosynthesis of nucleotide coenzymes, nucleotide metabolizing enzymes as a function of cell cycle and rate of cell division, antimetabolities of purine and pyrimidine nucleotide metabolism. heme metabolism, regulationof nucleotide metabolism, Lesch-Nyhan syndrome, gout, orotic aciduria.
4. **Tissue Specific Metabolism:** Specialized metabolic functions of mammalian tissues – liver, adipose tissue, muscle, brain and blood.

Text Books:

1. Voet & Voet, 1991. Biochemistry.
2. Nelson and Cox. Lehninger's Principles of Biochemistry.
3. Lubert Stryer, Biochemistry, 3rd edition, W.H. Freeman and Company, New York
4. Dr. A. C. Dev, Fundamental of Biochemistry.
5. Alberts, B. Bray, D. Lewis, J., 1989. Molecular Biology of the Cell. Garland Publishing.
6. Stryer, L. 1989. Molecular Design of Life. W.H. Freeman and Company, New York.

BGE 2205 Nutrition 3 Credits

Course Objectives

Nutrition, BGE 2109 will give the students an entire concept of nutritional aspect of carbohydrate, protein, lipid, vitamins and minerals. The course will also provide a background on food energy calculation, RDA and dietary management in special circumstances. This course will also emphasize in nutrigenomics, an update of current nutrition research and its application to the field of Biotechnology and Genetic Engineering.

1. **Introduction:** Foods, nutrition and health, functions of nutrients, food composition, absorption and utilisation of nutrients, recommended dietary allowances (rda) for nutrients, nutrition guidelines and assessment, complementary and alternative nutrition.
2. **Energy intake and expenditure:** Historical background, forms of energy, units of energy, energy in food, energy expenditure, estimation of energy requirements.
3. **Macro nutrients (Carbohydrate, protein and fat):** Sources, function, deficiency, RDA, deficiency and toxicity.
4. **Micro nutrients**
   a. **Vitamins:** *Fat-soluble vitamins:* A, D, E, K; *Water-soluble vitamins:* vitamin C and B, thiamine, riboflavin and niacin; vitamin B6; folate and vitamin B12; biotin and pantothenic acid.
   b. **Minerals:** *Major minerals:* Na, K, Cl, Ca, P, Mg, S; source, dietary recommendation, function, absorption, deficiency and toxicity.
   Trace minerals: definition; Fe, Zn, Se, I, Cu, Mn, Cl, Cr, Mb; importance, source, function, absorption, deficiency and toxicity.
5. **Water:** function, equilibrium between electrolytes and water, excretion, water balance, alcohol, caffeine and common medications affect fluid balance, dehydration, water-intoxication.
6. **Nutrition and Genetics:** Nutrigenomics-Genetic determinants of nutrient needs; essential and conditionally essential nutrients, racial differences in nutrient needs or nutritional processing; nutrient intake and processing; the range of genetic effects, the frequency of genetic abnormalities, polymorphisms and variable nutrient responses, macronutrients and gene expression, gene stability, genetic change and carcinogenesis, the genetic basis of obesity.
7. **Diet for Special Groups:** Pregnancy and lactation; infancy, child hood, and adolescence; nutrition and ageing.
   Sports nutrition: Muscle, Energy systems and physical performance.
   Clinical Nutrition: dietary management of various disease conditions heart disease, diabetes, gout, allergy, obesity; Public health crisis.
   Eating disorders: Anorexia Nervosa, binge eating disorder.
8. **Assessment of Nutritional Status:** Direct methods and anthropometric methods, body mass index, biochemical assessment.
9. **Food safety:** harmful substances in food; pathogens, pesticides, organic alternatives, animal drugs, pollutants, natural toxins, keeping foods safe, foodborne illness.
10. **Nutritional Problems in Bangladesh:** Hidden hunger; Vitamin A, Iodine, zinc and iron deficiency in Bangladesh.

Text Books:

1. Paul Insel, R. Elaine Turner, Don Ross, Nutrition, third edition, Jones and Bartlett.
2. Stanley Davidson, R. Passmore, J.F. Brock and A.S. Truswell, Human Nutrition and Dietetics, Churchill Livingstone.
3. N Swaminathan, Advanced Text Book on Food and Nutrition.
4. J.S. Garrow, W.P.T. James, A. Ralph, Human Nutrition and Dietetics, Churchill Livingstone.
5. S.R. Williams, Essential of Nutrition and Diet Therapy, Times, Merror/Mosby College Publishing.
6. Maria C. Linder, Nutritional Biochemistry, Elsevier.

BGE 2207 Immunology I 3 Credits

Course Objectives

Immunology is the study of immunity and related phenomenon. The science of immunology grew out of the study of the resistance to infectious disease and now encompasses the study of antigens, antibodies and their reaction both in vivo and in vitro and the cellular phenomena of recognition of and responsiveness to foreign substance. We divided entire immunology into three courses (Immunology I and Immunology II in B.Sc. and Advanced Immunology in MS). Immunology I is the basic understanding of Immunology, Immune systems, cells involved in immune response, antigen, antibody and some basic mechanisms narrating how immune system defend the body against microbes and pathogens.

1. **Properties and overview of Immune responses:** Innate and adaptive immunity, types of adaptive immune responses, cardinal features of adaptive immune responses, cellular components of the immune system, over view of immune response to microbes.
2. **Cells involved in immune response:** Lymphoid cells: morphological heterogenicity of lymphocytes. T cells, natural killer cells, cell surface markers, lymphocyte activation and proliferation, mononuclear phagocytes, antigen presenting cells, poly-morphonuclear granulocytes and platelets, neutrophils, eosinophils, basophils and mast cells.
3. **Lymphoid system:** Primary and secondary lymphoid tissue, primary lymphoid organs, secondary lymphoid organs and tissues.
4. **Antigens and antibodies:**
   Chemical basis of antigenicity, immunogenicity, antigenic determinants, haptens, antigen-antibody binding, antibody affinity and avidity, antibody specificity and cross-reactivity, antigen receptors, immunoglobulins and antibodies, physiological significance of high and low affinity antibodies, distribution of major human immunoglobulins, immunoglobulin classes and subclasses, physicochemical properties and functions of human immunoglobulins, general properties of immunoglobulins, antibody structure, antibody effector functions, structure of immunoglobulin in relation to function, enzymatic cleavage of human IgG1, structure in relation to antigen binding, genetic basis of antibody heterogeneity, monoclonal antibody and its production.
5. **Lymphocyte activation**: Interaction of T lymphocyte and APC, signals for T cell activation, B cell response to thymus, dependent and independent antigens, B cell activation by surface Ig and T cells.
6. **Complement system:** Activation and biological function of complements.
7. **Vaccination:** Antigens used as vaccine, effectiveness and safety of vaccine, current vaccine and modern approaches, adjuvants.
8. **Effector molecules:** Cytokines: origin, sources and effector function, cytokine action and network interaction.

Text Books:

1. Abul K. Abbas, Andrew H. Lichtman. Cellular and Molecular Immunology. Elsevier.
2. Roitt, Brostoff, Male. Immunology. 4th edition, Publisher: Dianne Zack: Mosby, (1996).
3. Roitt, I. Essential Immunology. 8th edition. Blackweell Scientific Publication, London, (1994).
4. Benjainini, E. Siney Leskowitz; Immunology- A Short Course. 2nd edition; (1992). Wiley-Liss, Jolm Wiley & Sons, Inc publications, New York, Singapore.

BGE 2208 Immunology I (Sessional) 1 Credit

1. Collection of blood serum and plasma.
2. ABO Blood grouping.
3. Total counting and differential counting.
4. Determination of ESR.
5. Widal test for typhoid detection.
6. ELISA.
7. RIA
8. Immunodiffusion.

BGE 2209 Economics 2 Credits

Course Objectives

This course gives the basic idea of economics that briefly discuss the production economics, factor-product analysis, factor-factor analysis and product-product analysis. Students also get the idea about profit maximization from this course.

1. **Introduction to economics:** Basic concepts in economics.
2. **Production economics:** nature, scope and importance of production economics, assumptions, advantages and limitations of static production economics.
3. **Factor-product analysis:** Physical product functions and related concepts, features of a typical production process, stages of production in factor-product analysis, forms of production function and their relative advantages.
4. **Factor-factor analysis:** Isoquants and their characteristics, isoclines and ridge lines, stages of production in factor-factor analysis, partial elasticity of production and function coefficients, changes in factor proportions and changes in the scale.
5. **Product-product analysis:** Derivation of production possibility curves, vertical and horizontal combinations of enterprises.
6. **Optimum input use:** Value product functions and their relationships, profit maximization and determination of optimum input use in factor-product, factor-factor and product-product analysis.
7. **Profit maximizing output:** Cost and revenue functions, equilibrium of the firm, determination of profit maximizing output under various market conditions, derivations of supply functions.

Text Books:

1. A. I. Ahuja. Modern Economics
2. Dr. I. Sunder. Introduction to Bioeconomics

BGE 2211 Biostatistics 3 Credits

Course Objectives

Biostatistics mainly comprise the knowledge of analyses of the data from different sources. After completion of this course students will learn the basic statistical methods especially required for biological data analyses. They will also have practical knowledge about the utilization of statistical software used for these analyses.

1. **Introduction:** Meaning of biostatistics, need and scope of biostatistical analysis in biochemistry, concept of variable, measurement and measurements scales.
2. **Descriptive Statistics:** Methods of collection of data, construction of frequency distribution and relative frequency distribution, graphical representation of data, measures of central

tendency, measures of dispersion, methods of computation, uses, merits and demerits of all these measures, stem-and-leaf plot, box-and-whisker plot, Skewness and kurtosis and their measures.

3. **Probability and Probability Distributions:** Basic concepts of probability**,** elementary properties of probability, conditional probability, Bayes theorem and its application, screening tests, sensitivity, specificity, random variable, probability mass function, probability density function, mathematical expectation and variance of a random variable, probability distributions: binomial distribution, poisson distribution, normal distribution, exponential distribution and their applications.
4. **Sampling and Sampling Distributions :** Concepts of population, sample, parameter, statistic, random sample, different sampling methods and their applications, sampling distribution, standard error and their uses, sampling distribution of the sample means, determination of sample size for estimating means.
5. **Test of Hypothesis:** Definition of statistical hypothesis, simple and composite hypothesis, procedure of a test, errors in testing of hypothesis, level of significance, one and two tailed tests, p-value, confidence interval, tests based on usual normal, chi-square (χ^2), t and F statistic, Nonparametric and distribution-free tests.
6. **Analysis of Variance:** Introduction, completely randomized design, randomized block design, latin square design, repeated measures design, factorial experiment.
7. **Regression and Correlation:** Introduction, regression model, simple regression, evaluating the regression equation, multiple regression, correlation analysis, simple, multiple and partial correlation, logistic regression.
8. **Chi-Square Distribution**: Introduction, tests of goodness-of fit, tests of independence, tests of homogeneity, the fisher exact test, relative risk, odds ratio and the Mantel-Haenszel statistic, survival analysis.
9. **Vital Statistics:** Introduction, death rates and ratios, measures of fertility and measures of morbidity.

Text Books:

1. M. Nurul Islam. Statistics and Probability, Mullick and Brothers, 3rd Edition, Dhaka.
2. M. Nurul Islam. An Introduction to Sampling Methods: Theory and Applications, Book World, Dhaka.
3. Biostatistics: A Foundation for Analysis in the Health Sciences. Daniel, Wayne W; (7th Edition) John Wiley, NewYork.
4. Methods in Biostatistics for Medical Students and Research Workers. B K Mahajan. (6th Edition) Jaypee Brothers Medical Publishers Pvt. Ltd, India.
5. Introductory Pratical Biostatistics. Misra, B. N. and M. K. Misra; Naya prokash, Calcutta.

BGE 2212 Biostatistics (Sessional) 1 Credit

To be designed by the course teacher.

BGE 2213 Course Viva 1 Credit

Viva-voce on all courses belonging to the respective year.

3rd Year 1st Semester

Course Code	Course Title	Class Hours/Week		Credit
		Theory	Sessional	
BGE 3101	Clinical and Molecular Basis of Diseases	3		3
BGE 3102	Clinical and Molecular Basis of Diseases (Sessional)		2	1
BGE 3103	Plant Physiology	3		3
BGE 3105	Recombinant DNA Technology	3		3
BGE 3107	Virology	2		2
BGE 3109	Bioinformatics	2		2
BGE 3110	Bioinformatics (Sessional)		2	1
BGE 3111	Microbial Genetics	3		3
BGE 3112	Microbial Genetics (Sessional)		2	1
BGE 3113	Cancer Biology	2		2
	Total	**18**	**6**	**21**

BGE 3101 Clinical and Molecular Basis of Diseases 3 Credits

Course objectives

This course is designed for the students to explore the molecular aspects of human disease and how this has contributed to knowledge based treatment strategies and the development of improved therapeutics. The course provides an insight into how molecular studies can be employed to further medical research and aid in the development of novel treatments and therapeutics. The course will cover a number of areas including the analysis of genetic diseases, metabolic disorders, molecular understanding of diabetes, cardiovascular diseases, liver diseases, gastrointestinal disease viral and bacterial infections.

1. **Introduction:** Definition of clinical Biochemistry, different steps, hazards and preventive measures to run biochemical analysis.
2. **Clinical application of enzymes and metabolites as diagnostic tools:** Enzymes and isoenzymes in diagnosis: alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatine kinase (CK), lactate dehydrogenase (LDH), amylase, acid phosphatase (ACP), alkaline phosphatase (ALP) and metabolites e.g. glucose, uric acid, bilirubin, blood urea nitrogen (BUN), cholesterol in diagnosis.
3. **Genetic disorders and their diagnosis:** Genetic basis of biochemical disorders and their transmission, diagnosis and apparent treatment. Examples; PKU; alkaptonuria; galactosemia, fructose intolerance, glycogen storage diseases (Gaucher's, Niemen Pick), sickle cell anaemia, thalassemia, hypercholesterolemia, lipid storage disease, haemolytic anaemia, hyperuricemia.
4. **Diarrheal disease:** Acute and chronic diarrhoea; causative agent of acute diarrhoea: *E. coli*, *Shigella*, *Vibrio cholerae* and *Salmonella*; molecular mechanism of the action of cholera and shigella toxin; Treatment: antibiotics and vaccine possibilities, zinc supplementation for diarrhoeal disease.
5. **AIDS:** Diagnostic test, Anti-HIV drugs; HIV therapeutic agents.
6. **Cardiovascular diseases:** Atherosclerosis- molecular mechanism of the formation atheromatus plaque-involvement of LDL and foam cell; ischemic heart diseases; myocardial infarction (MI) and biochemical marker for the diagnosis of MI, heart failure and lipoprotein metabolism.

7. **Overview and diagnosis of recent infectious disease outbreaks:** Anthrax, botulism, campylobacteriosis, dengue fever, flu (influenza), hepatitis, salmonellosis/salmonella, shigellosis/shigella, smallpox, tuberculosis, Rota virus.

Text Books:

1. Kaplan *et al*. Clinical Chemistry: Interpretation and Techniques. Lea & Febiger Pub.
2. Harper, Review of Biochemistry, 24th Ed.
3. Devlin, T.M. Text book of Biochemistry with clinical correlations, 1997.
4. John Macloed, Davidson's principles and Practice of Medicine, Churchill Livingstone, 1988.
5. Gillham, B., Despo, K.P., Thomas, J.H., Will's, Biochemical Basis of Medicine, Reed Educational and Professional Publishing Ltd, 1997.
6. J. Marshal & K. Bangert, Clinical Biochemistry.
7. A. L. Latner, Clinical Biochemistry.

BGE 3102 Clinical and Molecular Basis of Diseases (Sessional) 1 Credit

1. Estimation of glucose from blood sample.
2. Estimation of bilirubin from urine sample.
3. Estimation of alanine amino transferase (ALT) by enzymatic method.
4. Estimation of aspartate amino transferase (AST) by enzymatic method.
5. Estimation of serum ALP by colorimetry.
6. Molecular detection of TB.

BGE 3103 Plant Physiology 3 Credits

Course Objectives:

The main objective of this subject is to explain the specific physiological processes occurred in plant e.g Photosynthesis, Respiration, Nitrogen fixation etc. The course will also introduce the plant hormones and secondary metabolites produced in plant and describe their physiological importance as well as their applications.

1. **Special Features of Plant Cell:** *Cell wall* – structural organization, function. *Plastids* –fine structure, classifications, function. Vacuoles – vacuoles in different types of cells, their functions.
2. **Photosynthesis:**
   Light Phase – Photosynthetic pigments, Pigment system I and II, Mechanism of pigment system function, Non-cyclic electron flow and cyclic electron flow, Reagents that affect photosynthetic electron flow, Interrelation between light and dark reactions.
   Dark Phase – Variations in the mechanism of dark phase photosynthesis: C_3 Pathway (Calvin cycle), C_4 Pathway, CAM Pathway. Leaf morphology for different dark phase reactions. Factors affecting photosynthesis.
3. **Respiration:** Difference between respiration and photosynthesis, difference between respiration in plants and animals.
4. **Nitrogen fixation:** Nitrogen cycle, mechanism of nitrogen fixation, nitrate assimilation in leaves and roots, control of nitrate assimilation, biosynthesis of amino acids, legumes and nitrogen fixation.
5. **Plant hormones**: Definition, kinds of hormone, sources, physiology and application, auxin, cytokinin, gibberellins, abscisic acid, ethylene.
6. **Secondary metabolites**: Alkaloids and plant phenolics, types, commercial application, production

7. **Medicinal Plants:** Therapeutic potential of plants, chemical constituents of medicinal plants, drug development from plant derived chemicals, medicinal plants in Bangladesh.

Text Books:

1. Gerald Karp. Cell and Molecular Biology. (6th Ed.) John Wiley & Sons.
2. Lincoln Taiz, Plant Physiology, 5th edition, Sinauer Associates Inc. publishers, USA.
3. T. W. Goodwin & E. I Mercer, Introduction to Plant biochemistry, Pergamon press.
4. Hans-Walter, Heldt, Plant biochemistry and Molecular Biology, Oxford University Press.
5. S.N. Pandey. B.K. Sinha. Plant Physiology.
6. P. J. Davies, Plants Hormone and their Role in Plant Growth and Development.

BGE 3105 Recombinant DNA Technology 3 Credits

Course objectives: This course has been harnessed with different molecular genetic methodologies that are crucial for biological and medical research. After completing this course students will obtain knowledge how to manipulate DNA to produce recombinant proteins using molecular cloning, how vectors are orchestrated with a plethora of genes (protein coding gene, selectable marker gene, and screenable marker gene etc.) and transformed in the bacteria. Construction of both cDNA and genomic library will also be extensively discussed. The course also covers gene therapy and DNA delivery methods; genetic transformation of prokaryotes; and recombinant protein production in eukaryotic cells and mammalian cell expression vectors. To accomplish the above objectives, following topics will be thoroughly discussed.

1. **Restriction Modification System:** Restriction endonucleases and their classification, history and applications of restriction endonucleases, restriction endonucleases and bacterial defence, restriction modification enzymes.
2. **Cloning:** Vectors for cloning large piece of DNA – bacteriophage λ vector and phage vectors: cosmids, phagemids, YAC and BAC vectors, plasmid cloning vector PBR322, and other plasmid vectors.
3. **Gene Library:** Construction of cDNA library and genomic library, screening of gene libraries-screening by DNA hybridisation, immunological assay and protein activity.
4. **Gene Therapy & DNA delivery methods:** Physical and biological methods.
5. **Genetic transformation of prokaryotes:** Transferring DNA into *E. coli*, chemical induction and electroporation.
6. **Marker genes:** Selectable markers and screenable markers, non-antibiotic markers.
7. **Recombinant protein production in Eukaryotic cells:** *Saccharomyces cerevisiae* expression system; *S. cerevisiae* vectors.
8. **Mammalian cell expression vectors:** Selectable markers; two-vector expression system; two-gene expression vector.

Text Books:

1. Glick, B.R. and Pasternak, J.J. Molecular Biotechnology, ASM Press, USA. 1988.
2. Watson, Recombinant DNA. 1992.
3. Glover, D.M. and Hames, B.D. DNA cloning 1 and 2, IRL Press (Oxford University Press, USA). 1995.
4. Sambrook, J., Fritsch, E.F., Mariatis. Molecular cloning, A Laboratory Manual, Cold Spring Harbor Laboratory, USA. 1999.

BGE 3107 Virology 2 Credits

Course Objectives:

Virology is the study of viruses – submicroscopic, parasitic particles of genetic material contained in a protein coat and virus-like agents. After completing this course, students should be able to know about general properties of viruses, broadly about animal and plant viruses, interferon. As well as different kind of diseases created by them.

1. **General properties of viruses:** Terms and definitions in virology, evolutionary origin of viruses, baltimore classification of viruses, chemical compositions of viruses.
2. **Animal viruses:**
   Orthomyxoviruses: Properties of orthomyxoviruses, structure and composition classification and nomenclature, structure and function of the hemagglutinin and neuraminidase, antigenic drift and shift, replication and pathogenesis, prevention and treatment.
   HIV: Structure and genomic organization, mode of action of HIV infection, function of the different gene product, prevention, treatment and control, drawbacks of the development of HIV/AIDS vaccine.
   Hepatitis virus: Properties of hepatitis viruses, hepatitis type B, structure and composition,
3. replication, pathogenesis and pathology.
   Plant viruses:
   Tobacco mosaic virus (TMV) and cauliflower mosaic virus (CaMV), overview, history, virion
4. structure, infection, transmission, mode of replication translation and assembly.
   Interferon: Chemical nature and classification, induction of interferon synthesis and tumour cell growth, clonality and kinetics of tumour cell growth, host factors affecting tumour cell growth, in vitro tumour cell growth, and karyotypic changes in tumours.

Text Books:

1. Flint S.J. Principles of Virology
2. Alan J Cann, Principles of Molecular Virology, 6th edition.

BGE 3109 Bioinformatics 2 Credits

Course Objectives:

Bioinformatics is the use of computational approaches to analyse, manage, and store biological data. This is a part of science that utilize computer databases and algorithms to accelerate and enhance biological research. The course is designed for students with biological science background. After completion of the course student will learn the basic of Bioinformatics, data retrieval and analyses using various bioinformatics tools.

1. **Introduction:** Area and scope of bioinformatics; short discussion on sequence to structure and structure to function relationships; structure based drug designing; brief introduction to computational, systems and synthetic biology as well as personalized medicine.
2. **Biological Data Acquisition:** The form of biological information, retrieval methods for DNA sequence, protein sequence and protein structure information; Databases –
   - Nucleic acid sequence databases: GenBank, EMBL, DDBJ
   - Protein sequence databases: SWISS-PROT, TrEMBL, PIR, PDB
   - Genome Databases: NCBI, EBI, TIGR, SANGER

3. **Format and Annotation:** Conventions for database indexing and specification of search terms, common sequence file formats, annotated sequence databases - primary sequence databases, protein sequence and structure databases; organism specific databases;
4. **Data – Access, Retrieval and Submission:** Standard search engines; data retrieval tools – Entrez, DBGET and SRS; submission of (new and revised) data;
5. **Sequence Similarity Searches:** Local versus global, distance metrics, similarity and homology, scoring matrices PAM and BLOSUM series, dynamic programming algorithms, needleman-wunsch and smith-waterman, heuristic methods of sequence alignment, FASTA, BLAST and PSI BLAST, multiple sequence alignment and software tools for pairwise and multiple sequence alignment.
6. **Genome Analysis:** Whole genome analysis, existing software tools; genome annotation and gene prediction; ORF finding;
7. **Phylogenetic Analysis:** Comparative genomics, orthologs, paralogs, methods of phylogenetic analysis: UPGMA, WPGMA, neighbour joining method, Fitch/Margoliash method, character based methods.

BGE 3110 Bioinformatics (Sessional) 1 Credit

1. Retrieval of FASTA sequences from nucleic acid and protein sequence databases using gene name or accession number.
2. Identification of ORFs, promoter and transcription termination signals of the gene sequences.
3. Restriction mapping and designing of the gene for cloning
4. Translation of the nucleotide sequence into amino acid sequence and calculation of the protein mass.
5. Searching of homologous gene from diverse organism
6. Identification of conserved region by multiple sequence alignment and construction of phylogenetic tree.
7. Forward and reverse primer designing by using the gene sequence

Text Books:

1. Bioinformatics: Databases and Systems, by Stanley I. Letovsky
2. Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC Mathematical Biology & Medicine), by SorinDraghici
3. Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
4. Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

BGE 3111 Microbial Genetics 3 Credits

Course Objectives

This course will provide the details of extra chromosomal genetics of bacteria, the interrelationship between chromosome and extra chromosome, parasexual processes between the microorganism and the genetics of phages.

1. **Plasmid:** Introduction. Structure and replication, types of plasmid, plasmid incompatibility, detection of plasmid replication of Col El, and conjugative plasmid, control of plasmid replication, plasmid curing r-plasmid and antibiotic resistance, mechanism of antibiotic resistance.

2. **Conjugation:** F and F like plasmids, tra-operon, sex pilli, formation of Hfr strain, gene mapping by conjugation analysis, transfer of non-conjugative plasmid by conjugative plasmid, plasmid mobilization, chromosome transfer by F cultures of E. coli k-12, conjugation and chromosome transfer in other bacteria, conjugal transfer of r-plasmid.
3. **Transformation and Electroporation:** Competence, uptake of DNA, transfection, artificially induced competence. DNA transfer by electroporation.
4. **Transduction:** Generalized transduction, experimental evidence, origin of generalized transducing phages, genetic mapping by different transductant classes, specialized transduction, experimental evidence, origin of specialized transducing phage particle.
5. **Phage genetics:** Phage T4; T4 life cycle (lytic vs lysogenic), genetic recombination in Phage T4, genetic fine structure, unit of function. Phage φx174---life cycle, genetic organization, genetics of bacteriophage (Lambda) and phage induced mutation, DNA and its gene organization.
6. **Transposon and insertion sequences:** Transposable elements, the mechanism of transposition, tranposon mutagenesis.
7. **Genetics of yeasts:** Mating type genetics of yeast, yeast plasmid, mitochondrial inheritance in yeast.

Text Books:

1. Snustad D.P., Simmons M.J. and Jenkins J.B. Principles of Genetics, Jacaranda/Wiley publishers. 1997.
2. Avers, C.J. Genetics. Freeman and Co. NY, 1990.
3. Suzuki, Griffith and Miller. Introduction to Genetic Analysis. W.H. freeman and Co. USA,

BGE 3112 Microbial Genetics (Sessional) 1 Credit

1. Isolation of microbes from natural habitats.
2. Isolation of lactose fermenting bacteria.
3. Determination of bacterial drug resistance by disc diffusion method.
4. Conjugal transfer of R-plasmid.
5. Isolation of plasmid DNA from *E. coli.*
6. Transformation of *E. coli K-12* with plasmid DNA.
7. Plasmid curing.
8. Agarose gel electrophoresis of DNA and RNA.
9. Transduction experiment with available temperate phage and lysogenic bacteria.

BGE 3113 Cancer Biology 2 Credits

Course Objectives:

The term oncology literally means a branch of science that deals with tumors and cancers. Oncology also deals with the prevention, diagnosis and treatment of cancer. After completing this course, students should be able to know about biology, clonality, kinetics and in vitro tumor cell growth, Pathways and mechanism of metastasis. Different kinds of Carcinogenic agents and mechanism of carcinogenesis. As well as different kinds of oncogenic viruses and mechanism of viral oncogenesis. Students should know about Host tumor interactions, host defense against tumors and also know about diagnosis and treatment of cancer.

1. **Introduction: Benign and malignant tumor: B**iology of tumor cell growth, clonality and kinetics of tumor cell growth, host factors affecting tumor cell growth, in vitro tumor cell growth, karyotypic changes in tumours.
2. **Metastasis: P**athways and mechanism.
3. **Carcinogenic agents: Chemical carcinogenesis.** Mechanism of chemical carcinogenesis. Radiation carcinogenesis. UV rays, ionizing radiation, mechanism of radiation carcinogenesis. Viral carcinogenesis.
4. **Oncogenesis:** DNA and RNA oncogenic viruses, mechanism of viral oncogenesis.
5. **Oncogenes and cancer:** Product of protooncogenes and their functions, activation of protooncogene; cancer suppressor genes (antioncogenes).
6. **Host tumour interactions:** Effect of tumor on host, host defence against tumours.
7. **Diagnosis and treatment of cancer**: Chemotherapeutic agents in cancer treatment, gene therapy, immunotherapy.

Text Books:

1. Kumar V., Abbas A. K. and Fausto N. 2005. Pathologic basis Disease. International Edition, Elsevier.

3rd Year 2nd Semester

Course Code	Course Title	Class Hours/Week		Credit
		Theory	Sessional	
BGE 3201	Molecular Genetics	3		3
BGE 3203	Food Biotechnology	3		3
BGE 3204	Food Biotechnology (Sessional)		2	1
BGE 3205	Fermentation Technology	2		2
BGE 3207	Plant Genetic Engineering	3		3
BGE 3208	Plant Genetic Engineering (Sessional)		2	1
BGE 3209	Biopharmaceutical Chemistry	3		3
BGE 3210	Biopharmaceutical Chemistry (Sessional)		2	1
BGE 3211	Immunology II	2		2
BGE 3213	Course Viva			1
	Total	**16**	**6**	**20**

BGE 3201 Molecular Genetics 3 Credits

Course objectives:

Molecular genetics is the field of biology and genetics that studies the structure and function of genes at a molecular level. After completing this course, students should be able to know about chromosomes and gene expression of an organism, regulation of gene expression, genetic variation, mutations, gene repair and different kinds of diseases caused by defect in gene repair mechanism. To accomplish the above objectives, the course will discuss the following subjects.

1. **Regulation of gene expression in Prokaryotes**
   i. **Lac operon:** Lac operon is negative inducible, Lac repressor, Lac repressor is controlled by a small molecule inducer, Cis-acting constitutive mutations identify the operators, Trans-acting mutations identify the regulator gene.
   ii. **Trp operon:** Structure of Trp operon, feed-back regulation, attenuation or intrinsic termination, control of attenuation
   iii. Positive and negative control, glucose repression control.
   iv. **Regulation of RNA in bacteria:** Constitutive, inducible and repressible gene expression, translational regulation
   v. Alternative sigma(σ) factors in prokaryotes
2. **Regulation of transcription in Eukaryotes:** Spatial and temporal regulation, induction of transcriptional activity by environmental and biological factors, mechanism of action of activators and repressors, activators interaction, molecular control of transcription, chromatin remodelling, histone acetylation and transcription activation, methylation and phosphorylation of histone, gene expression & chromosome organization, activation and inactivation of whole chromosome.
3. **Mutation, DNA repair and Recombination**
   i. **Mutation:** Definition, classification, molecular mechanism, test/diagnosis of mutation.
   ii. **DNA repair mechanism:** Definition, types, molecular mechanism, limitation
   iii. **Inherited human diseases affect in DNA repair:** Name of diseases, cause, defect in repair mechanism, sign/symptom and treatment.
   iv. **Recombination:** Site specific recombination, homologous recombination, cleavage of DNA, rejoining of DNA.

Text Books:

1. Snustad, Simmons. Principles of Genetics. 4th Edition
2. Lewin, B. Genes X.
3. Brown, T. A. Genomes, Second Edition. BIOS Scientific Publishers Ltd. 2002.
4. Brown, T. A. Gene Cloning: An Introduction. 3rd Edition. Chapman & Hall Co. Ltd. UK.

BGE-3203 Food Biotechnology 3 Credits

Course objectives

This cousre will give students a comprehensive understanding of transgenic food, biotechnological food additives, about the constituents and additives present in the food, knowledge about the microorganisms which spoil food and causes foodborne diseases. The course covers the basic principles and practices of the major techniques used in food processing and preservation along with critical issues in food regulations and nutrition.

1. **Introduction:** Microorganisms important in food biotechnology: molds, yeast and bacteria.
2. **Milk and milk products:** Composition and food value of milk, adulteration of milk, pasteurization of milk and methods of pasteurization.
   - **i. Butter:** Definition and composition of butter, manufacture of butter, preparation of the butter churn, detects of butter.
   - **ii. Cheese:** Definition, classification, manufacturing and processing of different types of domestics and foreign cheese, production of cheese through biotechnology.
3. **Food from microorganisms:**
   a. Production of cultures for food fermentation: general principles of cultures maintenance and preparation, bacterial cultures, yeast cultures and mold cultures.
   b. Food fermentations: bread, malt beverages, vinegar fermented vegetables, fermented dairy products, oriental fermented food.
   c. Foods and enzymes from microorganism: microorganisms as food, single cell protein, fats from microorganisms, production of amino acids, production of other substances added to foods.
4. **Microbial Strain improvement:** Classical and targeted approach.
5. **Enzymes in the food industry:** Industrial enzymes and their applications, production of enzymes.
6. **GM Food:** Production, health benefits and environmental effects, long term intended and unintended effect, ethical issues.
7. **Prebiotics and Probiotics:** Definition, mechanism of action, applications.
8. **Technology of food preservation and marketing:** Food additives; food packaging, storage; transportation and merchandising of various products with added value.
9. **Food quality and food regulations:** Contamination of food by microorganisms, food adulteration, halal-haram detection**.**

Text Books:

1. Andrews, S. Food and Beverages Service Training Manual, Tata McGraw-Hill publishing Company Ltd., New Delhi.
2. King, R.D. Food Technology, John Wily and Sons, USA.
3. Kosikowskim, F. Cheese and Fermented Milk Foods, Cornel University, Ithaca, NY.

4. Choudhury A. C. Practical Dairy Science and Laboratory Methods, Scientific Book Agency, 103, Netazi Subash Road, Calcutta, India.
5. Eckles, C. H.; Combs, W. B. and Macy, H. Milk and Milk Products, Fourth edition, Tata McGraw-H publishing Company Ltd., Bombay, New Delhi. (1994).
6. Eskin, N. A. M. Biochemistry of Foods, Second edition, Academic Press, Inc. (1996).

BGE 3204 Food Biotechnology (Sessional) 1 Credit

1. Determination of fat by Babcock and Gerber method.
2. Determination of specific gravity, S.N.F. and T.S. of food.
3. Detection of adulteration of milk.
4. Test of quality: sediment test, acidity test, methylene blue reduction test and phosphatase test.
5. Judging of dairy products.
6. Determination of moisture, total protein, acid value, fat, ash, crude fibre, sucrose content, total reducing sugar and alkalinity in different food products.
7. Preservation of food by radiation and low temperature.

BGE 3205 Fermentation Technology 2 Credits

Course Objective

Fermentation technology focuses on advances in microbiology and its application in fermentation process. It also emphasizes on the physical and technical aspects of fermentation. This course provides the basic concepts, classification, mechanism and application of fermentation process with mathematical derivation.

1. **Introduction:** Definition and major areas of fermentation technology.
2. **Types and Configuration of Fermenters:** Different fermentation designs, types of fermenters, factors influencing fermenter design.
3. **Media Formulation and Sterilization Process:** Media composition, types of media, factors influencing media formulation, mechanism of sterilization, methods of sterilization, killing kinetics, determination of lethal effects and lethal units.
4. **Inocula Preparation and Development:** Criteria used for inocula preparation, different processes of preparation, bacterial and fungal inocula preparation and development.
5. **Fermentation Kinetics:** Rate equation for cell growth. Substrate utilization, product formation, transfers across phase boundaries.
6. **Mode of Fermentations:** Batch, fed-batch, continuous fermentation process.
7. **Instrumentation and Control:** Control systems, types of control, air flow monitoring, measurements of power input and temperature, theological measurements, foam and pH probe controls.

Text Books:

1. Standbury, P.F and Whitaker, A. "Principle of Fermentation Technology", Pergamon Press.
2. Wang, D. et al. "Fermentation and Enzyme Technology", John Wiley & Sons, New York, USA.
3. Rhodes, A. and D. Fleteher. "Principle of Industrial Microbiology", Pergamon Press, Oxford.

BGE 3207 Plant Genetic Engineering 3 Credits

Course Objectives

The main aim of the subject is to describe the genetic engineering techniques utilized specifically in plant system. The subject will also elucidate the application of plant genetic engineering.

1. **Plant genome specialties:** Overview and significance of eukaryotic, and prokaryotic and extranuclear genome, mechanisms of genetic changes.
2. **Synthetic seeds:** Definition, Concepts, merits and demerits, commercial production.
3. **Genetic engineering of plants:** Methodology; Plant transformation with Ti plasmid of *Agrobacterium tumefaciens*; Ti plasmid derived vector systems; Physical methods of transferring genes to plants – Micro projectile bombardment, Electroporation. Etc, Use of reporter genes in transformed plant cells; Manipulation of gene expression in plants; Production of marker free transgenic plants.
4. **Application of plant genetic engineering:**
   - Developing insect-resistance, disease resistance and herbicide resistance in plants.
   - Developing stress and senescence-tolerance in plants – oxidative, salt and submergence stress,
   - Fruit ripening, shelf life improvement of economic important crops.
   - Genetic manipulation of flower pigmentation.
   - Developing quality of seed storage.
   - Provitamin A, iron, proteins etc. coded gene insertion in rice.
   - Modification of food plant taste and appearance, yield increase in plants. Wild plant relatives as a source of novel genes.
   - Bioreactor or production of antibodies. Edible plant vaccine, polymers, foreign proteins in seeds.
5. **Application of Marker Aided Selection in Plant Genetic Engineering:** RAPD, RFLP, AFLP etc. Genetic analysis, Safety of plant genetic engineering applications.

Text Books:

1. Gresshoff, P.M. Plant Biotechnology and Development, SRC Series of Current Topics in Plant molecu Biology.
2. Kosuge, 1983. Genetic Engineering of Plants.
3. Anderson, L.A., Plant Cell Culture. Advances in Biochemical Engineering and Biotechnology.
4. Watson, 1992. Recombinant DNA.
5. Portykns, 1995. Gene Transfer to Plants.
6. Mantell and Smith, 1984. Plant Biotechnology.

BGE 3208 Plant Genetic Engineering (Sessional) 1 Credit

1. Techniques of media preparation and their stock solution including antibiotics for *Agrobacterium* culture for transferring gene of interest.
2. Co-culture of explants with *Agrobacterium.*
3. Culture putative transgenic plants in selective medium.
4. Production of transgenic plants, phenotypic data collection, and comparative study with mother plants
5. Conformation of transgene in transgenic plants and molecular analysis.

BGE 3209 Biopharmaceutical Chemistry 3 Credits

Course objectives

The aim of the course is to give strong foundation and advanced information on biopharmaceutical aspects such as drug action, metabolism and pharmacokinetics and pharmacodynamics in relation to drug development. And it will ensure knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals

1. **Pharmacokinetics:**
   (a) *Absorption of drugs:* Mechanism of absorption; effect of physiological and formulation factors on gastro intestinal absorption of drugs.
   (b) *Distribution of drugs:* Physical significance of drug concentration in blood, bioavailability, Biological half-life.
   (c) *Metabolism of drugs:* General pathways of drug metabolism, sites of drug biotransformation, role of cytochrome P-450 monooxygenases in oxidative biotransformations, oxidative reactions, reductive reactions, hydrolytic reactions, phase II or conjugative reaction, factors affecting drug metabolism.
2. **Pharmacodynamics:** Mechanism of drug action, drug receptor, their chemical properties, classification of receptors and drug effects, structure activity relationship and conformation of receptor surface, consequence of drug receptor interaction, relation between drug concentration and response, action of drug not mediated by receptors, effect of protein binding on drug deposition and characteristics.
3. **Histamine and anti-histaminic agents:** Histamine, histamine life cycle, H_1 antagonist, inhibition of histamine release, histamine H_2 receptor antagonist, histamine H_3 receptor ligands.
4. **Chemotherapeutic agents:** Definition, properties, drug resistance, trimethoprim, quinolone, isoniazid.
5. **Sulfa drugs and Antibiotics:** Definition, classification, mode of action, chemistry, pharmacological properties, therapeutic use.
6. **Steroids:** Synthesis and therapeutic properties of some important steroids. Oral contraceptive pills, their classification, ingredients, mode of action and therapeutic uses.

Text Books:

1. Wilson and Gisvolds, Text book of Organic, Medicinal and Pharmaceutical Chemistry Hardy.
2. Goodman and Gilman. The Pharmacological Basis of Therapeutics.
3. Richard A. Harvey and Pamela C. Champe, Lippincott's Illustrated Review: Pharmacology.
4. Bertram G. Katzung and Anthony J. Trevor, Examination and Board Review: Pharmacology.

BGE 3210 Biopharmaceutical Chemistry (Sessional) 1 Credit

1. Estimation of streptomycin from blood.
2. Estimation of ampicillin from blood.
3. Estimation of acetoaminophen and salicylate in serum.
4. Estimation of serum Vit-A.
5. Determination of potency of antibiotics.
6. Determination of antibacterial activity of plant extracts.

BGE 3211 Immunology II 2 Credits

Course objectives

Immunology II focuses mainly on effector mechanisms cell-mediated and humoral immunity and the inflammatory reactions related to immunity. This course is also important for understanding the principles of immunological techniques used in advance research.

1. **The Major Histocompatibility Complex molecules and antigen presentation to T lymphocyte:** Properties of antigen recognized by T lymphocytes, antigen capture and the functions of antigen presenting cells, the major histocompatiblity complex, MHC genes and MHC molecules, binding of peptides to MHC molecules, pathways of antigen processing, cross presentation, physiological significance of MHC associated antigen presentation.
2. **Effector Mechanisms of Cell-Mediated Immunity**-Types of Cell-Mediated Immune Reactions, Development of Effector T Cells , T Cell Antigen Recognition and Costimulation , Clonal Expansion of T Cells, Differentiation of I CD4+ T Cells into Subsets of Effector Cells , Differentiation of I CD8+ T Cells into CTLs.
3. **Effector Mechanisms of Humoral Immunity**-Neutralization of Microbes and Microbial Toxins, Antibody-Mediated Opsonization and Phagocytosis, Phagocyte Fc Receptors, Antibody-Dependent Cell-Mediated Cytotoxicity. Apoptosis.
4. **Inflammation:** Patterns of cell migration; and inflammation and their control.
5. **Immunological techniques:** precipitation reaction; immunodiffusion; immuni-electroporesis; agglutination; co-agglutination and hemagglutination; complement fixation; direct and indirect immuloflurescence; immunoassay; immunoblotting; immunopreciption; florescence-activated cell sorter (FACS).

Text Books:

1. Abul K. Abbas, Andrew H. Lichtman. Cellular and Molecular Immunology. Elsevier.
2. Roitt, Brostoff, Male. Immunology. 4th edition, Publisher: Dianne Zack: Mosby, (1996).
3. Roitt, I. Essential Immunology. 8th edition. Blackweell Scientific Publication, London, (1994).
4. Benjainini, E. Siney Leskowitz; Immunology- A Short Course. 2nd edition; (1992). Wiley-Liss, Jolm Wiley & Sons, Inc publications, New York, Singapore.

BGE 3213 Course Viva 1 Credit

Viva-voce on all courses belonging to the respective year.

4th Year 1st Semester

Course Code	Course Title	Class Hours/Week		Credit
		Theory	Sessional	
BGE 4101	Medical and Pharmaceutical Biotechnology	3		3
BGE 4103	Cell Biology	3		3
BGE 4105	Computational Biology	3		3
BGE 4106	Computational Biology (Sessional)		2	1
BGE 4107	Animal Biotechnology	3		3
BGE 4108	Animal Biotechnology (Sessional)		2	1
BGE 4109	Research Methodology	3		3
BGE 4111	Analytical Methods	3		3
BGE 4112	Analytical Methods (Sessional)		2	1
Total		**18**	**6**	**21**

BGE 4101 Medical and Pharmaceutical Biotechnology 3 Credits

Course objectives

A student will learn about the general principles of drug discovery and development. They know different new types of biotechnological drugs. Students know biotechnology and medical applications of specific biotech products categories. They understand technological procedures for the commercial production of some microbial and non-microbial products (insulin, interferon, vaccines, therapeutic enzymes, blood products, monoclonal antibodies).

1. **Manufacture of Immunological Products:**
   Antibody: Polyclonal and monoclonal antibody, animal/mammalian cell culture and hybridoma technology, purification techniques.
   Vaccine: Vaccine classification, recombinant vaccines, development of vaccines, purification techniques of vaccines.
2. **Production of new bio-pharmaceuticals by recombinant DNA Technology**: Interferon, insulin, somatostatin, human growth hormone, amino acids, alginate etc.
3. **Antibiotics:** Classification of antibiotics. Antibiotic resistance. Production of antibiotics. Semisynthetic antibiotics.
4. Concept of Good Manufacturing Practice (GMP), quality control, quality assurance and in-process control in pharmaceutical industry.
5. **Ecology of microorganisms which affects pharmaceutical industry**: Environment, water, skin and respiratory-tract flora, raw materials, plant sanitation and building and equipment.
6. Microbial spoilage, deterioration and preservation of pharmaceutical products: Mixture, suspension, syrups, sterile products, cosmetics and toiletry products.
7. Principles of sterilization, sterilization control and sterility testing.

Text Books:

1. Pharmaceutical Microbiology. Edited by- W.B, Huge & A. D. Russel,
2. J. R. Noris and M. H., Assays in Applied Microbiology. Ed. Richmond. John Wiley and Sons.
3. K.A. Malik, A. Nasim and A.M. Khalid (1995). Biotechnology for sustainable development.

BGE 4103 Cell Biology 3 Credits

Course objectives:

After completing this course, students should be able to recognize cell biology as the branch of biology dealing with the study of cells, especially their formation, structure, components, and function. Students will be able to know about Cytoskeleton as an internal framework of a cell, cell signalling processes to complete cell communication. Students become also able to know about Phases, checkpoint and regulation of Prokaryotic and Eukaryotic cell cycle and so on. To accomplish the above objectives, the course will discuss the following subjects.

1. **Cytoskeleton:** Cytoskeletal filaments. Structure and function of different cytoskeletal filaments. Cytoskeleton and changes in cell shape. Molecular motors. Cytoskeleton and intracellular transport. Assembly and dynamic structure of Actin filaments, Microtubules and IF. Effects of drugs and temperature on filament polymerization. Function of actin, Microtubules and IF in cell. Effects of cytoskeleton on Cytoplasmic streaming and Cell locomotion.
2. **Cell signalling:** General principle of cell signalling. Signalling through G-Protein linked cell surface receptors. Signalling through enzyme linked cell surface receptors. Signalling pathways that depend on regulated proteolysis. TGFα signalling receptors. Environmental approaches of signal induced responses. Cellular response to specific combinations of extracellular signal molecules. Different response by different cells to same extracellular signal molecules. NO mediated signalling. Nuclear receptor. Signal relay by intracellular signalling molecules. Molecular switch. cAMP and G protein, enzyme linked and IP3 signalling. Ca2+/Calmodulin dependent protein kinase. Tyrosine kinase receptor and MAP kinase. Ras activation. JAK-STAT pathway. Two component signalling pathway of bacterial chemotaxis.
3. **Cell cycle:** Prokaryotic and Eukaryotic cell cycle. Phases, checkpoint and regulation of Prokaryotic and Eukaryotic cell cycle, Process and control of plant development by hormone and environment.
4. **General principles and concepts of animal development:** Basic types of animal development, Developmental potential, determination and differentiation; Cell interactions and induction; mesoderm induction in Xenopus, development in Dictyostelium and Drosophila, Common developmental proteins from Drosophila to Man, use of these proteins for production of developmentally specific protein.

Text Books:

1. Darn ell, J., Lodesh, H. and Baltimore, D. 1986. Molecular Cell Biology. W.H. and Company.
2. Alberts, B. Bray, D. Lewis, J., 1989. Molecular Biology of the Cell. Garland Publishing.

BGE 4105 Computational Biology 3 Credits

Course Objectives:

The primary purpose of the course is to provide a rigorous introduction of Machine learning and their mathematical/probability models for DNA, RNA and protein sequence and structure. Students will come to appreciate current bottlenecks in molecular genetics research, and the present-day goals of computational biologists. Students will learn about and develop some facility in using and understanding algorithms and computational methods for sequence matching and analysis and available computer based tools for structure analysis and visualization. Students will also be

responsible for exploring and developing example applications of these techniques such as molecular docking or structure based drug designing.

1. **Machine Learning and Bioinformatics:** Introduction to various machine learning techniques and their applications in bioinformatics. genetic algorithms, support vector machine, neural networks and their practical applications towards the development of new models, methods and tools for bioinformatics.
2. **RNA Structure Simulation and Functional analysis:** Secondary and tertiary structure simulation of RNA. Various algorithms of RNA folding and their analysis. Theory and Practice of Energy minimization, Monte Carlo and Molecular Dynamics simulations. **e**nergy minimization in RNA folding, RNA sequence alignment based on secondary structure simulation and its applications in functional genomics and phylogeny.
3. **Protein Folding and Structure Prediction:** Principles of protein folding and methods to study protein folding. Visualization of structures using Rasmol or SPDB Viewer or CHIME. Basic concepts in molecular 41nalyse41g.
    - Secondary structure: algorithms of Chou Fasman, GOR methods.
    - Tertiary Structure: basic principles and protocols, Methods to study 3D structure.
    - Protein structure comparison and classification: classes, folds, 3D structure comparison, purpose of structure comparison, algorithms such as FSSP, VAST and DALI.
4. **Structure-Function analysis:** Gene ontology, metabolic pathways, gene set enrichment analysis, genomic comparisons, display genes and large genomic regions in genome browser, analyse sequence polymorphisms and linkage disequilibria, trends in personalized medicine.
5. **Characterizing Protein Associations:** Docking rigid structures, docking flexible structures.
6. **Expression Data Analysis:** Database and basic tools, gene expression omnibus (geo), arrayexpress, SAGE databases: understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools e.g. basic clustering algorithms; computing condition-specific patterns of co-expression and identifying sets of co-regulated genes.
7. **Drug Design:** Disease / disorder and drug targets, concept of receptor / target site, concepts in molecular recognition, drug-like properties and associated empirical rules. structure based drug design and computer aided drug design (CADD), molecular docking; applications of QM methods; Molecular descriptors in QSAR studies, small molecule force field parameters (charges), potentials, active site identification algorithms, ligand docking algorithms, thermodynamics & kinetics of protein-drug binding. drug stability, synthesizability and drug delivery.
8. **Programs and Algorithms:** LINUX operating system, Perl, BioPerl, Java Basics, HTML Python, and R. besides, greedy algorithms, dynamic programming, divide-and-conquer algorithms, finally, hidden markov models.

BGE 4106 Computational Biology (Sessional) 1 Credit

1. Simulation of the secondary structure of viral RNA genome.
2. Prediction and analysis of secondary structure of an human protein
3. Computation and clarification of the Ramachandran plot of a human protein
4. Protein 3-D structure prediction and determination of active site
5. Identification of the catalytic residues and hydrogen bond in the active sites of a protein.
6. Screening of a suitable ligand for a disease protein

BGE 4107 Animal Biotechnology 3 Credits

Course objectives

The subject will focus on providing students with a theoretical and practical understanding of animal biotechnology to provide students with a scientific and technical understanding of animal biotechnology to modify a living organism. The subject covers animal molecular biology, recombinant DNA technology, production of transgenic animals, reproductive biotechnology, biotechnology in animal breeding and ethics.

1. **Introduction:** Definition, History.
2. **Background of Animal Cell Culture:** Definition, history, advantages and disadvantages, major differences between i*n vitro* and *in vivo* techniques, types of cells, types of different animal cell cultures, subculture.
3. **Aseptic technique, Contamination, laboratory safety and biohazards:** Objective of aseptic technique, sterile handling, laminar flow, standard procedure, types of microbial contamination, detection of microbial contamination, cross contamination, general safety, fire, radiation and biohazards.
4. **The Culture Environment:** *The substrate:* plastic and glass wares; tissue culture flasks, culture vessels. *The gas phase:* oxygen, carbon-di-oxide. *Medium and supplements:* physical properties, constituents of media, serum, serum-free media; selection of medium and serum, other supplements, incubation temperature.
5. **Specialized Techniques of Cell Culture:** Mass cell culture technique and hybridoma cell culture technique and their uses.
6. **Preparation of Cell Line:** Isolation of different types of animal tissue: fibroblast, liver, kidney, bone marrow and their uses.
7. **Culture of specific cell type:** Epithelial cell, mesenchymal cell, endothelial cell.
8. **Embryo Transfer in Domestic Animals:** Definition, history advantages and application of embryo transfer, steps in embryo transfer technique: selection and management of donor and recipients; superovulation techniques; oestrus synchronization; oestrus detection; insemination of the donor; preparation of culture media; collection of embryos (surgical and non-surgical methods). Handling of embryos: identification of embryos; evaluation of embryos; cryopreservation of embryos; transfer of embryos (surgical and non- surgical transfer), limitations of embryo transfer techniques.
9. **In Vitro Fertilization:** Introduction; potential uses of *in vitro* fertilization. Mechanisms involved in fertilization, harvesting oocyte; maturation of oocytes; collection and capacitating of sperm; fertilization and development of embryos to a transferable stage, test tube baby, embryo splitting and embryo sexing.
10. **Transgenic animal:** Development of transgenic mice and their applications in therapeutics.
11. **Cloning:** Definition; history of animal cloning, different techniques of cloning, cloning of sheep, cattle and monkeys, Limitations of cloning.

Text Books:

1. Glick, B.R.: Molecular Biotechnology, Third Edition**.**
2. Brackett, G. Benjamin. New Technologies in Animal Breeding, Academic Press, NY (1981).
3. Gordon, I. Controlled Breeding in Farm Animals. Pergamon Press, Oxford, NY. (1983).
4. Hafez, E.S.E. Reproduction in Farm Animals. LEA and Febiger, Philadelphia. (1987).

BGE 4108 Animal Biotechnology (Sessional) 1 Credit

1. Deign, layout and laboratory requirements for an animal cell culture laboratory.
2. Essential, beneficial and useful additional equipments, consumable items.
3. Techniques of sterilization.
4. Preparation of media.
5. Preparation of primary cell lines, their routine observation and maintenance.
6. Isolation of Mouse or hen's embryos.
7. Embryo transfer in cattle or any domestic animal.
8. *In vitro* fertilization and embryo splitting.

BGE 4109 Research Methodology 3 Credits

1. **Introduction:** Definition, types and objectives of research; research process, criteria of good research, basic concept of experiment and research; meaning, characteristics, validity and steps of research, logistic support.
2. **Research Planning Methodology:** Meaning and characteristics of a problem, selection of a problem, meaning and characteristics of a good hypothesis, formulating and ways of stating of hypothesis; research approach, process, research project planning.
3. **Research areas of Biotechnology and Genetic Engineering in Bangladesh:** Agriculture, health, industry, fisheries, livestock & different universities).
4. **Experimental/research design:** Data collection and presentation, data analysis in multiyear and multilocation yield trial of genetically engineered crop varieties, and calculation of genetical values.
5. Rapid Rural Appraisal (RRA) and Rapid Rural System Appraisal (RRSA).
6. Research project preparation, implementation and evaluation.
7. Ex-ante analysis of research design and critical path method for planning and management of project.
8. **Literature Review:** Purpose and source of review; preparation of index card for reviewing and abstracting; review of scientific reports.
9. **Method of writing annual reports and research highlights and interpretation:** Concept, technique and significance and precautions of interpretation; types, purpose, format, steps and significance of research report writing, precautions of writing research reports; evaluation of research reports, salient feature of research highlights and executive summary, reliability and validity.
10. **Research Presentation:** Poster and oral presentation.

Text Books:

1. M. Nurul Islam. An Introduction to Research Methods. Mullick and Brothers. 2009. Dhaka.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. Wiley Estern Ltd.
3. BARI/BARC, 1990. Resource Manual of Research Planning and Evaluation Training Course. BAR Gazipur-1701, Bangladesh.
4. Singh, A.K., 1993. Tests, Measurements and Research Methods in Behavioral Sciences, Tata McGrav Hill Pub. Co, New Delhi, India.

BGE 4111 Analytical Methods 3 Credits

Course objectives

The primary objectives of this course are to introduce students to both classical and modern biochemical methods for the isolation and analysis of biological molecules, with an emphasis on proteins and nucleic acids. Methods include affinity chromatography, electrophoresis, centrifugation, Immunoblotting, spectrophotometry, fluorimetry, quantitative PCR, Mass spectrometry.

1. **DNA Isolation Techniques:** Isolation techniques of DNA from bacteria, plant, blood and different biological samples.
2. **Electrophoresis:** Agarose, Polyacrylamide.
3. **Hybridization techniques:** Southern, northern and western blotting and hybridization. FISH.
4. **Polymerase chain reaction:** Basic principles of PCR. Real time PCR. RT-PCR. Nested PCR. Multiplex PCR.
5. **Genetic Marker:** RFLP (Restriction fragment length polymorphism), AFLP (Amplified fragment length polymorphism), RAPD (Random amplification of polymorphic DNA), VNTR (Variable number tandem repeat), Microsatellite polymorphism, SSR (Simple sequence repeat), SNP (Single nucleotide polymorphism), STR (Short tandem repeat), SFP (Single feature polymorphism), DarT (Diversity Arrays Technology).
6. **Microarray:** Preparation of microarray. Use of microarray.
7. DNA sequencing and mutation analysis:
8. **Spectroscopy:** UV and visible spectroscopy. Infra-red (IR) spectroscopy. Nuclear magnetic resonance (NMR) spectroscopy. Mass spectroscopy.

Text Books:

1. Sambrook *et.al*. Molecular Cloning: A Laboratory Manual. Cold Spring Harber Lab Press.
2. Freifelder, D. Physical Biochemistry.

BGE 4112 Analytical Methods (Sessional) 1 Credit

1. SDS-PAGE – estimation of molecular weight of proteins using SDS-PAGE.
2. Labelling of DNA and RNA. Radiolabel, fluorescent label etc.
3. Southern blot hybridization for the detection of the gene of interest within a DNA.
4. Western blot hybridization in analyzing gene expression.
5. RFLP analysis of different DNA samples.
6. UV-vis spectroscopy. Assay of a chemical reaction using UV-vis spectroscopy.

4th Year 2nd Semester

Course Code	Course Title	Class Hours/Week		Credit
		Theory	Sessional	
BGE 4201	Forensic DNA typing and Molecular Diagnostics	3		3
BGE 4203	Protein and Metabolic Engineering	3		3
BGE 4205	Downstream Processing	3		3
BGE 4207	GEOs and Biosafety Regulations	3		3
BGE 4209	Environmental Biotechnology	3		3
BGE 4211	Research Project/Survey Report			2
BGE 4213	Course Viva			1
Total		**15**		**18**

BGE 4201 Forensic DNA Typing and Molecular Diagnostics 3 credits

Course Objective:

This course tells the basis of DNA typing and how it helps to identify crime suspect, sex, molecular diagnosis and kinship analysis.

1. **DNA Biology:** Sample collection, DNA extraction and quantitation, locus and allele, inheritance and population variation, repeat sequences within DNA, different types of repeat sequences, basis of polymorphism within repeat sequence.
2. **DNA Fingerprinting:** Basic principle of DNA fingerprinting. RFLP based and PCR based DNA fingerprinting, Commonly used short tandem repeat markers, biology of strs: stutter products, non-template addition, microvariants, null alleles and mutation rates, single nucleotide polymorphisms and other, Bi-allelic markers, SGM Plus and CODIS, hot start PCR. Capillary electrophoresis.
3. **Probe labelling:** Radioactive, Fluorescent and Chemiluminescent probe.
4. DNA analysis in the identification of crime suspects, studying kinship by DNA profiling, sex identification by DNA analysis.
5. **Molecular Diagnostics:**

i. Diagnosis of Cystic fibrosis by multiplex PCR. Clinical implications: Abnormal mucus clearance from the respiratory tract with frequent infections, pancreatic insufficiency, abnormal salt transport, infertility in males.
ii. Detection of β-thalassemia mutation using ARMS- PCR, Clinical implications of β-thalassemia.
iii. Philadelphia chromosome: Clinical implications, Acute Lymphoblastic Leukemia (ALL) and Chronic Myelogenous Leukemia (CML), detection of philadelphia chromosome by genomic southern hybridization.
iv. Bone marrow engraftment: Pre-engraftment and post-engraftment analysis, matching donor and recipient, tissue typing. HLA typing. VNTR markers to distinguish patient and donor cells as different.
v. Ribotyping: Identification of bacterial species based on the sequence of their 16s ribosomal RNA genes. Analysis of ribotype patterns with dendrogram.
vi. Use of real time PCR and molecular beacon in disease diagnosis.

Text Books:

1. Forensic DNA Typing: Biology, Technology and Genetics of STR Markers. John M. Butler. Elsevier Academic Press. 2nd edition.
2. Principles of Gene Manipulation. An Introduction to Genetic Engineering. R. Old, S.B. Primrose. Blackwell Sci Pub. 5th edition.
3. Molecular Biotechnology. Principles and Applications of Recombinant DNA. Glick and Pasternak. 4th edition.
4. From Genes to Genomes: Concepts and Applications of DNA Technology by J.W. Dale and M.V. Schartz.
5. Introduction to foreign genetics, William Goodwin, Adrian Lina, 2007. John Willey and Sons Ltd.

BGE 4203 Protein and Metabolic Engineering 3 Credits

Course Objectives

Protein engineering is the conception and production of unnatural polypeptides, often through modification of amino acid sequences that are found in nature. Metabolic engineering involves the redesign of metabolism to enable cells to produce new products, such as valuable chemicals and biofuels. The main aim of this course is to familiarize the students with recent techniques related to protein engineering and metabolic engineering used to improve the quantity of bio-products from prokaryotic and eukaryotic expression system.

1. Biotechnological applications of microorganisms in agriculture, food, medicine, pharmaceuticals, environment and industry.
2. Production of single-cell proteins for using in food or feed, yeasts and yeast products.
3. **Synthesis of Commercial products by recombinant microorganisms:** Small biological biomolecules, organic acids, indigo, amino acids, antibiotics, biopolymers, polysaccharides, alginate.
4. **Manipulation of Gene Expression in Prokaryotes:** Gene expression from strong and regulatable promoters, fusion protein: cleavage of fusion protein, uses of fusion protein, surface display, metabolic load.
5. Bacterial cell Engineering by protoplast fusion.
6. Directed mutagenesis and protein engineering
7. Immobilization and co-immobilization of microorganism, biosensor and its applications.
8. Production of foreign proteins from recombinant microorganisms.
9. **Heterologous Protein Production In Eukaryotic Cells:** *Saccharomyces cerevisiae* expression Vector system, *Pichia pastoris* and other yeast expression systems, Mammalian cell expression systems.
10. **Metabolic Engineering:** Definition, Metabolic control analysis, Metabolic flux, Metabolic flux analysis, application of metabolic engineering in production of biofuels.

Text Books:

1. Suzuki, Griffith and Miller, 1986. Introduction to Genetic Analysis. W.H. freeman and Co. USA.
2. Brock, T.D., Madigan, M.T., Martinco, J.M. and Parker, J., 1990. Biology of Microorganism.
3. Hardy, K.M., 1986. Bacterial Plasmid. Published by American Society of Microbiology.
4. Avers, C.J., 1990. Genetics. Freeman and Co. NY.
5. Strickberger, M.W., 1990. Genetics. Macmillan pub. Co. NY.

BGE 4205 Downstream Processing 3 Credits

Course Objectives:

Downstream processing mainly refers to the recovery and purification of the specific bio-products usually enzymes, diagnostics, chemicals, pharmaceuticals and foods from biological sources utilized in research purpose and industrial level. The main objective of this course is to explain the disruption of cells and separation of different fractions consisting of the active material; isolation of specific proteins/bio-products, their detection methods and purification processes.

1. **Introduction:** Definition, selection criteria, importance of different processes, broth characteristics, operational sequences.
2. **Disruption of Microbial Cell:** Introduction, composition and structure of different cell wall (bacteria, yeast, other fungi), analysis of disruption, laboratory-scale and large-scale disruption techniques.
3. **Recovery and Purification Processes:** Membrane separations, precipitation, crystallization, cell recovery by filtration, centrifugation, drying.
   Electrophoresis: Principle, types, factors affecting electrophoresis; agarose gel electrophoresis, polyacrylamide gel electrophoresis (PAGE), SDS-PAGE, isoelectric focusing, capillary electrophoresis, two-dimensional gel electrophoresis, immunochemical electrophoresis, pulsed field gel electrophoresis, visualization and detection method.
   Chromatography: Principle, types and application. ion-exchange chromatography, paper chromatography, gel filtration, affinity chromatography, immuno affinity chromatography, protein-a chromatography, lectin affinity chromatography, dye affinity chromatography, metal chelate affinity chromatography, hydroxy apatite chromatography, thin layer chromatography, hydrophobic interaction chromatography, reverse phase chromatography, HPLC, FPLC, chromatofocusing.
4. **Ultra Filtration:** Introduction, development of semi permeable membrane, methods of preparation, factors affecting membrane structure, UF membrane characteristics and performances, membrane fouling and treatment, UF equipment, UF processes in biotechnology.
5. **Liquid-liquid Extraction:** Introduction, principles of liquid extraction, solvent selection, extraction equipment, process considerations.
6. **Ion-Exchange Recovery:** Scope, materials, processing methods, ion-exchange recovery of protein.
7. **Distillation:** Introduction, advantages, principle, process.

Text Books:

1. Gary Wlash, 2007. Pharmaceutical Biotechnology, Concepts and Application, Wiley & Sons, UK.
2. Moo-Young, M.(ed.), 1985. Comprehensive Biotechnology, volume-2, Pergamon Press, UK.
3. Bailey, J.E. and D.F. Ollis, 1986. Biochemical Engineering Fundamentals, second ed., McGraw-Hill Book Co., Singapore.

BGE 4207 GEOs and Biosafety Regulations 3 Credits

Course Objectives:

As students of Biotechnology and genetic engineering GEOs is one of the most fascinating term and it stands for genetically engineered organism: an organism or microorganism whose genetic material has been altered by means of genetic engineering. As well as Biosafety is the prevention of large-scale loss of biological integrity, focusing both on ecology and human health. After completing this course, students should be able to know broadly about GEOs and risk for animal, human health, agriculture, pollution with non-target organism, environment. Students are also should be able to learn about loss of familiarity, ethical issues and biosafety guidelines of Bangladesh.

1. Topics of concern related to the environmental release of genetically Engineered organisms (GEOs)
2. Risk for animal or human health – toxicity and food quality/safety, allergies, Pathogen drug resistance (antibiotic resistance).
3. Risk for agriculture – weeds or super weeds, alteration of nutritional value (attractiveness of the organism to the pests), reduction of cultivars (increase of susceptibility) and loss of biodiversity
4. Risk of pollution with non-target organism – genetic pollution through pollen or seed disposal, horizontal gene transfer (transgene or promoter dispersion), transfer of foreign gene to microorganisms (DNA uptake), generation of new live viruses by recombination.
5. Risk for the environment – Persistency of gene or transgene or transgene products, resistance/tolerance of target organism or susceptibility of non-target organisms, increased use of chemicals in agriculture, unpredictable gene expression or transgene instability
6. General concerns – loss of familiarity, higher cost of agriculture, field trials not planned for risk assessment, ethical issues (labelling).
7. Genetically modified foods – Benefits and Risks, Regulations and public acceptance
8. Biosafety regulations to protect nature, growers and consumers interest and national interest.
9. Biosafety guidelines of Bangladesh.

Text Books:

1. Rissler, J. and Mellon, M., 1996. The Ecological Risks of Engineered Crops, Cambridge, USA: The MIT Press.
2. Maurizio G. Paoletti and David Pimentel, Genetic Engineering in Agriculture and the Environemnt: Assessing risk and benefits. http:\\www.ag.auburn.edu/biotech/genetic.html.
3. Biosafety guidelines of Bangladesh. Ministry of Environment and Forest, Government of the People's Republic of Bangladesh

BGE 4209 Environmental Biotechnology 3 Credits

Course Objectives

The application of biotechnology is immensely increased for the betterment of environment in the twenty first century. This course is designed such a way that the students can learn the basic environmental science, the factors that can give merits or demerits to the environment and environmental remediation from the aspect of biotechnology & genetic engineering. The course also highlighted the present international and national environmental laws and legislation.

1. **Introduction:** Environment and sustainable development. Biogeochemical transformations of C, N, S and P.
2. **Environmental Pollution:** Definition, Nature of Pollutants. Types of pollution: origin, effects and control systems.
3 **Biodegradation Management:** Microbial degradation of cellulose, pesticides, aromatics and hydrocarbons.
4 **Waste Utilization:** Production of Single-cell protein, biogas, biofertilizer etc.
5 **Bioremediation:** Pollution control of heavy metals: zinc, lead, mercury, copper and cadmium. Arsenic pollution; its effects and possible remedies.
Biodeterioration: Prevention of biodeterioration of valuable materials.
6 **Waste water management:** Introduction, softening, coagulation and flocculation, sedimentation, filtration, water pollutant and their sources; water quality and standards. Water quality management techniques. Rapid detection of water borne pathogens and risk assessment

of chemicals, Waste water microbiology, waste water characteristics of different sources, re-treatment, primary treatment and secondary treatment, advanced waste water treatment, domestic, municipal and industrial waste water treatment systems. Sludge treatment and disposal.

7. **Environmental Laws and Standards:** Environmental legislation and regulation, environmental ethics.

Text Books:

1. Young, M.M., 1997. Environmental Biotechnology. Elsevier Pub. Ltd. Netherlands.
2. Sohal, M.S., 1994. Environment and Biotechnology. Ashish Publishing House, India.
3. Davis, M.L., and D.A. Cornwell, 1991. Introduction to Environmental Engineering, Second editio McGraw-Hill Inc. Singapore.

BGE 4209 Research Project/Survey Report 2 Credits

The students will have to undertake a project involving literature survey, an experimental investigation or observation, and finally they will have to prepare their project/survey report on the selected topic. In his course, they will have to participate in 2/3 weeks practical training or orientation course in biotechnology, genetic engineering and research establishments and also will have to be submitting their thesis project or report.

BGE 4211 Course Viva 1 Credit

Viva-voce on all courses belonging to the respective year.