Department of Biotechnology and Genetic Engineering
Jahangirnagar University
Savar, Dhaka

Syllabus for four-year B. Sc. (Honours) courses in Biotechnology and Genetic Engineering for 2012-2013, 2013-2014 and 2014-2015 academic sessions

Courses of study for B. Sc. (Honours) degree shall extend over a period of four academic years and shall be divided into four parts viz. Part-I, Part-II, Part III and Part-IV. Part-I examination shall be held at the end of the first year, Part-II at the end of the second year, Part-III at the end of the third year and Part-IV at the end of fourth year. The marks and credits for four years B. Sc. (Honours) degree is as follows:

Part	Theoretical Courses	Practical/Fieldwork/Project	Viva-Voce	Total Marks	Total credit
Part-I	450	200	50	700	28
Part-II	650	200	50	900	36
Part-III	650	200	50	900	36
Part-IV	750	200	50	1000	38
Total	2500	800	200	3500	140

Courses and Credit Hour

The courses of study for the Degree in a subject will be defined in terms of credit hours (abbreviated as 'credits'). One theoretical course will be equivalent to one credit as per the following criteria-
(a) Theoretical Course: One class hour per week for a period of 14 weeks shall be considered as one credit.
(b) Practical Course: Minimum Two class hours of practical class/ week for a period of 14 weeks shall be considered as one credit.
(c) Each credit shall be equivalent to 14 class lectures or academic work. Thus, for 2-credit theory course, at least 28 lectures, for a 3 credit course 42 lectures and for a 4 credit course at least 56 lectures have to be conducted
(d) Viva-voce Examination: There will be a viva-voce examination at the end of each part of the program which will constitute a Two Credit/50 marks course.

Written Tutorial of Theoretical Course and Tutorial of Practical/Field Work Course

There will be a minimum number of tutorial tests spread over the entire academic year, each of at least one class hour duration in each course as prescribed below:

For a 100 marks/4-credit theoretical Practical / field-work course	4 written/practical tests
For a 75 marks/3-credit theoretical Practical / field-work course	3 written/practical tests
For a 50 marks/2-credit theoretical Practical / field-work course	2 written/practical tests

For a 4-credit course, the duration of theoretical examination will be 4 hours and total marks will be 70. For a 3-credit hour course, the duration of the theoretical examination will be 3 hours and the total marks will be 52.5. For a 2-credit hour course, the duration of the theoretical examination will be 2.5 hours and the total marks will be 35.

For each theoretical examination, the question paper will contain 7 sets of questions of which 5 must be answered .
Assessment of Student

(a) The distribution of marks of each theoretical course:

Tutorial/Assignment	20%
Class attendance	10%
Year end examination	70%
Total	100%

(b) The distribution of marks of each Practical course:

Tutorial/Assignment	20%
Class attendance	10%
Year end examination	70 % (example for 4 credit course: 60 marks for practical tests + 10 marks for Note book)
Total	100%

The courses and marks distribution for each part are given below:

Summary of the Syllabus

Part	Theory courses (Credits)	Practical course (Credits)	Viva-voce (Credits)	Total Credits	Total Marks
Part-I	18	8	2	28	700
Part-II	26	8	2	36	900
Part-III	26	8	2	36	900
Part-IV	30	8	2	40	1000
Total	**100**	**32**	**8**	**140**	**3500**

Part –I (1st Year, Examination of 2013, 2014 and 2015)

Theory Courses

Course No.	Course Title	Credits	Marks
BGE 101	Fundamentals of Biotechnology and Genetic Engineering	3	75
BGE 102	Basic Biology	3	75
BGE 103	Basic Chemistry	2	50
BGE 104	Basic Physics	2	50
BGE 105	Basic Biochemistry	2	50
BGE 106	General Microbiology	2	50
BGE 107	Basic Mathematics	2	50
BGE 108	Communicative English	2	50
Sub Total		**18**	**450**

Practical Courses and Field Work

BGE 109	Chemistry & Biotechnology laboratory & field work	2	50
BGE 110	Biology laboratory & field work	2	50
BGE 111	Biochemistry laboratory	2	50
BGE 112	Microbiology laboratory	2	50
BGE 113	**Viva-voce**	2	50
Sub Total		**10**	**250**
Year Total		**28**	**700**

Part –II (2nd Year, Examination of 2014, 2015 and 2016)

Theory Courses

Course No.	Course Title	Credits	Marks
BGE 201	Basic Genetics	3	75
BGE 202	Biophysical Chemistry	3	75
BGE 203	Fundamentals of Molecular Biology	3	75
BGE 204	Enzymology	2	50
BGE 205	Metabolism - I	3	75
BGE 206	Human Physiology	3	75
BGE 207	Plant Breeding	2	50
BGE 208	Animal Breeding	2	50
BGE 209	Food Biotechnology	2	50
BGE 210	Biostatistics	3	75
Sub Total		**26**	**650**

Practical Courses and Field Work

BGE 211	Plant and Animal Breeding Laboratory	2	50
BGE 212	Instrumentation in Biotechnology Laboratory	2	50
BGE 213	Metabolism Laboratory	2	50
BGE 214	Computer Basics and ICT for Biotechnologists	2	50
BGE 215	**Viva-voce**	2	50
Sub Total		**10**	**250**
Year Total		**36**	**900**

Part –III (3rd Year, Examination of 2015, 2016 and 2017)

Theory Courses

Course No.	Course Title	Credits	Marks
BGE 301	Microbial Genetics	3	75
BGE 302	Environmental Biotechnology	3	75
BGE 303	Immunology	3	75
BGE 304	Advanced Molecular Biology	3	75
BGE 305	Fermentation and Bioprocess Technology	3	75
BGE 306	Developmental Biology	2	50
BGE 307	Metabolism - II	2	50
BGE 308	Analytical Methods in Biotechnology	2	50
BGE 309	Biosafety, Ethics and Regulation in Biotechnology	2	50
BGE 310	Bioinformatics	3	75
Sub Total		**26**	**650**

Practical Courses

BGE 311	Techniques in Immunology and Cell Biology	2	50

BGE 312	Techniques in Molecular Biology	2	50
BGE 313	Bioinformatics Laboratory	2	50
BGE 314	Plant Tissue Culture: Principle and Practice	2	50
BGE 315	**Viva-voce**	2	50
Sub Total		**10**	**250**
Year Total		**36**	**900**

Part –IV (4th Year, Examination of 2016, 2017 and 2018)
Theory Courses

Course No.	**Course Title**	**Credits**	**Marks**
BGE 401	Genomics and Proteomics	3	75
BGE 402	Medical and Pharmaceutical Biotechnology	3	75
BGE 403	Microbial Biotechnology	3	75
BGE 404	Animal Biotechnology	3	75
BGE 405	Plant Biotechnology	3	75
BGE 406	Cell Signaling	3	75
BGE 407	Genetic Engineering	3	75
BGE 408	Molecular Diagnostics	3	75
BGE 409	Downstream Processing	3	75
BGE 410	Entrepreneurship in Biotechnology	3	75
Sub Total		30	750

Practical Courses

BGE 411	Fermentation Technology Laboratory	2	50
BGE 412	Genetic Engineering Laboratory	2	50
BGE 413	Plant and Animal Biotechnology Laboratory	2	50
BGE 414	Internship /Review Study/Project	2	50
BGE 415	**Viva-voce**	2	50
Sub Total		**10**	**250**
Year Total		**40**	**1000**
Grand Total		**140**	**3500**

Part –I (1st Year Examinations of 2013, 2014 and 2015)

BGE 101 Fundamentals of Biotechnology and Genetic Engineering 3 Credits

Biotechnology: Definition; history and multidisciplinary nature of biotechnology; applications of biotechnology and genetic engineering;

Basic concepts in major Biotechnology areas:

Microbial Biotechnology: Introduction, history, tools in modern research and diagnostics, application in agriculture, value-added products, human nutrition and functional foods, probiotics.

Agricultural Biotechnology: Application of biotechnology in agriculture, biological nitrogen fixation and biofertilizers, biocontrol of plant pathogens, transgenic plants and their applications.

Plant Biotechnology: Introduction and importance, plant biotechnology products, plant Immunochemistry, plant tissue culture.

Animal Biotechnology: Animal wealth, products from animals, animal cell culture, pharmaceuticals from transgenic animals, blood substitutes from transgenic animals.

Medical and pharmaceutical biotechnology: Introduction, antibiotics, vaccines, drug discovery and development, genomic technologies, molecular pathogenesis and diagnosis of disease.

Environmental Biotechnology: Environmental impact of biotechnology, microbes and geological environment, consideration of application of biotechnology for oil pollution, pesticides and herbicides pollution, heavy metal pollution and bioremediation; waste management.

Basic concepts in Genetic Engineering and related technologies:

Introduction: DNA and RNA as hereditary materials; Central dogma of life (Replication, transcription and translation), Reverse transcription;

Gene cloning: basic concept, Basic applications of bacterial and viral genetic engineering. Tools of recombinant DNA technology: Restriction enzymes, DNA ligases, different types of vectors, different marker genes.

Biotechnology commercialization: Understanding of biotechnology as a commercial product based discipline, biotechnology in developing countries

Recommended Books:

1. Introduction to Biotechnology. Bilgrami & Pandey. (1990), CBS Publishers, India
2. Basic Biotechnology. Bullock, J. & Uritiansen, B. (1995). Academic Press, UK.
3. Introduction to Biotechnology. Dubey, R. C. (1995). 7th Edition. S. Chand & Co. Pvt. Ltd. India
4. Biofertilizer in Agriculture and Forestry. Rao, N. S. S. (1996). Oxford & IBH Pvt. Ltd. India.
5. Biotechnology. Smith, 3. E. (1988). 2 Ed. Edward Arnold Pub NY, UK.
6. Molecular Biology of the Cell. Bruce Alberts, Alexander Johnson, Julian Lewis (2008) 5th Edition. Garland Science.
7. Introduction to Biotechnology and Genetic Engineering. AJ Nair. Infinity Science Press (2008), Hingham, Massachusetts, USA

BGE 102 **Basic Biology** **3 Credits**

Origin and varieties of life: What is life, theories of origin of life, nature of the earliest organism? Evolution. A brief introduction of five kingdoms; Prokaryote, Protista, Fungi, Plantae and Animalia.

Tissue system: Simple tissue (parenchyma, collenchymas, sclerenchyma); Complex tissue (xylem and phloem); Tissue systems (epidermal, ground, vascular); primary body and growth (root, stem, leaf); Secondary growth. Animal Epithelial tissue, connective tissue, muscle tissue and nervous tissue and their function in body.
Nutrition: Autotrophic Pigment systems, Chloroplast, light absorption by chlorophyll and transfer of energy, two pigment systems, photosynthetic unit, phosphorylation and electron transport system, Calvin-Benson Cycle (C3), Hatch Slack Pathway (C4), Crassulacan Acid Metabolism (CAM), factors affecting photosynthesis; Mineral Nutrition in plants.
Transport: Diffusion, osmosis, imbibitions, movement of water in flowering plants, uptake of water by roots, the ascent of water in xylem, apoplast symplast theory, Transpiration-structure of leaf and stomata in plants opening and closing mechanism of stomata. General characteristics of blood vascular system, composition of blood, circulation in blood vessels, formation of tissue fluids.
Coordination and control: Plant movements (Tactic, Tropic, Nastic), plant growth substances (Auxins, Cytokinins, Gibberellins, ABA, Ethylene), phytochrome and effect of light on plant development, vernalisation and flowering. Nervous system, parts of the nervous system, sensory receptors, structure and function of receptors.
Ecology, Ecosystem and Biodiversity: Concept of ecology and ecosystem, Habitat, community and ecological factors, niche, Structure and function of ecosystem, Ecosystem types, Biomass production and productivity, producers, consumers, decomposers, Food chain, food web, energy flow.
Economic Importance of Plants: Important families (Fabaceae, Poaceae, Malvaceae, Cucurbitceae, Crucifereae, Legumin oseae), Economic importance of cereals, beverages, fibers, woods, rubber, spices, medicinal plants.

Recommended Books:

1. Neil A. Campbell, Jane B. Reece, Martha R. Taylor, and Eric J. Simon. Biology: Concepts and Connections 2008. 6th Edition. Benjamin Cummins
2. Cecie Starr. Biology: Concepts and Applications 2007. 7th Edition. Brooks Cole
3. Dutta, A. C. Botany for Degree Students1974, 4th Ed., Oxford University Press, Calcutta.
4. Stephen A Miller, John P Harley, Stephen Miller, and John Harley. Zoology 2009. 8th Edition. McGraw-Hill, USA.

BGE 103 **Basic Chemistry** **2 Credits**

Physical Chemistry: The basics; mole concept; Avogadro's number, Normality, Molarity, Molality, Periodic table.
Acids and bases; The Bronsted-Lowry acids and bases; Arrnhenius concept, Lewis acids and bases, Physical properties of water, ionic product of water and pH scale; Ionization of acids and bases; Acid— base indicators common ion effect; Buffer solution Buffer capacity; Henderson—Hasselbach equation.
Conductance; Faraday's law of electrolysis; conductivity and its measurement; Equivalent and molar conductance Variant of equivalent conductivity with concentrations of weak and strong electrolytes.
Inorganic Chemistry: Ionization potential; Electron affinity; Electronegativity; Oxidation states.
Ionic bonds (general characteristics), types of ions; Covalent bond (general characteristics; Coordinate covalent bond; Valence bond approach; Sigma and Pi bonds; Bond length; Bond order; Hydrogen bonds Van der Waal's forces; Metallic bond; Concept of coordination complexes; Werner's theory; Bonding in coordination compounds.
Role of inorganic elements in some vital complexes of coordination complexes, e.g. hemoglobin, cytochromes, ferredoxin, chlorophylls.
Organic Chemistry: Chemical bonding reconsidered; Atomic and molecular orbits; Polarity of bonds; Bond length and bond strength: Bond energy; bond moment and dipole moment; Nucleophiles and electrophiles and their importance in biological systems; Characteristics and type of organic reactions; Addition, elimination, substitution and rearrangement reactions.
Aliphatic hydrocarbons (Petroleum and related products); Aliphatic alcohols; Aldehydes and ketones; Acids and their derivatives.
Basic principles of stereochemistry; Cis-trans isomers; Plane polarized light; Optical activity, Chirality and chiral molecules; D & L designation; Absolute configuration.

Recommended Books:

1. General Chemistry. Atkins 1992, 2nd Ed. W. H. Freeman and Company, New York.
2. Chemistry. Gillespie, Fitimpherys, Bairds and Robinson 1989, Allyn and Bacon Inc. Boston.
3. Steriochemistry of carbon compounds. Eliel and Wilen. 1994. Wiley Interscience.
4. Organic chemistry: A short course, Atkins and Carey 1991. McGraw Hill Publishing Company.

BGE 104 **Basic Physics** **2 Credits**

Gravitation: Kepler's and Newton's Law, gravitational attraction of sphere, the acceleration of gravity, gravitational effect of spherical distribution of matter.
Hydrostatics and Surface Tension: Hydrostatic pressure, Change of pressure with elevation; equilibrium of floating bodies; pressure gauges; surface tension and energy; factor affecting surface tension capillarity, Causes and effect of surface tention.
Hydrodynamics and Viscosity: Lines and tubes of flow, equation of continuity; Bernoulli's equation and its application; viscosity, co-efficient of viscosity of liquids and gases; variation of viscosity with temperature.
Kinds of Gases and their characteristics: Kinetic theory of gas, fundamental assumption in the kinetic theory; pressure exerted by a perfect gas; Brownian movement; molecular and atomic specific heat; mean free path.
Optics: Light as electromagnetic wave, Total internal reflection, Superimposition principle, Interference of light, Young's double slit experiment, Calculation of fringe width, Interference due to reflected light, Newton's rings.
Electricity & Magnetism: Electric charge and Coulomb's law; Electric dipole, Electric field and its intensity, Gauss's law, Electric field due to a uniformly charged sphere, Electric potential and potential difference, Potential due to a point charge, Potential due to a group of point charges, Calculations of E from V, Magnetic field, Magnetic flux, Force due to a current carrying wire, Faraday's law, Biot-Savart Law and its application, Ampere's law and its applications.
Atomic and Nuclear Physics: Photoelectric effect, Compton effect, Atomic structures, Thomson model, Rutherford model and Bohr's model, Orbital energy of electron, Energy level of electron, Bohr atom, Origin of spectral lines and atomic spectra, Nuclear properties, Binding energy, Radioactive disintegrations, Nuclear reactions. Different kinds of rays like x-ray, gamma ray, UV ray and their characteristics and their applications.

Recommended Books:

1. Fundamentals of Physics. Halliday, Resnick and Walker 2007. 8th Edition, Wiley & Sons.
2. Physics for Engineers Vol. 1 and Vol. 2. Dr. Giasuddin Ahmad.
3. The Feynman lectures on Physics. Feynman, Leighton and Sands 1970. Addison Wesley Longman.
4. Waves and Oscillations. Subrahmanyam and Brijlal.
5. Optics. Zenkins and White.
6. Optics. Subrahmanyam and Brijlal.
7. Basic Physics: A self teaching guide. Carl F Kuhn 1996. 2nd Edition. Wiley & Sons

BGE 105 Basic Biochemistry 2 Credits

Introduction: History, Scopes, Significance of Biochemistry in Biotechnology.
The Cell: Concept of life and living processes; Identifying characteristics of a living matter; Historical background; Cell theory; Cell size and structure; Structure of Prokaryotic and Eukaryotic Cells.
Cellular Organelles: Structure and function of the following cellular organelles; Cell membrane, ribosome, nucleus, mitochondria, chloroplast, Golgi bodies, endoplasmic reticulum, lysosomes, vacuoles, peroxisomes, cytoskeleton, plant cell wall, Cell fractionation and distribution of cellular components.
Biomolecules: The small molecules of life, sugars, amino acids and nucleotides.
Sugars: Monosaccharides, Oligosaccharides, Polysaccharides: Introduction, properties and derivatives.
Lipid: types and classifications, nomenclature: Structural lipids and storage lipids eg, triacylglycerol, phospholipids, glycolipids, sphingolipids, waxes, sterols.
Amino acids: Structural features, Optical properties, Classification of amino acids, Zwitter ions, Isoelectric properties.
Proteins: General idea of primary, secondary, tertiary & quaternary structures. Structural protein and functional proteins.
Nucleic Acids, The central dogma; DNA as a genetic material, Double helix structure of DNA; Types of RNAs and their structures, differences between DNA and RNA, Ribosomes and protein synthesis.

Recommended Books:

1. Lehninger Principle of Biochemistry, David L. Nelson, Michael M. Cox, 5th edition, W.H. Freeman.
2. Cell and Molecular Biology- E.D.P. De Robertis, 7th edition, Marcel and Dekker, NY.
3. Biochemistry, 5th edition, J. M. Berg, J.L. Tymoczko and L. Stryer, Freeman, 1995.
4. Harper's Illustrated Biochemistry, 28th Edition. Robert Murray, Victor Rodwell, David Bender, Kathleen M. Botham, P. Anthony Weil, Peter J. Kennelly 2009 McGraw-Hill.

BGE 106 General Microbiology 2 Credits

Introduction: History and Development of Microbiology, Classification of Microbes, Spontaneous generation and biogenesis, Germ theory of diseases, Pure culture concept, Concept of Immunization, Importance of Microbiology in Biotechnology.
Microscopic Observations of Microorganisms: Bright field, dark field, Fluorescence and phase contrast microscopy, Electron microscopy, Preparations of microscopic examinations: wet mount and hanging drop techniques, Microbiological stains: simple and differential staining methods.
Bacteria: Cell Structure and Function in Bacteria: Nomenclature of bacteria, Morphology, Structures of flagella, pili, glycocalyx, cell-wall .
Bacterial Growth: Nutritional requirements, Bacteriological media, Bacterial growth curve, Quantitative measurement of bacterial growth, Maintenance of pure culture of bacteria. Overview of bacterial isolation and identification.

Control of Microbial Growth**:** Temperature and microbial growth, other environmental factors affecting growth
Fungi: Brief outline on growth and reproduction; importance in natural process. Yeasts-types: morphology, reproduction and physiology of yeast featuring *Saccharomyces cerevisiae*.
Viruses: Morphology, Classification with representative examples; Lambda phage, FMV; lytic cycle and lysogeny of bacterial virus.
Actinomycetes: Importance in industry and natural process.
Rickettsiae: Introduction, characteristics of rickettsiae, pathogenic rickettsiae, laboratory diagnosis of rickettsial deseases.
Disease causing microbes: Infections, pathogen, pathogenecity and virulence, Transmission of common infectious diseases eg. Cholera, Anthrax.

Recommended Books:

1. Microbiology- Michael J. Pelczar, Noel R. Kreig and E.C.S Chan. 5th edition, Tata McGraw Hill Publishing Company Limited, New Delhi.
2. Microbiology: An Introduction- Tortora, Berdell R.Funkee & Case, 8th edition, Prentice-Hall.
3. Biology of Microorganisms- TD Brock, MT Madigan, JM Martinko, and J. Parker, 7th edition, Prentice-Hall, Englewood Cliffs.
4. Fundamental Principles of Bacteriology- A.J. Salle, 7th edition, McGraw Hill Book Company.

BGE 107 Basic Mathematics 2 Credits

Trigonometry: De Moiver's theorem and its application, Gregories series, summation of series.
Vector Analysis: Vector algebra- addition and multiplication of vectors, linear dependence and independence of vectors, dot and cross product of vectors.
Matrices: Definition of various type of matrix; addition, subtraction and multiplication of matrices; transpose, adjoint and inverse of a matrix; rank and elementary-transformation of a matrix.
Introduction to Calculus: Introduction, Basic concepts of functions, Graphing functions, combining functions, Inverse functions, Polynomial Functions, Limits and continuity.
Differential Calculus: Rules and techniques of differentiation of various functions, Concavity and convexity of a curve, Points of inflexion, Asymptotes and curvature, Partial derivatives, Maxima and Minima of functions.
Integral Calculus: Rules and techniques of Integration, Simple application of integral calculus, Double and triple integrals.

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Recommended References:

1. Calculus and Analytic Geometry by George B. Thomas/ and Ross L. Finney.
2. Vector Analysis by Murry R. Spigel, Schaum's Outline Series.

BGE 108 Communicative English 2 Credits

Reading in context: Reading comprehensions and answering questions, Reading and reviewing short texts (Recent advances in biotechnology, debates about GM food, biography of Nobel laureates), Vocabulary building, Intensive reading develops a better understanding of the language; structure analysis, Remedial grammar; test and revision

Development of writing skills: Paragraph and essay writing, Outlining and structure (Topic sentence/ thesis statement, introducers, developers, modulators, terminator etc), Paragraph development by specific details and examples (chronological order, spatial order, time definition, classification, cause and effect, comparison and contrast, listing etc), Letter writing (Formal eg, cover letter, different types of applications etc.), CV/resume writing, Free hand writing, Learn to use the language in a more communicative way, report writing, cause and effect, generalization, test revision.

Listening: Listening comprehensions, Listening and note taking, answering questions. Test and note revision.

Speaking: Asking and answering questions, Situational English: Exchanging information, polite and formal expressions (requesting, inviting, asking for help, accepting and rejecting etc.), Remedial grammar; test and revision.

Grammar: Tenses, Auxiliaries, Verbs, Comparatives and superlatives, Prepositions, Active and passive voices, Making questions, Conditionals, Articles, Clauses and phrases, Reported speech.

Phonetics: IPA symbols for learning accurate pronunciations, Tone, Intonation and stress (for speaking English to communicate properly), Use of dictionary and texts.

Reference Skill: Using a dictionary, encyclopedia and atlas; how to use a text book; test and revision.

Book references:

1. Q.M. Billah, G.S. Chowdhury & Monjurul Alam. Foundation English for Undergraduate.
2. A. Thomson & A.V. Martinet. A Practical English grammar, 1986
3. W. Stannard Allen. Living English Structure, 1958

Laboratory and Field Work 8 Credits

BGE 109 Chemistry & Biotechnology laboratory and field work 2 Credits

1. Biotechnology laboratory experience and field work
2. Laboratory Basics and Safety
   - i) Chemical safety measures
   - ii) Understanding MSDS
   - iii) Purity of chemicals and calculation of impurities
   - iv) Buffers and solutions
   - v) Understanding laboratory chemicals
   - vi) Solutes, solvents, preparation of solution
3. Experiments:
   - i) Experiments covering Course No. BGE 103

BGE 110 Biology laboratory & field work 2 Credits

- i) Study of starch grain and simple cell (onion).
- ii) Study of permanent slides (Volvox, spirogyra, moss, fungi, euglena, bacterium, amoeba, mitosis, meiosis)
- iii) Measurement of soil temperature, air temperature of soil/air, humidity and light intensity
- iv) Determination of biomass, moisture and organic residues in soil.
- v) Study of biotic components of a pond; collection and identification of existed plants and animals.
- vi) Demonstration of osmosis, imbibition, water movement through xylem, oxygen release and CO_2 requirements during photosynthesis, photosynthesis rate under different condition, respiration, and properties of enzyme.
- vii) Study of monocot and dicot plants.
- viii) Study of economically important plants/ their parts with specific uses.
- ix) Collections of different specimen.
- x) Field note & report.

BGE 111 Biochemistry laboratory 2 Credits

- i) Determination of strength of a solution by titration method
- ii) Determination of protein content by spectrometric method
- iii) Determination of extinction coefficient of protein
- iv) Measurement of Vitamin C in biological samples
- v) Other Experiments Covering Courses BGE-105

BGE 112 Microbiology laboratory 2 Credits

- i) Introduction to compound light microscope
- ii) Simple staining method
- iii) Gram staining method
- iv) Concepts of sterilization and instrumentation
- v) Preparation of culture media for bacteria
- vi) Isolation of pure culture: Streak plate method
- vii) Enumeration of bacteria: Spread plate method
- viii) Enumeration of bacteria: Pour plate method

Part –II (2nd Year Examinations of 2013, 2014 and 2015)

BGE 201 Basic Genetics 3 Credits

1. **Introduction to Genetics:** Classical and Molecular Genetics; Genetics in genomics and proteomics era; Genetics and medicine, Agriculture and Society.
2. **Mendelian Genetics:** The basic principles of inheritance, Mendel's study of heredity, Application of Mendel's Principles; Formulating and testing genetic hypotheses; Mendelian principles in human genetics.
3. **Extensions of Mendelism:** Allelic Variation and Gene function; Gene action: from phenotype to genotype;
4. **Inheritance of Complex Traits:** Complex pattern of inheritance; statistics of quantitative genetics; analysis of quantitative traits; inbreeding and resemblance between relatives.
5. **The Chromosomal Basis of Mendelism:** Sex-linked genes in human; Sex chromosomes and sex determinations; Dosage compensation of X-linked genes.
6. **Variation of Chromosome Number and Structure:** Cytological techniques, Polyploidy, Aneuploidy; Rearrangements of chromosome structure
7. **Linkage Crossingover and Chromosome Mapping in Eukaryotes:** Linkage, recombination and crossing over; Chromosome mapping; Recombination and evolution
8. **Advanced Linkage Analysis:** Detection of linkage in experimental organisms; Specialized mapping techniques; Linkage analysis in humans.

Recommended Books:

1. Essential Cell Biology. Bruce Alberts, D. Bray, K. Hopkin, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter 2003. Second Ed. Garland Science.
2. Molecular Biology of Cell. Bruce Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, J. D. Watson, 2002. Fourth Ed. Garland Science.
3. Genes VI and VII. Benjamin and Lewin, 1997. Sixth Edition. Oxford University Press.
4. Molecular Biology of the Gene. Watson, J.D. and Hopkins, A.M., Roberts, J.W., Steitz, J.A. and Weiner, A.M., 1988. Benjamin/Cummings Scientific Publishing, Menlo Park, California.
5. Lehninger Principle of Biochemistry, David L. Nelson, Michael M. Cox, 2004. 4th edition, W.H. Freeman.
6. Genomes. Brown, T. A. 2002.Second Edition. BIOS Scientific Publishers Ltd.
7. Principles of Genetics Snustad, D.P. Simmons, M.J. and Jenkins, J.B., 1997. Jacaranda/Wiely pub.
8. Concepts of Genetics. Klung, W.S. and Cummings, M.R., Scott, 1980. Foresman and Co. USA.

BGE 202 Biophysical Chemistry 3 Credits

1. **Introduction:** Scope, Importance of biophysical chemistry, relation to biotechnology
2. **Properties of Liquid and Solution:** introduction, kinetic molecular description, intermolecular forces in liquids, viscosity (definition, units of viscosity, measurement of viscosity by Ostwald viscometer, effect of temperature on viscosity). surface tension (definition, effect of temperature on surface tension, determination of surface tension by capillary – rise method, drop formation method and drop - number method), solution; definition, types of solution, concentration units and volumetric problems.
3. **Colloid:** General properties, lyophobic and lyophilic systems, dispersion, Brownian movement, origin of colloidal charge, coagulation, gel and emulsion, colloidal electrolytes and Zeta potential.
4. **Colligative Properties of Solution:** Introduction, definition, dilute solution, real solutions, colligative properties, partial molar quantities, chemical potential, Raoult's law, Henry's law, activity and activity coefficient, osmosis and osmotic pressure, semi-permeable membranes, determination of osmotic pressure, determination of molecular weight, isotonic solution.
5. **Thermodynamics:** First law; definition, system, state and state function, properties of thermodynamics first law of thermodynamics, nature of heat and work, pv work, maximum work, internal energy, molar heat capacity, isothermal and adiabatic changes and enthalpy; Second law of thermodynamics: Thermodynamic reversibility and irreversibility, spontaneous processes, entropy, thermodynamic efficiency and Carnot's theorem, statement of second law. Changes of entropy in various processes of ideal gases (at constant temperature, pressure and volume), Phase transition.
6. **Thermochemistry:** Exothermic and endothermic reactions, standard enthalpy of formation, thermochemical equations, reaction enthalpy, dependence of temperature
7. **Free Energy**: Variation with temperature, pressure, Gibbs Helmoholtz equation. Clausius Clapeyron equation. Application of thermodynamics to Biochemistry and Biotechnology.
8. **Distribution Law:** Introduction, Nernt's distribution law, solubility and distribution law, distribution law and molecular state, Henry's law, Determination of equilibrium constant.
9. **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.

Recommended 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. 2005
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.
6. K. K. Sharma and L. K. Sharma, A text book of Physical Chemistry
7. B.S. Bahl and G.D. Tuli, Essential of Physical Chemistry, S. Chand and Company Ltd.2006
8. V.M. Khanna, M.M. Kapur, and V.P. Sharma, Physical Chemistry
9. N. Kundu and S.K. Jain, Physical Chemistry
10. Morris, J. G. A, Biologist's Physical Chemistry

BGE 203 Fundamentals of Molecular Biology 3 Credits

1. **Introduction to Biomolecules:** Importance of biomolecules; Nucleic acids, proteins, carbohydrates and Lipids
2. **Proteins:** Conformational analysis and forces that determine protein structures and geometries; hydrogen bonding; disulphide bonds; hydrophobic interactions; alpha helices; beta sheets; helix to coil transition, general features and thermodynamic aspects of protein folding and folding kinetics, protein-ligand interactions, Relationship between the primary, secondary, and tertiary structure of proteins. Fibrous proteins; Quaternary structures: dimers, homo and hetero dimers, trimers, tetramers; Domain structures of proteins.
3. **Nucleic Acids:** Primary, secondary and tertiary structure of DNA. Melting of DNA double helix (Hyperchromicity). Structure and types of RNA**.**
4. **DNA Replication:** Basic features, DNA polymerases, complex replication apparatus; DNA repair during replication; unique aspects of eukaryotic chromosome replication; Control of DNA synthesis for both prokaryotic and eukaryotic system, inhibitors of replication.
5. **Transcription and RNA Processing:** RNA polymerase, transcriptional factors, promoter, Promoter recognition by RNA polymerases, Mechanism of prokaryotic and eukaryotic transcription, post transcriptional modification, RNA processing
6. **Genetic code:** Characteristic features of genetic code, specificity, redundancy and wobble hypothesis, concept of gene, gene-protein co-linearity
7. **Translation and Expression:** Components required for protein synthesis; Structure of ribosome; initiation, elongation and termination of protein synthesis, post-translation modification, Example of gene expression

Recommended Books:

1. Essential Cell Biology. Bruce Alberts, D. Bray, K. Hopkin, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter 2003. Second Ed. Garland Science.
2. Molecular Biology of Cell. Bruce Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, J. D. Watson, 2002. Fourth Ed. Garland Science.
3. Genes VI and VII. Benjamin and Lewin, 1997. Sixth Edition. Oxford University Press.
4. Molecular Biology of the Gene. Watson, J.D. and Hopkins, A.M., Roberts, J.W., Steitz, J.A. and Weiner, A.M., 1988. Benjamin/Cummings Scientific Publishing, Menlo Park, California.
5. Lehninger Principle of Biochemistry, David L. Nelson, Michael M. Cox, 2004. 4th edition, W.H. Freeman.
6. Genomes. Brown, T. A. 2002.Second Edition. BIOS Scientific Publishers Ltd.
7. Principles of Genetics Snustad, D.P. Simmons, M.J. and Jenkins, J.B., 1997. Jacaranda/Wiely pub.
8. Concepts of Genetics. Klung, W.S. and Cummings, M.R., Scott, 1980. Foresman and Co. USA.

BGE 204 Enzymology 2 Credits

1. **Introduction:** Definition, classification and nomenclature of enzymes, enzyme assay, apoenzyme and holoenzyme, coenzyme and prosthetic group, specific activity and enzyme activity units.
2. **Enzyme Kinetics:** Monosubstrate reactions, Michaelis-Menten equation and its linear transformations; Km and Vmax: definition, determination, and significance.
3. **Factors Influencing the Rate of Enzyme-catalyzed Reactions:** Substrate concentration, enzyme concentration, pH, temperature, co-enzyme and cofactors; factors affecting the catalytic efficiency of enzyme: proximity and orientation, covalent catalysis, acid-base catalysis, strain.
4. **Regulation and Mechanism of Enzyme Action:** Covalent modification; feedback inhibition, allosteric regulation, ATKase; mechanism of enzyme action: Examples – Chrymotrypsin, Ribonuclease A.
5. **Inhibition of Enzyme:** Reversible and irreversible inhibition, Competitive, non-competitive and uncompetitive inhibition with specific examples.
6. **Isoenzyme:** Characteristics, clinical and biological importance.
7. **Enzyme Isolation, Purification and Assay:** Introduction, objectives and strategies in enzyme purification; primary clarification of the soluble enzyme; methods of concentrating enzymes; various chromatographic methods for enzyme purification; examples of purification procedure; techniques of enzyme assay.
8. **Industrial Applications of Enzymes:** Introduction, Application of Enzymes in Biotechnology, economic significance, Enzymes isolated on an industrial scale and their application.

Recommended Books:

1. Lehninger Principle of Biochemistry, David L. Nelson, Michael M. Cox, 2004. 4th edition, W.H. Freeman.
2. Nicholas C. Price and Lewis Stevens. Fundamental of Enzymology. 2nd edition. Oxford Science Publications, UK. (1990).
3. Wiseman, A. Principles of Biotechnology. Surrey University Press and Chapman and Hall. New York. (1985).
4. Watson. J.D., Gilman. M., Witkowskli, J., Zoller, M. Recombinant DNA Technology, Scientific American Books. (1992).

BGE 205 Metabolism - I 3 Credits

1. **Introduction to metabolism:** Important differences and relationship between Anabolic & Catabolic mechanisms in cell, High-energy phosphate compounds and Biological oxidation-reduction reactions, ATP generation by different processes, ATP cycle.
2. **Membrane and membrane transport system:** Structure and Composition of membrane, Active transport, Passive transport, Facilitative diffusion, and Group translocation.
3. **Glycolysis:** Glycolytic pathway, Importance and Regulation of glycolysis.
4. **Citric acid cycle and electron transport system:** Pathways of Citric acid cycle, The Electron carriers of electron transport chain, Mitochondrial electron flow, Uncouplers of oxidative phosphorylation.
5. **Alternative pathways for glucose catabolism:** Hexose monophosphate shunt, Entner-Doudoroff pathway, methyl-glyoxal bypass.
6. **Pathway for utilization of sugars other than glucose:** Fructose, mannose, maltose, lactose, sorbitol, mannitol, starch, cellulose.

7. **Metabolism of alternate carbon sources:** Glyoxylate cycle, Gluconeogenesis, Other Anaplerotic reactions.
8. **Catabolic activities of aerobic heterotrophs:** Growth with Organic acids (beta-oxidation), Amino acids, Aromatic compounds, Aliphatic hydrocarbons and CI compounds.
9. **Anaerobic metabolic processes:** Fermentation of Ethanol, Lactic acid, Acetate-butyrate, Acetone-butanol and Methane.

Suggested readings:

1. Lehninger Principles of Biochemistry, Fourth Edition - David L. Nelson, Michael M. Cox, 2004. 4th edition.
2. Microbial Physiology—A.G Moat & J.F Foster
3. Bacterial Metabolism—G. Gottschalk

BGE 206 Human Physiology 3 Credits

1. **General Physiology:** Introduction to human physiology, branches of physiology.
2. **Blood:** Composition, origin and functions; properties plasma proteins, erythrocytes-morphology, function, developmental fate, leukocytes-morphology, function, classification, properties, development; thrombocytes-morphology, function, development; hemoglobin-synthesis, structure, function, fate; homeostasis and coagulation-concept of coagulation, anti-coagulation; Blood grouping-ABO system; R^h factor, lymph-function circulation.
3. **Cardiovascular System:** Structure and properties of cardiac muscle, generation and conduction of cardiac impulse, electro-physiology of cardiac muscle (ECG); events of cardiac cycle and cardiac output, blood pressure, heart rate, factors affecting heart rate, hemodynamic blood pressure and its regulation.
4. **Respiratory System:** Introduction of respiratory apparatus and pulmonary circulation, mechanism of respiration, pulmonary ventilation, pulmonary volume, alveolar ventilation, capacities, gaseous exchange, ventilation-perfusion relationship, oxygen transport, oxygen dissociation saturation curve, carbon dioxide transport, oxygen carriage, regulation of respiration- nervous and chemical.
5. **Nervous System:** Nerve cells, 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.
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 (eg. Diarrhoea, gastritis etc.).
7. **Kidney and Urinary Excretory System:** Structure and function of kidney, renal circulation, urine formation-filtration, re-absorptions of different components of tubular fluid, secretion of substances by the kidney, concentration of urine, concept of plasma clearance, Acidification of urine.
8. **Reproductive System:** Anatomy and function of male and female reproductive system, composition, reproductive disorders.

Recommended Books:

1. Arthur C. Guyton, M.D. & John E. Hall 2006, Text Book of Medical Physiology, W.B. Saunders Company, London.
2. Anatomy and Physiology- The Unity of Form and Functions. 3rd Edition. Keneth Saladin.
3. William F. Ganong, 2006, Review of Medical Physiology. 21st Edition.
4. Dr. C.C. Chatterjee. Human Physiology, Vollume.1 & 2.
5. Grays. Gray's Anatomy.
6. Shana and Ghosh. Human Physiology.
7. Smith. E. Pateson. C.R. Scratecherd. T. and Read. N.W. 1988, Text Book of physiology. Hong kong.
8. Elaine. N. Human Anatomy and physiology 4th Ed. Benjamin/Cummings. Scientific publishing, California.

BGE 207 Plant Breeding 2 Credits

1. **Introduction:** History, nature and objectives of plant breeding. Genetic erosion, crop genetic resources, gene bank, center of diversity, domestication and germplasm conservation, cryopreservation. Institutes for crop improvement.
2. **Modes of reproduction and Pollination control:** Asexual and sexual reproduction, pollination, apomixes, self-incompatibility, male sterility.
3. **Qualitative and quantitative characters and Biometrical techniques in Plant Breeding:** Genotype, phenotype, qualitative and quantitative characters, inheritance of characters, genotypic, phenotypic and environmental variance and covariance, aids of selection, choice of parents and breeding procedures, varietal adaptation. Practical applications of hybrids and cybrids
4. **Selection, Hybridization, Heterosis and Inbreeding depression:** Selection, progeny test, hybridization, procedure of hybridization, hardy-weindberg law, inbreeding depression, heterosis.
5. **Breeding methods:** Mass, pureline, pedigree, bulk, backcross selections. Development of hybrid varieties, clonal selection.
6. **Stress resistance breeding:** Abiotic and Biotic stress. Breeding for: drought resistance, salinity resistance, mineral stress resistance, heat and cold resistance, disease and insect resistance.
7. **Molecular marker and marker assisted breeding:** Morphological marker, biochemical marker, molecular marker (non PCR based, PCR based), targeted PCR and sequencing, fingerprinting, marker system selection. Application, advantages and limitations of molecular markers.
8. **Evaluation and Multiplication:** Evaluation, variety release, multiplication, quality seeds

Recommended Books:

1. **Allard R.W** 1995. Priniples of Plant Breeding. John Wiley and Sons, Ice., Singapore.
2. **Sharma J.R** 1994 Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.
3. **Singh B.D** 1996 Plant Breeding – Principles and methods. Kalyani Publications, Ludhiana.
4. **Chahal G.S and Ghosal S.S** 2002. Principles and procedures of Plant Breeding, Narosa Publishing House, New Delhi.

BGE 208 Animal Breeding 2 Credits

1. **Principles of Animal Breeding:** Concept of Animal Breeding, its development and application, domestication of farm animals, development of breed association.
2. **Breeding Value and Selection:** Definition, measurement and uses, most probable producing ability. (MPPA) transmitting ability (TA), Variation, Selection, Natural and artificial selection, selection objectives and selection criteria, Selection method, Prediction and estimation, implication to livestock improvement , Selection limit, Breeding efficiency, Heritability and Repetability.
3. **Systems of breeding:** Inbreeding, Outbreeding, Topcrossing, Grading, Cross-breeding, Intersemating, Criss-crossing, Triple crossing, Breeding guidelines
4. **Specialized Breeding:** Traits of economic importance, selection and breeding plants for the improvement of cattle, goat and poultry for specific purposes, systems of breeding for captive animals, conservation of endangered animal genetic resources.
5. **Artificial Insemination of Animals:** Importance and techniques of cryo-preservation of semen and utilization; Semen processing; Separation of X and Y chromosomes bearing spermatozoa and its applicability.
6. **Embryo Transfer in Domestic Animals:** Definition, history advantages, steps of embryo collection, selection and transfer techniques; cryopreservation of embryos; limitations of embryo transfer techniques.
7. ***In Vitro* Fertilization in Ruminants:** Introduction; potential use of *in vitro* fertilization. Mechanisms involved in fertilization**,** harvesting of oocyte; maturation of oocytes; collection and capacitating of sperm; fertilization and development of embryos to a transferable stage.

Recommended Books:

1. **Banerjee, G. C**. (1987). A Textbook of Animal Husbandry, 6th Ed. Oxford and IBM Publishing Company, NY, Delhi, Calcutta & Mumbai.
2. **Mukherjee D.P, Banarjee G.C.** Genetics and Breeding of Farm Animals. New Delhi, Oxford & IBH Pub. Co. Pvt.
3. **Janusz M and Jozef Zieba (1982).** Genetics and Animal Breeding. Part A. Elsevier Scientific Publishing Company, Amsterdam, oxford, NY.

BGE 209 Food Biotechnology 2 Credits

1. **Introduction:** Biotechnology: its role and future in the food industry, Importance of microorganism in food Biotechnology: molds, yeast and bacteria. Keeping our supply food safe.
2. **Impact of biotechnology on major food ingredients:** Physical/chemical changes and improvement of sweeteners, fats, carbohydrates, proteins, bulking agents.
3. **Flavors, aromas, taste and olfaction:** Ingredients to improve taste; role of biotechnology in flavor manufacturing and recovery, biochemistry of taste and olfactory.
4. **Improvement of existing fermentation technologies:** Improvements of traditional fermentation processes such as beer, wine, bread, cheese, etc.
5. **Nutraceuticals and Nutragenomics and Functional Food:** Nutrition, health sustaining and health enhancing ingredients.
6. **Microorganisms as foods:** SCP and MBP, Production of single-cell proteins for using in food or feed, yeasts and yeast products. Baker's yeast.
7. **Biotechnology of Milk and Dairy Products:** Composition and food value of milk, adulteration of milk. Pasteurization of milk and methods of pasteurization. Starter culture, yogurt, cultured yogurt buttermilk, acidophilus milk and kefir, Fermented food
8. **Food Preservation & Processing: Salting:** Types of salting; Technological aspects of salting; Salting process and characteristic feature of salting with special aspect on Hilsha fish processing. **Canning:** Principles of canning; Preparation of raw material, canning operation; Examination of can, prospect of canned food industry in Bangladesh. Food additives; Packaging of food, storage. Food spoilage and food regulation, quality control of food processing, fruits processing
9. **Genetically modified foods**: Examples of different genetically modified foods.

Recommended 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-Hill publishing Company Ltd., Bombay, New Delhi. (1994).
6. Eskin, N. A. M. Biochemistry of Foods, Second edition, Academic Press, Inc. (1996).
7. Clusas IJ. 1985. Fish Handling, Preservation and Processing in the tropics. Part I and II. Tropical Development and Research Institute, London
8. Govinda TK 1985. Fish Processing Technology. Oxford and IBM Publishing Co., New Delhi.
9. Brogstrom G. 1965. Fish as Food Vol I to IV. Academic Press London.
10. Stansby ME. 1963 Industrial Fishery Technology. Rehnold Publishing Co. New York.
11. Wheaton FW and Lawson TB 1985. Processing of aquatic food products. Wiley Inter Science, New York.

BGE 210 Biostatistics 3 Credits

1. **Introduction:** Research and experimentation, the role of statistics, the nature of statistics scope of this presentation. Basic statistical principles and terminology. Populations and parameters, sampling techniques, variables, statistical characterization of samples. Graphs, charts and diagrams, distributions, Statistical concepts pertaining to interpretation and decision.
2. **Descriptive Statistics:** Calculation of mean, variance and standard deviation, range, standard deviation of the mean
3. **Estimation:** Point of estimation, Confidence interval estimation. Confidence limits of a difference between means.
4. **The Relationship Between Variables:** Correlation, linear regression, the 'least squares' regression line, test for linearity of a regression, confidence limits of regression coefficient.
5. **Tests of Significance:** The t test, the t test in paired experiments, the t test in non-paired experiments, selection of the appropriate method of calculating t. Categorical data, the chi-square ($\chi 2$) test, The 1 x n table, The 2 x n table, the use of x2

with occurrence nonoccurrence data, x2 analysis of a 2 x 2 or four fold table, alternate methods of calculating x2, test of significance when cell frequencies are small. The F test.

6. **Analysis of Variance**: Single classification data with subgroups. Analysis of variance: Multiple classification data, Duncan's multiple range test, least significant difference test; The relationship between t and F;
7. **Experimental Design:** Principles of experimental design, Completely randomized design, Randomized block design, Latin Square Design, Matched pair design. Factorial design.

Recommended Books:

1. J.M.A. Hannan. Medical. And Pharmaceutical Statistics. 2007, Parash Pulishers, Dhaka 1205, Bangladesh.
2. Manning A: The Elements of Biometry.
3. Jerrold H. Zar: Biostatistical Analysis
4. Biostatistics: Daniel.

Practical Courses and Field Work

BGE 211 Plant and Animal Breeding Laboratory 2 Credits

A. Plant breeding:

1. Floral biology in self and cross pollinated species
2. Selfing and crossing techniques
3. Selection methods in segregating populations and evaluation of breeding material
4. Analysis of variance (ANOVA)
5. Estimation of heritability and genetic advance
6. Maintenance of experimental records
7. Learning techniques in hybrid seed production using male-sterility in field crops

B. Animal breeding:

1. Preparation of Animal cell culture media and sterilization
2. Organ culture and fibroblast culture
3. Live cell count
4. Synchronization and superovulation protocols.
5. Collection of embryos using non-surgical procedures.
6. Embryo freezing protocols.
7. In vitro fertilization protocols.

BGE 212 Instrumentation in Biotechnology Laboratory 2 Credits

1. Sterilization: principles & operations - Autoclave,Hot Air Oven, Filtration, Laminar Air Flow
2. Principles & operations of Incubators & Shakers
3. Principle & operation of Centrifuge
4. Principle & operation of pH meter
5. Principle & operation of Colorimeter
6. Principle & operation of Spectrophotometer
7. Electrophoresis

BGE 213 Metabolism Laboratory 2 Credits

1. Extracellular enzymatic activities of microorganisms
2. Carbohydrate fermentation
3. TSI test
4. IMViC test
5. Hydrogen sulfide test
6. Urease test
7. Nitrate reduction test
8. Catalase test
9. Oxidase test
10. Utilization of amino acids
11. Identification of unknown bacterial cultures

BGE 214 Computer Basics and ICT for Biotechnologists 2 Credits

Introduction to Computer Systems: Types of computer, application areas, concept of CPU, keyboard, mouse, hard disk. Windows and the like peripheral, working principles of computer systems.

Hardware and Software: Organization and structure motherboard and microprocessor system, memory and other devices, classification of software's importance, components, basic functions. DOS, Windows, Unix, Linux etc.

File Management and Word Processing: Concept of file and folder, creation of file, saving, editing and deleting file/ document. File copy, file move, layout, formatting, page setup and printing, tables and graphs etc.

Spreadsheet analysis: Mathematical and statistical function: frequency, standard deviation, variance, mean, medium, line, bar, pie graph, correlation, regression etc. Creating and formatting chart, printing sheet, problem solving using formulas, data consolidation.

Power Point Presentation: Preparation of slides, tables, graphs, editing, copying.

Database: Concept of field, record, table, database and database management system. Creating and adding information to a database, editing and viewing the data, designing and viewing/ printing reports, understanding sorting and indexing.

Introduction to ICT: Computer networking, basic concept of LAN, MAN and WAN; email and www. How to use a search engine.

Computer Maintenance and Security: Power supply, stability, grounding, handling and protection. Protecting privacy and data; Ergonomics. Computer viruses and troubleshooting.

Programming with Visual Tools: Basic methods, object, method, event, event-driven programming. Working with forms, basic active control, text box control, list-box control, command button, MS Flex grid control. Visual basic language, variable, constants, arrays, collections, procedures, subroutines, functions, calling procedures, arguments, control flow statements, if---then, if—then---else, select case. Loop statements: Do loop, for…next, nested control structures, the exit statement.

Programming with C/C++: Constants, variables, data types, operators, expression, input and output operations, branching, looping, arrays, pointer, functions, structures and union, files, dynamic memory allocation.

Database Programming: database, DBMS, relational concepts, keys, referential integrity, introduction SQL, basic structure, joins, attaching queries to a database, the data control, advanced data bound controls, the ADO data control, entering data, accessing fields in record sets.

HTML and front page

Applications: Introduction and applications of WINBOT, BLAST, PDB, Perl and Linux programs.

Recommended Books:

1. Peter Norton, Introduction to Computers.
2. Sarah E. Hutchinson and Stacey C Sawyer, Computer and Information Systems.

Part –III (3rd Year, Examination of 2013, 2014 and 2015)

BGE 301 **Microbial Genetics** **3 Credits**

1. **Introduction:** History, relevance in Biotechnology
2. **The genetics of Bacteria:** Genetic Exchange in bacteria: an overview; Mutant phenotypes in bacteria; Evolutionary significance of parasexuality in bacteria.
3. **Transformation***:* Competence, uptake of DNA, transfection. Artificially induced competence. DNA transfer by electroporation.
4. **Conjugation:** Mechanism of conjugation, F and F like plasmids, tra-operon, sex pilli, formation of Hfr strain, transfer of non-conjugative plasmid by conjugative plasmid, plasmid mobilization, chromosome transfer by F cultures of E. coli k-12, Conjugation in other bacteria;
5. **Transduction:** Generalized transduction, experimental evidence, origin of generalized transducing phages. Genetic mapping by different transductant classes. Specialized transduction, experimental evidence, and origin of specialized transducing phage particle.
6. **Recombination:** types of recombination; molecular basis of homologous, non-homologous recombination and Site-specific recombination
7. **Plasmids:** Introduction. Basic features; Size and copy number; 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. Plasmids in organisms other than bacteria.
8. **The genetics of Viruses:** The discovery and origin of viruses; Mapping the bacteriophage genome; T4: A circular genetic map but a linear chromosome; Genes-within-genes: øX174; HIV: a Eukaryotic Virus: HIV structure, life cycle, Genome and course of infection.
9. **The genetics of Fungi:** Alteration of generation study of *Aspergilus nidulans*, *Neurospora crassa* and yeast.

Recommended Books:

1. Molecular Genetics of Bacteria: Dale and Park. John Wiley & Sons Ltd,
2. Principles of Genetics. Gardner, E. J., Simmons, M.J. and D.P. Snustad. 8th Edition. John Wiley and Sons Inc. Singapore, NY. (1997).
3. Molecular Genetics of Bacteria: Jeremy W Dale and Simon F Park. Fourth Edition. John Wiley and Sons.
4. Benjamin Lewin: Gene IX. Ninth Edition. Jones and Bartlett Publishers.
5. Lehninger Principles of Biochemistry. Nelson and Cox. W. H. Freeman.
6. Molecular Biology of the Gene. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Sixth Edition. Benjamin Cummings.
7. Molecular Biology. David Freifelder. Second Edition. Jones and Barlett Publishers.
8. Cells: Principles of Molecular Structure and Function. David M. Prescott. Jones and Barlett Publishers.

BGE 302 **Environmental Biotechnology** **3 credits**

1. **Introduction:** concept of water cycle, carbon cycle, nitrogen cycle, sulphur cycle**,** other biogeochemical cycles.
2. **VBNC Organisms:** Concept of VBNC, recent advances in molecular genetics methods for VBNC detection in environment and its implication in environment and health. Isolation and enrichment of microorganisms capable of detoxifying environmental pollutants: environmental and genetic approaches.
3. **Environmental pollution & biotechnological control:** Pollution of air, water and soil and their mitigation by biotechnological means- use of commercial blends of microorganisms and enzymes in pollution control, immobilized cells in pollution control, novel biotechnological approaches like use of genetic manipulation, enzymes and specialized bacteria.

4. **Recalcitrant molecules in the environment and control**: Types of recalcitrant molecules, Characterization of microbial activity and biodegradation of recalcitrant substances including pesticides in soil; Persistence and biomagnification of xenobiotic molecules.
5. **Biodegradation:** Concept, application, biodegradation and metabolism of chemical pesticides, phenols, dyes, petrochemicals.
6. **Bioremediation:** Heavy metal pollution, metal bioavailability in the environment, mechanisms of microbial metal resistance and detoxification, effects of metal-microbes interaction. Approaches to bioremediation- environmental modification for bioremediation, microbial seeding and bioengineering approaches, DNA and RNA based methods.
7. **Biotechnological approaches of industrial waste management:** Industrial wastewater/toxic effluents and their physical, chemical & biological treatment, ETP.
8. **Bioleaching:** Definition, Application, Example Cu-bioleaching, Prospect: Au-Bioleaching
9. **Biosensor:** principle, transducers, biocomponent of biosensor, application of enzyme based and organelle-based biosensors, affinity binding assay, biological reactant pairs, application of immunosensor and receptor based sensor.

Recommended Books:

1. Microbial Ecology: Fundamentals and Applications. Atlas and Bartha. Fourth Edition. Benjamin Cummings Publishers.
2. Biotechnology and Environment. Trivedi, R N, Yadav, Seema. Anmol Publications.
3. A Textbook of Environmental Chemistry and Pollution Control. Dogra S S. Swastik Publishers.
4. Environmental Biotechnology. Young, M.M., 1997. Elsevier Pub. Ltd. Netherlands.
5. Environment and Biotechnology. Sohal, M.S., 1994. Ashish Publishing House, New Delhi.
6. Introduction to Environmental Engineering- Davis, M.L., and D.A. Cornwell, 1991. Second edition, McGraw-Hill Inc.
7. Food Processing and Waste Management, Green. J.H., 1979. AVI Pub. Co. Inc. Westport.
8. Comprehensive Biotechnology. Moo-Young, M. M, 1985. Pergamon Press Ltd. Oxford, England.
9. Microbial Biotechnology: Fundamentals of Applied Microbiology. Glazer AN and Nakaido H. Second Edition. Cambridge University Press.
10. Wise DL. Biotreatment Systems. Vol 2. CRC Press.
11. Molecular Approaches to Environmental Microbiology- Pickup RW and Saunders IJR. Ellis Horwood.
12. Microbial Ecology- A Conceptual Approach. Lynch JM and Poole. Wiley.
13. Environmental Biotechnology- Alan Scragg. Pearson Education Limited, England.
14. Environmental Biotechnology by S.N. Jogdand. Himalaya Publishing House. Bombay
15. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata Mc Graw Hill, NewDelhi
16. Environmental chemistry by A.K. De Wiley Eastern Ltd. NewDelhi.
17. Introduction to Biodeterioration by D. Allsopp and k.J. Seal, ELBS/Edward Arnold

BGE 303 Immunology 3 Credits

1. **Introduction to Immunology:** Components of immune system; Types of immunity - Humoral and cell mediated immunity, innate and adaptive immunity; Features of immune response: memory, specificity and recognition of self and non-self; Chemotaxis, inflammation; Lymphoid systems: primary and secondary lymphoid organs.
2. **Cells Involved in Immune Response:** T cells, B cells, natural killer cells, antigen presenting cells; Polymorphonuclear granulocytes: neutrophils, eosinophils, basophiles; Platelets; Mast cells and it's triggering.
3. **Innate Immunity: Phagocytosis;** Process of phagocytosis; **Complement systems**; biological functions
4. **Acquired Immunity:** Antibodies; Immunoglobulin structure; Memory B-cells and its development; Monoclonal antibodies. **Antigens:** General properties of antigen; Antigenic determinants; Haptens.
5. **Membrane Receptor of Antigens:** B cell surface receptors for antigens; T-cell receptors (TCR), Major Histocompatibility Complex (MHC); Antigenic structure and functions of MHC: class-I and class-II molecules, Gene map of MHC antigens; Processing and presentation of peptides by MHC molecules;
6. **Lymphocyte Activation:** Antigen recognition; Antigen-antibody interaction; Interaction of T lymphocytes and APCs; signals for T cell activation, B cell response to thymus dependent and independent antigen; B cell activation by surface Antigen and T cells. Haplotype restriction of T cell reactivity; Pattern of cell migration and inflammation and their control.
7. **Effector Molecules:** Cytokines; origin, source and effector function; Cytokine action and network interaction.
8. **Complement**: Activities of complement proteins, activation of complement, classical pathway, regulation of classical pathway activation, alternative pathway activation and amplification loop, their regulation, membrane attack complex, and biological effects of complement
9. **Immunoglobulin Genetics:** Distribution and function of different classes and subclasses of immunoglobulins; Genetic basis of antibody heterogenecity, generation of antibody diversity; Antibody class switching.
10. **Immunity to Infection:** Immunity against intracellular and extracellular bacteria, viral infection, parasitic infections and evasive strategies by the pathogens.

Recommended Books:

1. Immunology- David Male, Jonathan Brostoff, David B. Roth and Ivan M. Roitt. Seventh Edition. Elsevier.
2. Essential Immunology- Ivan M. Roitt and Peter J. Delves. Tenth Edition. Blackwell Publishing.
3. Advanced Immunology- David Male, Anne Cooke, Michael Owen, John Trowsdale, Brian Champion. Third Edition. Mosby.
4. Textbook of Immunology – T.J Barrett. Fifth Edition. Mosby.
5. Immunology: An introduction – I.R Tizard. Fourth Edition. Brooks Cole.

BGE 304 Advanced Molecular Biology 3 Credits

1. **Introduction:** Concept of gene, gene expression, definition and example.
2. **Control of Gene Expression in Prokaryotes:** Constitutive, inducible and repressible gene expression; Positive and negative control of gene expression; Operons; Lac Operon, Trp operon; Positive and negative control of the operon, Transcription Factors, Translational and Post-translational control. Attenuation and anti-termination, Cis-acting regulatory elements, Trans-acting regulatory factors,
3. **Control of Gene Expression in Eukaryotes:** Spatial and Temporal regulation of eukaryotic genes; Ways of regulating eukaryotic genes; Molecular control of transcription in eukaryotes; Activation and inactivation of chromosomes,

4. **Mutation:** Source of the genetic variability required for evolution; Basic features of mutation; mutation rate; types of mutations; Phenotypic effects of mutation, The molecular basis of mutation; Basic Features of mutation process; Phenotypic effects of mutation; detection of mutations; Chemicals for mutagenicity; molecular basis of mutagenesis; mutations induced by chemical and radiations.
5. **DNA repair mechanisms:** nature of DNA damage; light dependent repair; excision repair; mismatch repair; post-replication repair; error prone repair system; SOS repair. Inherited Human diseases with defects in DNA repair;
6. **Transposable genetic elements:** transposable elements in prokaryotes; IS elements, composite transposons, Tn3 elements, mutagenic effect of bacterial transposable elements; the medical significance of bacterial transposons; transposable elements in Eukaryotes: Ac, D_s and D_t elements, Maize, P. elements and hybrid degeneracy in drosophila

Recommended Books:

1. Essential Cell Biology. Bruce Alberts, D. Bray, K. Hopkin, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter 2003. Second Ed. Garland Science.
2. Molecular Biology of Cell. Bruce Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, J. D. Watson, 2002. Fourth Ed. Garland Science.
3. Genes VI and VII. Benjamin and Lewin, 1997. Sixth Edition. Oxford University Press.
4. Molecular Biology of the Gene. Watson, J.D. and Hopkins, A.M., Roberts, J.W., Steitz, J.A. and Weiner, A.M., 1988. Benjamin/Cummings Scientific Publishing, Menlo Park, California.
5. Lehninger Principle of Biochemistry, David L. Nelson, Michael M. Cox, 2004. 4th edition, W.H. Freeman.
6. Genomes. Brown, T. A. 2002.Second Edition. BIOS Scientific Publishers Ltd.
7. Principles of Genetics Snustad, D.P. Simmons, M.J. and Jenkins, J.B., 1997. Jacaranda/Wiely pub.
8. Concepts of Genetics. Klung, W.S. and Cummings, M.R., Scott, 1980. Foresman and Co. USA.

BGE 305 Fermentation and Bioprocess Technology 3 Credits

1. **Introduction:** Definition, scope and importance of fermentation technology, range of fermentation processes, Chronological development of fermentation industry, Component parts of fermentation industry.
2. **Kinetics of cell growth:** Unstructured kinetic models for microbial growth, Monod model, Product formation kinetics, Different modes of cultivation systems, Batch, Continuous and Fed batch, Introduction to structured models for growth and product formation,
3. **Introduction to fermentation processes:** Overview of fermentation industry, Microbial Fermentation, Bioreactors for Plant Cell Tissue and Organ Cultures.
4. **Requirements of a fermentation process:** Fermentation media, Types of fermentation media, Effect of nutrient concentration on growth rate, Design and optimization of media by response surface methodology, oxygen requirements of microbial growth, mass transfer and determination of Kla, Factors affecting Kla.
5. **Sterilization:** Thermal death kinetics of microorganisms, Batch and continuous heat, Sterilization of liquid media, Filter sterilization of liquid media, Air sterilization, Design of sterilization equipment.
6. **Stoichiometry of cell growth and product formation:** Elemental balances, Degrees of reduction of substrate and biomass, Yield coefficients of biomass and product formation, Maintenance coefficients, Oxygen consumption and heat evolution in aerobic cultures
7. **Configuration of bioreactor and ancillaries**: Control of pH, temperature, dissolved oxygen and other environmental parameters, Agitation.
8. **Fermenter Design:** Introduction, Equipment and Space Requirements, General Design Data, Continuous Sterilizers, Fermenter Cooling, The Design of Large Fermenters (Based on Aeration), Trouble Shooting in a Fermentation Plant

Recommended Books:

1. H. C. Vogel, C. C. Haber. Fermentation and Biochemical Engineering Handbook, 2nd Ed. Principles, Process Design and Equipment. Noyes Publications, New Jersey, U.S.
2. J. E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn., McGraw Hill Publishers, 1986.
3. M. L. Shuler and F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall, 2004.
4. P. M. Doran, Bioprocess Engineering Principles, 2nd Edition, Academic Press, 2005.
5. P. F. Stanbury, S. J. Hall, and A. Whitaker, Principles of Fermentation Technology, 2nd Edn., Elsevier, Science & Technology Books, 2005.
6. J. M. Lee, Biochemical Engineering, 1st Edn., Prentice Hall, 1991.

BGE 306 Developmental Biology 2 Credits

1. **Introduction:** Origin and history of development, Basic anatomical feature, Regulation of the program of development, Developmental decisions of cell/cell fate, Positional values.
2. **The cell cycle and programmed cell death**: Cell cycle overview; Components of cell cycle control system; Intracellular control of cell cycle events; Programmed cell death/ Apoptosis; Extracellular control of cell division, cell growth, apoptosis.
3. **Early embryonic development:** Early embryonic development of Drosophila, Axis formation: Anterior/posterior patterning of Drosophila, Genes responsible for early development of Drosophila, Early embryonic development of Xenopus, Axis formation : Anterior/posterior patterning in amphibians, Genes responsible for early development of Xenopus
4. **Axial patterning:** Axis formation in amphibians. Anterior/posterior patterning in *Drosophila* (material effect genes). Anterior/posterior patterning in *Drosophila* (segmentation genes), *Hox* genes, Anterior/posterior patterning in amphibians.
5. **Later embryonic developments:** Patterning the central nervous system. Ectoderm-eye-development, Ectoderm-epidermis and hair development. Ectoderm-neural crest development, Ectoderm-tooth development and axon guidance. Mesoderm-somites formation. Mesoderm-muscle and bone development, Mesoderm-Kidney development. Mesoderm-heart and vessels development. Mesoderm-limb formation: Endoderm; Heamatopoiesis.
6. **Post-embryonic development:** Sex determination (Drosophila) and X-inactivation, Sex determination-mammals, Regeneration, Environmental Regulation of development.
7. **Specialized Tissues, Stem Cells and Tissue Renewal:** Definition, Kinds of Stem Cell, Renewal of Epidermis, Blood, other part of body by Stem cells, Stem Cell Engineering, Novel theory about Stem cell

Recommended Books:

1. Molecular Biology of the Cell. Alberts, B. Bray, D. Lewis, J., 1989. Garland Publishing, Inc. NY.
2. Developmental biology. Scott F. Gilbert 2003. Sinauer Associates Inc. USA
3. Molecular Cell Biology. Darn ell, J., Lodesh, H. and Baltimore, D. 1986. W.H. and Company, NY.

BGE 307 Metabolism - II 2 Credits

1. **Amino acid metabolism:** types of amino acids, deamination, urea cycle, amino acid biosynthetic precursors; the glutamate or ketoglutarate family; the aspartate and pyruvate families; the serine-glycine family; aromatic amino acids; regulation of amino acid biosynthesis.
2. **Lipid metabolism:** fatty acid oxidation and biosynthesis, role of cofactors in fatty acid biosynthesis; regulation of fatty acid metabolism; biosynthesis of triacylglecerol, phospholipid, mevalonate, squalene, cholesterol and wax.
3. **Nucleotide metabolism:** synthesis of purine and pyrimidine nucleotides, formation of deoxyribonucleotides , degradation of purines and recycle of purines pyrimidines, regulation of purine and pyrimidine biosynthesis
4. **Biological nitrogen fixation**: inorganic nitrogen metabolism; assimilation of inorganic nitrogen; fermentation of nitrogenous compounds; regulation of biological nitrogen fixation.
5. **Autotrophic CO_2 Fixation**: mechanisms of photosynthesis in green, sulphur, and cyanobacteria; physiological groups of aerobic chemolithotrophs, hydrogen and CO oxidizers; facultative obligate chemolithotrophs.

Recommended Books:

1. Microbial Physiology. A.G Moat, J.F Foster and Michael P. Specter. Fourth Edition. John Wiley & Sons Inc.
2. Bacterial Metabolism. G. Gottschalk. Second Edition. Springer. ISBN-13: 978-0387961538
3. Bacterial Physiology and Metabolism. Byung H. Kim and Geoffrey M. Gadd. Cambridge University Press. ISBN-13 978-0-521-71230-9
4. Lehninger Principles of Biochemistry (4th edition). Nelson and Cox. W. H. Freeman. ISBN-13: 978-0716743392

BGE 308 Analytical Methods in Biotechnology 2 Credits

1. **Spectroscopic Techniques:** Spectrum, visible, ultraviolet and infrared spectrophotometers, spectrofluorimetry, luminometry, NMR, mass spectrometry
2. **Centrifugation Techniques:** Principle of sedimentation, centrifuges and their use, density gradient centrifugation and ultracentrifuge
3. **Chromatographic Techniques:** Principle of chromatography, column, thin-layer and paper chromatography, adsorption, gas-liquid, ion exchange, exclusion, affinity and high performance liquid chromatography.
4. **Techniques for detecting Protein, DNA and RNA:** SDS PAGE, Western blot, protein sequencing, Physico-chemical properties of DNA such as T_m value, Cot value, different conformations of DNA hybridization kinetics, DNA-DNA & DNA-RNA hybridization, DNA and RNA isolation and purification, quantification; fractionation of RNA; electrophoresis southern and Northern blot.

Recommended Books:

1. Molecular Genetics of Bacteria: Dale and Park. John Wiley & Sons Ltd,
2. Katoch, Rajan. Analytical Techniques in Biochemistry and Molecular Biology. Springer. Germany
3. Ahindra Nag. Analytical Techniques In Agriculture, Biotechnology And Environmental Engineering. Prentice-Hall. India

BGE 309 Biosafety, Ethics and Regulations in Biotechnology 2 Credits

1. **Introduction:** Concepts of biosafety and ethical issues
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 (labeling).
7. **Genetically modified foods:** Benefits and Risks, Regulations and public acceptance
8. **Regulations:** Cartagena Protocol, Biosafety regulations to protect nature, growers and consumers interest and national interest. Biosafety guidelines of Bangladesh

Recommended 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 Environment: 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 310 Bioinformatics 3 credits

1. **Introduction and Overview:** Definition, goal, history and scope of Bioinformatics, Major areas of applications and limitations.
2. **Databases:** Definition, types of databases, Major databases, pitfalls of biological databases, sequence retrieval from biological database, global bioinformatics centers and servers
3. **Alignment of DNA and Protein Sequences:** Pairwise sequence alignment, sequence similarity versus sequence identity, alignment methods, scoring matrices, statistical significance of sequence alignment, database similarity searching, exhaustive algorithms, heuristic algorithms, Dynamic Programming, Basic Local Alignment Search Tool (BLAST), FASTA, Multiple Sequence Alignment, ClustalW/ ClustalX, position-specific scoring matrices, profiles, markov model and hidden markov models.
4. **Prediction of RNA Secondary Structure:** basics, features of RNA secondary structure, limitations of prediction, various prediction methods: minimum free energy method, suboptimal structure prediction by MFOLD, using sequence co-variation to predict structure, stochastic context-free grammars for modeling RNA secondary structure, searching genomes for RNA splicing genes, applications of RNA structure modeling.
5. **Phylogenetic Prediction:** relationship of phylogenetic analysis to alignments, the concepts of evolutionary trees, various methods: Maximum parsimony method, Distance methods, the maximum likelihood approach, sequence alignment based on evolutionary model, reliability of phylogenetic predictions, complications from phylogenetic analysis
6. **Gene Prediction:** microbial genomes, eukaryotes, evaluation of prediction, promoter prediction in pro- and eukaryotes, categories of gene prediction programs, prediction algorithms
7. **Protein Structure Prediction:** Protein structure basics, amino acids, peptide formation, dihedral angles, hierarchy, secondary structures, tertiary structures, review of terminology, methods: viewing protein structures, protein structure classification databases, alignment of protein structures, structural prediction: secondary structure prediction of globular, transmembrane, coiled coil proteins, protein tertiary structure prediction, methods, homology modeling, threading and fold recognition, *Ab initio* protein structural prediction, CASP evaluation, structural modeling, future prospects. Scanning or searching for patterns, motifs, profiles, domains and families, finding post-translational modifications, designing proteins.

Recommended Books:

1. Bioinformatics: Sequence and Genome Analysis. David W. Mount. Cold Spring Harbor Laboratory Press.
2. Essential Bioinformatics. Jin Xiong. Cambridge University Press. 2006.
3. Introduction to Bioinformatics. Arthur M. Lesk. Oxford University Press. 2002.
4. Bioinformatics: From Genomes to Drugs. Edited by Thomas Lengauer. Wiley-VCH. 2002.
5. Lecture Notes on Biological Sequence Analysis. Martin Tompa. 2000.
6. Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis. 2nd Edition. Wiley Interscience. 2002.
7. Bioinformatics Computing. Bryan Bergeron. Prentice Hall PTR. 2002.
8. Blast. Joseph Bedell. Ian Korf, Mark Yandell. O'reilly. 2003.
9. Developing Bioinformatics Computer Skills. Cynthia Gibas, Per Jambeck. O'reilly. 2001.

Practical courses

BGE 311 Techniques in Immunology and Cell Biology 2 Credits

1. Immunological Techniques: Precipitation reactions; Immunodiffusion, Immuno-electrophoresis, Agglutination, co-agglutination and haemagglutination; Complement fixation; Direct and indirect immunofluorescence; Immunoassay; Immunoblotting; Immunoprecipitation; Fluorescence activated cell sorter (FACS); radioimmune assay (RIA), enzyme linked immunosorbent assay (ELISA); immunofluorescence.
2. Antigens, Antibodies and Immunoglobulin: Antibody production, purification of antibody
3. Experiments covering course BGE

BGE 312 Techniques in Molecular Biology 2 Credits

Principles and Techniques: Micropipetting, Bacterial culture techniques, Isolation of individual colonies, Basic concepts of Molecular biology reagents and kits. Basic concepts of spectrophotometry, Gel Electrophoresis and Thermal cycler (PCR). Gel documentation.

Experiments:

1. Isolation of plasmid DNA from bacteria.
2. Isolation of genomic DNA from bacteria.
3. DNA quantification using spectrophotometer.
4. Restriction digestion of plasmid DNA.
5. Gel electrophoresis of RE digested plasmid DNA and analysis.
6. PCR amplification of DNA.
7. Isolation of PCR product DNA from gel.

BGE 313 Bioinformatics Laboratory 2 credits

1. Analyzing Protein, DNA and RNA sequences
2. Sequence alignment
3. Use of GenBank
4. Using Protein and specialized sequence databases
5. Working with single DNA sequence
6. Working with single protein sequences
7. Working with protein 3D structures
8. Working with RNA structures
9. Building phylogenetic trees

BGE 314 **Plant Tissue Culture: Principle and Practice** **2 Credits**

Cell and tissue culture in plants: Introduction to Cell & Tissue Culture, Cell potency (totipotency, pluripotency). Design & setup of tissue culture laboratory, Tissue culture media (Composition and preparation), Types of culture. Role of plant hormones in growth & development of plants. Micro propagation of plants. Hardening, Acclimatization of plants and green house technology.

Practices:

1. Plant tissue culture laboratory design
2. Sterilization of plant materials
3. Medium preparation
4. Establishment of callus culture from different plant explants
5. Establishment of shoot culture through efficient regeneration
6. Isolation of single cells from intact plant organs using mechanical methods.
7. Isolation of single cells from intact plant organs using enzymatic methods.
8. Inducing adventitious shoot and roots.
9. Somatic embryogenesis and plant regeneration.

Part –IV (4th Year, Examination of 2014, 2015 and 2016)

BGE 401 **Genomics and Proteomics** **3 Credits**

1. **Introduction:** The "omes" genome, transcriptome, proteome, metabolome and The rise of 'omics. Organization, structure and mapping of genomes.
2. **Genome Sequences Analysis:** defining genomes, features of human genome sequence, evolution of genomes, genomic identifications, genomic variations. Sequence methods and strategies: Automated sequencing, large scale genomic sequencing, nextgen sequencing, Sequencing and individual variation.
3. **Genome Expression:** DNA microarray. Principle and applications In depth analysis of gene expression. Introduction to gene networks and epigenetic analysis. Next generation Multiplex Assay Technology for genomics. Hybridization principles. Array platforms, Transcript arrays, RNA versus DNA, DNA methylation, In vivo technologies for assessing gene expression, analysis/visualization and issues with imaging. Forward and reverse genetic approaches for studying gene function.
4. **Genomic Circuits in Single Genes:** genomes controlling individual genes, how gene controls location, timing and transcriptome, integrating single gene circuits. Simple integrated circuits, complex integrated circuits, modeling whole-genome circuits.
5. **Overview of proteomics;** Introduction, methods used in proteome analyses:
6. **Protein sequencing:** Protein sequencing by Edman degradation and protein sequence analyses.
7. **Electrophoresis in Proteomics:** 2D Gel Electrophoresis, SDS-polyacrylamide gel electrophoresis, Isoelectric focusing, Spot identification, 2D gel data analysis, Differential in-gel electrophoresis (DIGE), Drawbacks and limitation of 2D gel electrophoresis, Applications of 2D-PAGE.
8. **Mass Spectrometry and Proteomics:** Characterization and identification of proteome using mass spectrometry, MALDI (Matrix-assisted Laser Desorption/Ionization), nESI (nanoelectrospray ionization), (MALDI-TOF (time of flight), Tandem mass spectrometry (MS/MS), Surface enhanced laser desorption ionization (SELDI).
9. **Application of proteomics:** Protein Arrays: Types of protein Arrays, Data analysis, Applications of protein microarrays; Organelle and cellular proteomics; Protein and Enzyme Assays; Next generation multiplex Assay Technology for Proteins. Immunoassay principles. Antibody validation, Particle and bead assays, Biosensors, Plasmon Resonance, Flow Cytometry.

Recommended Books:

BGE 402 **Medical and Pharmaceutical Biotechnology** **3 Credits**

1. **Introduction to Medical & Pharmaceutical Biotechnology:** Biotechnology, Medical & Pharmaceutical Biotechnology, Historical perspective of pharmaceutical biotechnology, Traditional pharmaceuticals of biological origin: Pharmaceuticals of Animal, Plant and Microbial origin- brief study & therapeutic uses.
2. **Sources of Biopharmaceuticals**: Bacteria, yeasts, animal cells, transgenic animals, transgenic plants, Insect-cell based systems, production of final product and analysis of biopharmaceuticals.
3. **Therapeutics based on biotechnology:** Brief study, production & purification, applications of Hormones, Enzymes, Antibiotics, Blood products-Cytokines- Interferons, Interleukins I & II, Tumor Necrosis Factor (TNF), Nucleic acid therapies.
4. **Vaccine Production:** Introduction, Classification of vaccines, Cultivation of virus, Amplification, Harvesting and Assay techniques. Adjuvant technology.
5. **Pharmacodynamics and pharmacokinetics:** Dose-effect relationships, drug receptor theory, mechanism of drug action. Principles of Pharmacokinetics: Biological half-life, Renal clearance, Absorption, Distribution of drugs, Biotransformation and bioavailability of drugs.
6. **Pharmacogenetics and Pharmacogenomics:** Historical perspective Metabolism and transport, Therapeutic response.
7. **Drug Development & Discovery:** Drug discovery, impact of genomics, Proteomics and related technologies upon drug discovery; Transforming new molecular entities into drug, Application of biotechnologies in drug development; Biologic drug development and approval: pre-clinical and clinical trials.
8. **Advanced drug delivery:** Different routes of drug delivery, Basic principles; Controlled and sustained release: Polymer-based drug carriers, Lipid-membrane-based drug carriers: Permeation enhancement; Molecular approaches of drug delivery.
9. **Gene therapy** – Background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, Gene Delivery methods– Viral delivery (Retroviral vectors, Adenoviral and Adeno-associated viral vectors), Non-viral delivery, Antibody engineering, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics. Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases, Circulated gene products, Cancer & Auto-immune diseases.
10. **Synthetic therapy** – synthetic DNAs, therapeutic Ribozymes, synthetic drugs.
11. **Techniques for Good Pharmaceutical Product:** Concept of Good Manufacturing Practice (GMP), manufacturing facilities for biopharmaceuticals, quality control, quality assurance and in-process control in pharmaceutical industry.

Recommended Books:

1. Biopharmaceuticals ; Biochemistry and Biotechnology by Gary Walsh, 2nd Edn., John Wiley 2002.
2. Biotechnology and Biopharmaceuticals by Rodney J.Y. Ho and Milo Gibaldi.
3. Pharmaceutical Microbiology. Edited by- W.B, Hugo & A. D. Russel, 1993.
4. Preservatives in pharmaceutical, food and environment industries. Edited by R.G. Board M.C. Allowodd and .J. G. Bank Blackwell Scientific Publication. 1987.
5. Aan Crommelin, Robert D Sindelar, "Pharmaceutical Biotechnology", Tailor and Francis Publications, New York, 2002.
6. Jay P Rho, Stan G Louie, "Hand book of Pharmaceutical Biotechnology", Pharmaceutical products press, New York, 2003.

BGE 403 Microbial Biotechnology 3 credits

1. **Introduction:** historical development scope and major classes of microbial products and process. Microbes as cell factory
2. **Industrially important microorganisms:** yeast, molds, bacteria and actinomycetes; screening and selection of microorganisms for useful products. Conventional routes to strain improvement, in vivo and in vitro genetic manipulation.
3. **Production of industrial biochemicals:** organic acids, indigo, acetate (vinegar), citrate, lactate, polysaccharides, alginate and amino acids; solvents: alcohol, butanol and acetone; enzymes; antibiotics, steroids. Organic acids, amino acids, alcohols, drugs- antibiotics, steroids, biopolymer, insulin
4. **Biofertilizer:** a) *Rhizobium*: physiology, mass-production, inoculants, quality control, methods of inoculation and agronomic improtance. b) *Azotobacter*: Physiology and fuction, crop response. c) *Azospirillium*: Physiology and function, Inoculant, crop response. d) *Frankia*: Infection and nodule development. e) *Mycorrhizae*: Types, physiology and function, inoculum production and inoculation techniques.
5. **Blue green algae (BGA):** Nitrogen transformations in a low land rice ecosystem; heterocysts-modes of nitrogen fixation in BGA, isolation of BGA, agroclimatic variations; algalization-mass cultivation; multiplication of BGA in the field and effect of inoculation on the yield of rice. Application
6. **Biofuel, Renewable Energy and Biotechnology:** domestic and industrial scale biogas production from waste materials. Biomass fuel, ethanol and methane fermentation; biofuels cells and other bio electrochemical devices.
7. **Immobilized enzyme technology:** principles and benefits, methods of immobilization of enzymes and cells. Applications in biosensor
8. **Recombinant Protein Production in Yeast:** *Saccharomyces cerevisiae* expression systems; *Saccharomyces cerevisiae* vectors.
9. **Strain Improvement:** rational of strain improvement, Improvement of antibiotic producing strains under local conditions, Bacterial cell engineering by protoplast fusion.

Recommended Books:

1. Dubey, R. C. 2004. A text Book of Biotechnology. S. Chand & Co. Ltd. New Delhi-110055
2. Gary Stacey, Robert H. Burris and Harold J. Evans (1997). Biological Nitrogen Fixation. First Indian edition, CBS Publishers & Distributors, New Delhi, India.
3. Klass, Donald E., Emert, George 11, 1981.Fuels from Biomass and Waste. Ann Arbor Science Pub. Ins. USA.
4. Mital, K. M. 1996.Biomass System-Principles and applications. New Age international (P) Ltd. India
5. Postagate J. R. (1982). The Fundamentals on Nitrogen Fixation. First Edition, Cambridge University Press, Cambridge CB21RP
6. Principles of Gene Manipulation--R.W Old & Primrose.
7. Molecular biology of the Gene-Watson, Hopkins Roberts, Steitz and Weiner.
8. Brock, T.D., Madigan, M.T., Martinco, J.M. and Parker, J., 1990. Biology of Microorganism.
10. Hardy, K.M., 1986. Bacterial Plasmid. Published by American Society of Microbiology.

BGE 404 Animal Biotechnology 3 Credits

1. **Introduction:** History, scope and application of animal biotechnology.
2. **Media used for Animal Cell Culture:** Media composition, media preparation and sterilization.
3. **Culture of Animal cells:** Major Basics for animal cell culture, cell culture environment, required media and reagents, Culture of Mammalian cells, Tissues and Organs, Common cell culture contaminants.
4. **Culture of specific cell type:** Primary culture, Secondary culture, Suspension cultures, Development of continuous cell lines, Characterization and Maintenance of cell lines, Commercial Scale Production of Animal cells.
5. A**pplication of animal cell culture**: Application for *in vitro* testing of drugs, Application in production of pharmaceutical products; Hybridoma technology; Phage display technology for production of antibodies; Commercial scale production of diagnostic antigens and antisera.
6. **Transgenesis:** Classic transgenic mice - History, Production and Use for biomedical research such as Immunology, Neurobiology and Oncogenesis.
7. **Transgenic animals:** Transgenic manipulation of animal embryos and gene knockout technologies; Methods for production of transgenic animals for a) pharmaceutical use, b) improving desired characteristics of domestic animals and c) production of animal models for human or animal disease.
8. **Animal Cloning:** Animal viral vectors; Animal Cloning basic concept; Cloning from- Embryonic cells and Adult cells; Characterization of embryonic stem cells; Different applications of embryonic stem cells; Cloning of different animals; Cloning for conservation of endangered species; ethical, social and moral issues related to cloning.

Recommended Books:

1. Freshney RI. 2005. Culture of Animal Cells. Wiley Liss.
2. Portner R. 2007. Animal Cell Biotechnology. Humana Press.
3. Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.
4. Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

BGE 405 Plant Biotechnology 3 Credits

1. **Introduction**: Definition, concept of plant biotechnology, history and origin of plant biotechnology, scope, plant genome and its organization, tools of plant genetic engineering, application of biotechnological methods for plant development, cryopreservation.
2. **Plant Tissue culture**: Secondary metabolites, types of suspension culture, biotransformation, cell suspension protocols, applications. Haploid production: Significance and uses of haploids, androgenesis, anther culture, microspore culture, gynogenesis, anther culture protocols.

3. **Protoplast culture and fusion**: Isolation of protoplast, protoplast development, somatic hybridization, cybrids, potentiality problems and limitations of somatic hybridization, protocol for protoplast isolation and fusion, somaclonal variation.
4. **Transgenesis in plants**: Gene transformation mechanism, gene transfer in plants, gene transfer through vectors: Biology of vectors used - Ti and Ri plasmids, binary vectors, viral vectors; cloning strategy and method of gene transfer; Vector less gene transfer: electroporation and gene gun method. DNA bar coding, Ti -plasmid, organization of Ti- plasmid, transfer of T-DNA in to host genome, advantage and disadvantages of A*grobacterium* mediated gene transfer, binary vectors, co-integrative vector.
5. **Transgenic Plants:** Transgenic plants for crop improvement, monocot system, dicot system, advantages and disadvantages of monocot and dicot system, development of resistance plants to biotic stress (insect resistance, virus resistant, disease resistant), resistant to abiotic stress, herbicide resistance, applications of transgenic plants. Detection of transgenes by molecular techniques, artificial seeds, encapsulation
6. **Molecular Farming and GM Crops:** Future Prospects, Introduction-carbohydrates and lipids production-molecular farming of proteins-economic considerations for molecular farming.GM crops-current status-concerns about GM crops- regulations of GM crops and products-Greener genetic engineering.

Recommended Books:

1. R.C Dubey: A Text book of Biotechnology
2. H.S Chawla: Introduction to Plant Biotechnology
3. Gilmartin and Bowler: Molecular Plant Biology: A practical approach (Vol. I and II).
4. Mantel and Smith: Plant Biotechnology

BGE 406 Cell Signaling 3 Credits

1. **General Principles of Cell signaling:** Extracellular signaling molecules and other receptors, Operation of signaling molecules over various distances, Sharing of signal information, Cellular response to specific combinations of extracellular signal molecules; Different response by different cells to same extracellular signal molecules, NO signaling by binding to an enzyme inside target cell, Nuclear receptor; Ion channel linked, G-protein linked and enzyme linked receptors; Relay of signal by activated cell surface receptors via intracellular signaling molecules., Intracellular signaling proteins as molecular switches, Interaction between modular binding domain and signaling proteins, Remembering the effect of some signal by cells.
2. **Signaling Through G-protein-linked Cell Surface Receptors:** Disassembly of G-proteins to relay signals from G-protein linked receptors, cAMP and G-protein signaling, role of c-AMP dependent protein kinase in mediating effects of cAMP, Inositol phospholipids signaling pathway, Ca^{2+} as a intracellular messengers, role of Ca^{2+} / Calmodulin-dependent kinase in mediating actions of Ca^{2+}, Regulation of ion channels by G-proteins, Amplification and extracellular signals by intracellular mediators and enzymatic cascade, desensitization of G-protein linked receptors.
3. **Signaling Through Enzyme Linked Cell Surface Receptors:** Receptor tyrosine kinases, docking sits for proteins, Activation of Ras, Ras cycles between Ras to a cascade of protein kinases including MAP-kinases, PI3-kinase/protein kinase B signaling pathway, Insulin receptor acts through PI3-kinase pathway, Cytokine receptors and the JAK-STAT pathway, Two component signaling pathway of bacterial chemotaxis.
4. **Signaling Pathways That Depends on Regulated Proteolysis:** Activation of Notch receptor by cleavage, binding of WNT proteins to Frizzled receptors, stressful and proinflammatory stimuli act through NFκB-dependant signaling pathway.
5. **TGFα Signaling Receptors:** Activated type ITGα receptors phosphorylate Smad transcription factors, Smad signaling via negative feedback loop, TGFα signaling and abnormal cell proliferation.
6. **Environmental Approaches of Signal Induced responses:** Evolutionary conservation and proliferation of genes encoding signals and regulators, detection of transcription changes by in situ hybridization, Protein microarrays for monitoring cell responses, Regulation of glycogenolysis by multiple second messengers, Cellular response by oxygen deprivation.
7. **Apoptosis:** TRAIL, Mitochondria, apoptosis and ageing.

Recommended Books:

1. Darnell, J., Lodish H. And Baltimore, D. 1986. Molecular Cell Biology, W.H. Freeman and Company, New York.
2. Alberts B. Bray, D. Lewis, J., 1989. Molecular Biology of The Cell. Garland Publishing Inc. New York.
3. DNA cloning 1 and 2. Glover, D.M. and Hames, B.D. 1995. IRL Press (Oxford University Press, USA).
4. Molecular Biology of the Cell (4th edition). Alberts, Johnson, Lewis, Raff, Roberts and Walter.
5. Molecular Cell Biology (5th edition). Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipersky and Darnell.
6. Lehninger Principles of Biochemistry (4th edition). Nelson and Cox. W. H. Freeman. ISBN-13: 978-0716743392

BGE 407 Genetic Engineering 3 Credits

1. **Introduction:** History and milestones in Genetic Engineering. Importance of PCR in gene cloning. Genetic engineering guidelines.
2. **Tools for Genetic Engineering:**
   A. DNA Manipulative Enzymes: Restriction endonulceases and other nucleases, ligases; polymerases; DNA modifying enzymes.
   B. Cloning Vectors: cloning vectors for prokaryotes: bacteriophages M13, bacteriophage lambda; plasmid pBR322, plasmid pBR325, pUC119, cosmids, fosmids, phagemids, and charomid, Bacterial Artificial chromosomes (BACs), cloning vectors for eukaryotes organisms: yeast-episomal plasmid (2 um circle), yeast artificial chromosome (YAC).
3. **Gene Cloning:** Cloning Strategies, cloning of genomic DNA, cDNA synthesis and cloning, cDNA library; screening strategies. Alternative Strategies of Gene Cloning: Cloning interacting genes- Two-and three hybrid systems, cloning differentially expressed genes. Site-directed Mutagenesis and Protein Engineering
4. **Ligation Systems:** blunt end ligation; sticky-end ligation; putting sticky ends on to a blunt-ended molecules: homopolymer tailing, use of linkers and adaptors.
5. **Introduction of rDNA into Living Cells:** transformation of bacterial cells and selection/ identification of recombinants; introduction of phage DNA into bacterial cells and selection of recombinant phage; transformation of non-bacterial cells.
6. **Cloned gene selection:** The problem of selection; Methods for clone identification; chromosome walking; sequence confirmation by DNA sequencing

7. **Cloned Gene Expression:** requirements for gene expression; expression vectors; transcript of a cloned gene; regulation of gene expression; identifying and studying the translation product of cloned gene. Expression Strategies for Heterologous Genes: Vector engineering and codon optimization, host engineering, *In vitro* transcription and translation, expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants.

Recommended Books:

1. Principles of Gene Manipulation--R.W Old & Primrose.
2. Molecular biology of the Gene-Watson, Hopkins Roberts, Steitz and Weiner.
3. Genetic Engineering-- Kingsman & Kingsman.
4. Principles of genetics- D.P Snustad, M.J Simmon & J.B Jenkins.
5. Gene Cloning --An Introduction-- T.A Brown.
6. Suzuki, Griffith and Miller, 1986. Introduction to Genetic Analysis. W.H. freeman and Co. USA.
7. Brock, T.D., Madigan, M.T., Martinco, J.M. and Parker, J., 1990. Biology of Microorganism.
8. Hardy, K.M., 1986. Bacterial Plasmid. Published by American Society of Microbiology.
9. Avers, C.J., 1990. Genetics. Freeman and Co. NY.
10. Strickberger, M.W., 1990. Genetics. Macmillan pub. Co. NY.

BGE 408 Molecular Diagnostics 2 credits

1. Introduction: Concepts of molecular diagnostics
2. Variable number of tandem repeats/ minisattellite sequences, Short tandem repeats/ microsattellite sequences, polymorphism of some genetic locus in relation to disease (HLA, APO and ACE gene).
3. Hybridization based DNA fingerprinting (RFLPs)- radioactive method, fluorescent method, chemiluminsescent method.
4. PCR-based Diagnostics: DNA fingerprinting, HCV RNA, HCV genotyping, HBV DNA, MTB DNA
5. Single locus and multi-locus DNA fingerprinting
6. Isolation of DNA from whole blood, soft tissues, semen stains and swabs, bone, plant material
7. Application of DNA fingerprinting- criminal investigation (personal identification), immigration, paternity dispute, identification of missing baby, bodies found in plane crash & road accident, varietal identification of plants.
8. Diagnosis of cystic fibrosis by multiple PCR clinical implications, abnormal mucus clearance from the respiratory tract with frequent infections, pancreatic insufficiency, abnormal salt transport, infertility in males.
9. Detection of ß-thalassemia mutation using ARMS, PCR clinical implication, anemia (red cell deficiency).
10. Detection of fragile X syndrome by FMR-I gene trinucleotide repeat analysis clinical implications, mental retardation, long faces, large ear, prominent jaws, post-pubertal macroorchidism.
11. Detection of Philadelphia chromosome [BCL-ABL (9:22) translocation] by genomic southern hybridization- acute leukemia and chronic myelogenous leukemia.
12. DNA microarrays/ DNA chips/gene chips- basic concept, application of DNA microarray technology in diagnostics.

Recommended Books:

1. From Genes to Clones, Introduction to Gene Technology by Ernst-L. Winnacker. VCH Publishers. 1987.
2. Principles of Gene Manipulation. An Introduction to Genetic Engineering. R. Old, S.B. Primrose. Blackwell Sci Pub. 1985.
3. Gene Cloning and DNA Analysis: An Introduction (4th edition) by T.A. Brown
4. From Genes to Genomes: Concepts and Applications of DNA Technology by J.W. Dale and M.V. Schartz.
5. Micklos, Davod A. and Frayer, Greg A. 1990. DNA Science, Cold Spring Harbor Laboratory press and Carolina Biological; Supply Company.
6. Devlin, A Text Book of Biochemistry with Clinical Correlation.
7. Lehninger, Albert., Principle of Biochemistry, M/S Worth Publishers Inc., New York
8. Medical Microbiology (1997). Edited by Greenwood. D, Slack. R and Peutherer. J, ELST Publishers.
9. Bailey and Scott's Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissefeld, Ernest A Trevino. Published by C.V. Mosby
10. Fundamental of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Sauders group.
11. Henry's Clinical Diagnosis and Management by Laboratory Methods (2007). Mepherson.
12. Molecular Diagnostics for the Clinical Laboratorian 2nd ed. (2006). W.B.Coleman. Humana Press.

BGE 409 Downstream Processing 3 credits

1. **Introduction:** Importance of downstream processing in biotechnology, Problems, Requirement of purification, Characteristics of biological molecules, Classes of bio-products,
2. **Physicochemical basis of separation:** separation of different chemical compunds, Physico-chemical basis of different bioseparation processes.
3. **Physical separation processes:** Solid and liquid system, Electrophoretic separation. Flocculation, Centrifugation, Precipitation, Filtration, Settling,
4. **Cell disruption methods:** Chemical, mechanical and enzymatic methods, Extraction, Absorption, Adsorption, Leaching, Crystallization and drying.
5. **Membrane separation process:** Separation of intracellular, extra-cellular, heat and photosensitive materials, case study with design aspect, Enzyme processing using Ultra filtration membranes, Use of membrane diffusion for separating and characterizing naturally occurring polymers.
6. **Chromatographic methods:** Partition chromatography, Ion exchange chromatography, Affinity chromatography, High performance liquid chromatography, Thin layer chromatography, Adsorption chromatography, Gas liquid chromatography.
7. **Sterile Formulations:** Introduction, Sterile Bulk Preparation, and Isolation of Sterile Bulk Product, Crystallization, Filtering, Drying, Milling, Blending, and Bulk Freeze Drying, Spray Drying

Recommended Books:

1. R. Gosh, Principles of Bioseparation Engineering, World Scientific Press, Singapore, 2006
2. M. R. Ladisch, Bioseparations Engineering: Principles, Practice and Economics, 1st Edn., Wiley-Interscience, 2001.
3. J. D. Seader and E.J. Henley, Separation Process Principles, 2nd Edn., Wiley, 2005.

4. R. G. Harrison, P.W. Todd, S.R. Rudge, and D. Petrides, Bioseparations Science and Engineering, Oxford University Press, 2002.
5. M. L. Shuler and F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall, 2004.
6. H. C. Vogel, C. C. Haber. Fermentation and Biochemical Engineering Handbook, 2nd Ed. Principles, Process Design and Equipment. Noyes Publications, New Jersey, U.S.
7. J. E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn., McGraw Hill Publishers, 1986.

BGE 410 Entrepreneurship in Biotechnology 3 Credits

1. **Biotech products:** Introduction, Public perceptions of Biotech products; The Global marketplace for Biotech products, Prospects and limitation of Biotech products in Bangladesh.
2. **Major considerations in establishment of Biotechnological start-up:** The business potential of a Biotechnological company, Entrepreneurship, The Company, Seed capital raising for a Biotechnological start-up company, Stakeholders, Venture capital, Corporate strategies, Licensing, Alliances, and Mergers.
3. **Market Survey Techniques:** Market survey, cost analysis, Price estimation, COGS, SWOT analysis, product positioning, marketing strategies
4. **Business regulations in Biotechnology:** Laws, Regulations, and politics involved in Biotechnology; Ethical concerns regarding the use of Biotechnology.
5. **Commercialization of Biotech Products:** Fundamentals of marketing and selling of Biotech products. Creating and marketing the image of the Biotech company, The Art of negotiation. Effective advertising and marketing, Opportunities of international marketing.
6. **Intellectual property rights in Biotechnology:** Introduction, Collaborative research, Competitive research, Invention as intellectual property, Ownership of intellectual property, Basic requirements of patentability, Special issue in Biotechnology patents, Recent developments in patent system and patentability of Biotechnological invention.
7.

Recommended Books:

1. Pisano, Gary P. Science Business : The Promise, the Reality, and the Future of Biotech. Harvard Business School Press, USA
2. Yali Friedman, Building Biotechnology: Business, Regulations, Patents, Law, Politics, Science. Logos Press. USA
3. The coming biotech age: The business of biomaterials. By Richard Oliver. NY : McGraw Hill 2000

Practical courses

BGE 411 Fermentation Technology Laboratory 2 Credits

1. Construction of growth curve of bacteria – estimation of biomass, calculation of specific growth rate, yield coefficient, utilization and product formation kinetics in shake flask culture.
2. Control of pH and temperature in a bioprocess.
3. Control of flow rates and pressure in a bioprocess.
4. Determination of volumetric oxygen transfer co-efficient (Kla) in a fermentor by static gassing out and sulphite oxidation methods.
5. Determination of Residence Time Distribution (RTD) of CSTR.
6. Determination of mixing time in stirred tank reactor with Newtonian and Non- Newtonian fluids.
7. Determination of thermal death kinetics.
8. Fermentation process of some biomolecules.
9. Measurement of ethanol production in a fermentor.

BGE 412 Genetic Engineering Laboratory 2 Credits

1. Isolation of genomic DNA from various samples
2. Isolation of RNA from various samples
3. Purification of DNA from agarose gels
4. Primer design
5. Restriction digestion and ligation of DNA
6. PCR and randomly amplified polymorphic DNA
7. Preparation of competent bacterial cells
8. Transformation of Gram Negative and Gram Positive bacteria with Plasmid DNA
9. Beta-galactosidase assay
10. Colony PCR
11. DNA sequencing

BGE 413 Plant and Animal Biotechnology Laboratory 2 Credits

Plant Biotechnology:

1. Cell suspension and protoplast culture medium preparation and sterilization
2. Cell Suspension culture technique
3. Protoplast culture technique
4. Studies of secondary metabolites in plants (phenolics, flavonoids, antioxidants)
5. Isolation, quantification and detection of genomic DNA
6. PCR, RT-PCR
7. Electroporation and Agrobacterium mediated transformation

Animal Biotechnology:

1. Preparation of animal cell culture medium and sterilization
2. Organ culture and fibroblast culture techniques
3. Live animal cell count