Curriculum for

Bachelor of Science (B. Sc.) in Genetic Engineering and Biotechnology

2018-2019

Department of Genetic Engineering and Biotechnology
Shahjalal University of Science and Technology

Curriculum for

Bachelor of Science (B. Sc.) in Genetic Engineering and Biotechnology

This Curriculum is prepared by the Faculty Members of the Department of the Genetic Engineering and Biotechnology (GEB) with the Support of SAC of the Department and IQAC of Shahjalal University of Science and Technology

Department of Genetic Engineering and Biotechnology
Shahjalal University of Science and Technology

1. Program name: Bachelor of Science (B. Sc.) in Genetic Engineering and Biotechnology

2. Vision: GEB of SUST will be the educational and research-based department of choice for the best and brightest students in Bangladesh as well as the world.

3. Mission:

To ensure the GEB graduate with enriching in following qualities.

- *Capable of using knowledge to identify, clarify and provide the best possible solutions to issues and emerging problems relating to individual, workplace, society and the country.*
- *Leadership and managerial capabilities of any relevant organizations;*
- *To develop morale characters*
- *To make the students humane as well as nature lovers;*

4. Program objectives:

To provide solution based education with cutting-edge knowledge in Genetic Engineering and Biotechnology in order to harness the latest techniques, technologies, and methodologies for the graduates in the field of:

1. *Plant and Agricultural (Plant and Animal) Biotechnology*
2. *Medical and Pharmaceutical Biotechnology*
3. *Microbial Biotechnology*
4. *Food Biotechnology*
5. *Industrial (bioprocess) Biotechnology*
6. *Environmental Biotechnology*

5. Program Outcomes:

After graduation students will be able to:

Program Outcomes	Achievement
1. Demonstrate a comprehensive understanding of the multidisciplinary as well as interdisciplinary fundamental concepts in Genetic Engineering and Biotechnology. 2. Analyze, synthesize and integrate knowledge and information within the context of multidisciplinary as well as interdisciplinary areas in Genetic Engineering and Biotechnology.	***Cognitive Level***
1. Recognize and practice the concept of lifelong learning for continuous self-improvement. 2. Communicate and demonstrate adequate interpersonal skills. 3. Appreciate social, moral and bioethical perspectives in Genetic Engineering and Biotechnology education and research.	***Affective Level***
1. Operate and maintain the basic biotechnology equipment adhering to good laboratory practices and bio-safety and security issues. 2. Develop practical skills for addressing the problems in biosciences.	***Psychomotor Level***

6. Course structure:

Program duration: 04 Years
Number of the semester: 08
Semester duration: 21 Weeks (Excluding vacations and holidays)

Total number of credit hours available: 163.5
Minimum credit hours to be earned for degree requirements: 161.5

6.1 Summary of the total available credits (major or non-major) from different areas of study and distributions of credits in different areas of study

Areas of study	**Theory**		**Lab/ Field Work**		**Total (Major/Non Major)**		**Total**
	Major	**Non-Major**	**Major**	**Non-Major**	**Major**	**Non-Major**	
Genetic Engineering and Biotechnology	119	3	28	-	147	3	150
Basic Science	-	02*+03	-	1.5	-	6.5	6.5
Arts and Humanities and Social Science	-	02	-	01	-	03	03
Information Technology (IT)	-	02	-	02	-	04	04
Total	**119**	**12**	**28**	**4.5**	**147**	**16.5**	**163.5**

*Optional (MAT 201: Mathematics)

Year-wise distribution of credits

Year	**Semester**	**Theory**		**Lab/ Field Work**		**Total**
		Major	Non-Major	Major	Non-Major	
First	First	12	05	03	2.5	22.5
	Second	12	02	03	02	19
Second	First	16	02	02	-	20
	Second	11	3	04	-	18
Third	First	16	-	03	-	19
	Second	19	-	04	-	23
Fourth	First	19	-	03	-	22
	Second	14	-	06	-	20
Total		**119**	**12**	**28**	**4.5**	**163.5**

6.2 The distribution of courses for the respective academic years and semesters is given below along with the detail of the courses.

First Year Semester I

Course No.	Course Title	Hours/week Theory + Lab.	Credits
GEB 121	Introduction to Genetic Engineering and Biotechnology	3+0	3
GEB 123	Introduction to Animal Sciences	3+0	3
GEB 124	Introduction to Animal Sciences Lab	0+2	1
GEB 125	Basic Plant Science	3+0	3
GEB 126	Basic Plant Science Lab	0+2	1
GEB 127	Basic Microbiology	3+0	3

GEB 128	Basic Microbiology Lab	0+2	1
CHE 101J	Chemistry	3+0	3
CHE 102J	Chemistry Lab	0+3	1.5
ENG 101J	English Language	2+0	2
ENG 102J	English Language Lab	0+2	1
Total credits		17+11	22.5

First Year Semester II

Course No.	Course Title	Hours/week Theory + Lab.	Credits
GEB 131	Basic Biochemistry	3+0	3
GEB 132	Basic Biochemistry Lab	0+2	1
GEB 133	Cytology	3+0	3
GEB 134	Cytology Lab	0+2	1
GEB 135	Principles of Genetics	3+0	3
GEB 137	Plant Physiology	3+0	3
GEB 138	Plant Physiology Lab	0+2	1
CSE 203J	Introduction to Computer Language	2+0	2
CSE 204J	Introduction to Computer Language Lab	0+4	2
Total credits		14+10	19

Second Year Semester I

Course No.	Course Title	Hours/week Theory + Lab.	Credits
MAT 201J GEB*	Mathematics	2+0	2
GEB 211	Animal and Human Physiology	3+0	3
GEB 212	Animal and Human Physiology Lab	0+2	1
GEB 213	Molecular Biology	3+0	3
GEB 217	Enzymology	2+0	2
GEB 221	Animal Reproduction and Embryology	2+0	2
GEB 223	Biofertilizer and Renewable Energy	3+0	3
GEB 224	Biofertilizer and Renewable Energy Lab	0+2	1
GEB 225	Microbial Genetics	3+0	3
Total credits		18+4	20

*Optional

Second Year Semester II

Course No.	Course Title	Hours/week Theory + Lab.	Credits
GEB 231	Metabolism I	2+0	2
GEB 235	Plant Breeding	3+0	3
GEB 236	Plant Breeding Lab	0+2	1
GEB 237	Animal Breeding	3+0	3
GEB 238	Animal Breeding Lab	0+2	1
STA 211J	Biostatistics	3+0	3
GEB 239	Environmental Biotechnology	3+0	3
GEB 240	Environmental Biotechnology Lab	0+2	1
GEB 200	Seminar and Oral	0+2	1
Total credits		14+08	18

Third Year Semester I

Course No.	Course Title	Hours/week Theory + Lab.	Credits
GEB 311	Plant Tissue Culture	3+0	3
GEB 312	Plant Tissue Culture Lab	0+2	1
GEB 317	Food Biotechnology	3+0	3
GEB 318	Food Biotechnology Lab	0+2	1
GEB 319	Techniques in Molecular Biology	3+0	3
GEB 320	Techniques in Molecular Biology Lab	0+2	1
GEB 323	Animal Cell Technology	2+0	2
GEB 325	Metabolism II	2+0	2
GEB 327	Immunology	3+0	3
Total credits		16+6	19

Third Year Semester II

Course No.	Course Title	Hours/week Theory + Lab.	Credits
GEB 331	Cell Signaling	3+0	3
GEB 335	Fermentation Technology	3+0	3
GEB 336	Fermentation Technology Lab	0+2	1
GEB 337	Recombinant DNA Technology	3+0	3
GEB 341	Aquaculture and Fish Genetics	3+0	3
GEB 342	Aquaculture and Fish Genetics Lab	0+2	1
GEB 343	Bioprocess Engineering	2+0	2
GEB 347	Oncology and Virology	3+0	3
GEB 348	Immunology and Virology Lab	0+2	1
GEB 349	Bioenergetics	2+0	2
GEB 300	Industrial Visit and Seminar	0+2	1
Total credits		19+8	23

Fourth Year Semester I

Course No.	Course Title	Hours/week Theory + Lab.	Credits
GEB 411	Proteomics, Genomics and Bioinformatics	3+0	3
GEB 412	Proteomics, Genomics and Bioinformatics Lab	0+2	1
GEB 413	Medical and Pharmaceutical Biotechnology	3+0	3
GEB 417	Stem Cell Technology	3+0	3
GEB 419	Bioreactor and Downstream Processing	2+0	2
GEB 421	Microbial Biotechnology	3+0	3
GEB 423	Plant Biotechnology	3+0	3
GEB 424	Plant Biotechnology lab	0+2	1
GEB 425	Fisheries Biotechnology	2+0	2
GEB 402	Field Work and Study Tour		1
Total credits		19+4	22

Fourth Year Semester II

Course No.	Course Title	Hours/week	Credits

		Theory + Lab.	
GEB 431	Forensic and Molecular Diagnostics	3+0	3
GEB 432	Forensic and Molecular Diagnostics Lab	0+2	1
GEB 433	Protein and Enzyme Technology	3+0	3
GEB 435	Agricultural Biotechnology	3+0	3
GEB 437	Animal Biotechnology	3+0	3
GEB 438	Animal Biotechnology Lab	0+2	1
GEB 439	Research Methodology	2+0	2
GEB 440	Project + Seminar	0+7	3
GEB 400	Viva Voce	0+2	1
Total credits		14+13	20

7. Teaching strategy:

Popular strategies are Lecture, Case method, Discussion, Active learning (Apply what students are learning), Cooperative learning (small groups work together for achieving a common goal), Integrating technology, Distance learning, etc.

8. Assessment strategy:

Distribution of Marks: [To be prepared as per the ordinance]

- Marks distribution for theory courses: [To be prepared as per the ordinance]
- Marks distribution for sessional courses: [To be prepared as per the ordinance]
- Bases for class attendance marks (both for theory and sessional): [To be prepared as per the ordinance]

Continuous Assessment: [To be prepared as per the ordinance]

- **Thesis evaluation:** [To be prepared as per the ordinance]
- **Grading system and grading scale:** [To be prepared as per the ordinance]

Assessment tools:

Theory courses:

- Class participation (Example: attendance)
- Continuous assessment (examples: Quiz, spot test, open book exam, presentation, assignments, written exams, etc.)
- Midterm or Term test
- Term final examination (written test)

Sessional courses:

- Class participation (Example: attendance)
- Sessional assessment (examples: field work, lab work, case study, performance, spot test, open book exam, presentation, assignments, written exams, etc.)
- Viva-voce (oral)

Thesis/project:

- Participation (Example: Contact/Discussion/Communication with the supervisor)
- Evaluation (examples: report, project paper, monograph, etc.)
- Viva-voce (oral)

Detailed Curriculum

Course Title: Introduction to Genetic Engineering and Biotechnology

Course No.: GEB 121 Credits: 3 Contact Hours: 36 Total Marks: 100

Course: GEB-121: Introduction to Genetic Engineering and Biotechnology	**Credit Hour: 03**	**Year: 1st**	**Semester: I**

Rationale: The course is designed to provide the fundamental concepts of Genetic Engineering and Biotechnology (GEB) and its scope of application in various fields of biological sciences.

Course Objectives:

- Provide basic concepts in Genetic Engineering and Biotechnology
- Understanding of sector-wise application of GEB
- Acquaintance with safety concerns in biotechnological applications

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Explain the applications of biotechnology
- Know the fundamentals of recombinant DNA technology
- Understand necessary biotechnological tools for animal production, production of plant and agricultural products, plant and animal tissue culture, enzyme technology, biological fuel generation, and environmental protection
- Know renewable energy resources and the sustainable environment and biosafety

Teaching Strategy: Lecture, Projector Display, Audio Visual, etc.

Assessment Strategy: Q/A, Short Essay, MCQ, Assignment, Exercise.

Course Contents

Concept: Definition of Biotechnology, history and multidisciplinary nature of Biotechnology, applications of Biotechnology, Biotechnology and developing countries, commercialization of Biotechnology in a developing country.

Recombinant DNA Technology: Concepts of Recombinant DNA technology, biological tools of Recombinant DNA technology, modification of the gene, methods of gene transfer, transgenic organisms.

Biotechnology in Medicine: Introduction, production of human peptide hormones, insulin, somatotropin, somatostatin, human interferon, different types of vaccines, commercial chemicals, regulation of proteins, blood products, antibiotics, and vaccines.

Biotechnology in Food: Introduction, dairy products, fish and meat products, food enzymes, sweeteners, bakery products, food wastes, microbial products, oriental fermented foods, drinks, alcoholic and non-alcoholic beverages.

Biotechnology in Plant and Agriculture: Impact of Biotechnology in Agriculture, list of biotechnological products produced from plant and crops and their uses, biotechnological methods used in crop production, genetic manipulation of the plant, biofertilizer, biopesticide, biocontrol of weeds, plant tissue culture its application.

Biotechnology in Animal Production: Animal wealth, products from animal, biotechnological methods used in animal production, genetic manipulation of animal, animal cell culture, pharmaceuticals from transgenic animals, blood substitutes from transgenic animals.

Enzymology and Enzyme Technology: Definition of enzyme, enzymology and enzyme technology, nature of the enzymes, applications of enzymes, the technology of enzyme

production, immobilization of enzymes.
Biosensor Technology and Probiotics: Definition, scope, and applications.
Biological Fuel Generation: Photosynthesis- ultimate energy resources, sources of biomass, ethanol from biomass, methane from biomass, biogas production.
Biosafety and Environmental Biotechnology: Concepts of bio safety, Sources of environmental pollution, use of commercial blends of microorganism and enzymes in pollution control. Biotechnological approaches in waste treatment.

Recommended References:

1. Bilgrami and Pandey. 1990. Introduction to Biotechnology. CBS Publishers. India.
2. Bullock, J. and Uritiansen, B. 1995. Basic Biotechnology. Academic Press, UK.
3. Dubey, R. C. 1995. Introduction to Biotechnology. S. Chand and Co. Pvt. Ltd. India.
4. Jack, G. Chirikjian. 1995. Biotechnology: Theory and Techniques. Volume I . Jones and Bartlett publisher, Boston, London, Singapore.
5. Natesh, S. 1993. Biotechnology in Agriculture. Oxford and IBM Pvt. Ltd. India.
6. Smith, J. E. 1988. Biotechnology. Edward Arnold Pub. NY, UK

Course Title: Introduction to Animal Sciences

Course No.: GEB 123 Credits: 3 Contact Hours: 36 Total Marks: 100

Course: GEB-123: Introduction to Animal Sciences	**Credit Hour: 03**	**Year: 1st**	**Semester: I**
Rationale: To develop the students' appreciation, understanding and practical capability in all aspects of Animal kingdom.			
Course Objectives: The course will provide students with fundamental knowledge and skills regarding animal classification and systematic, animal structure and functional relationships, evaluation between and within major animal groups, human evaluation, animal health, ecology and management of various species of domestic animals.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Learn Classification, the anatomy of higher animals and human, nutrition, health management, diseases, economics and management of profitable animals. • Explain the mechanisms and role of reproductive physiology in animal production. • Develop feeding systems for farm animal production and companion animals. • Understand how the application of modern animal production technologies and management practices impact their production facilities, their communities, and the world.			
Teaching Strategy: Lecture, Projector display, animation, Experiment in the lab, Visit, etc.			
Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Viva, short answer, short question			
Course Contents			
Origin of life: **Classification:** General classification of a major phylum of Animal Kingdom.			
Anatomy of Higher Animals: Comparative anatomy (Skeletal, circulatory, digestive, respiratory, excretory and reproductive systems) of higher animals (Human, Cattle, Goat, etc).			
Type Study of Animals: Type study including habitat, distribution, external morphology,			

organ system, the economic and biotechnological significance of the following: Arthropoda (*Macrobrachium rosenbergii*), Mollusca (*Lamellidens* sp.), Pisces (*Labeo rohita*), Aves (*Gallus domesticus*) and Mammalia.
Laboratory Animals: Different animals used in the laboratory for practical and research purposes.
Animal Ecology: Definition, branches, ecosystem, the relationship of ecology with another discipline. Effect of environment and human habitation on animal adaptation and their relationship with civilization.
Economic Study of Animals: Apiculture, sericulture, poultry and dairy farming including technical, commercial and financial aspects.
Major Diseases of Animals: Major Microbial (Viral, bacterial, fungal), Parasitic (protozoan, helminth, arthropod) Metabolic and Nutritional diseases of poultry birds, dairy animals with their causal agents, etiology, pathogenesis, clinical symptoms, diagnosis, treatment and control measures.
Human Biology: Human type and race, Different systems, Food and nutrition, Environmental stress and Plasticity, Disease and Health Management, Demography and Family Planning.

Recommended References:

1. Getty, R.: Sisson and Grossman's The Anatomy of the Domestic animals, 5th edition, W.B. Saunders and Co. Philadelphia (USA).
2. Hairston, N. G. 1994. Vertebrate Zoology- An Experimental Field approach. CUP.
3. Jardan, E. I. and Verma, P. S. Invertibrate Zoology. S. Chand and Com. Ltd. New Dilhi
4. Jardan, E. I. and Verma, P. S. Chordate Zoology. S. Chand and Com. Ltd. New Delhi.
5. Parker, T. J., and Haswell, W. A. 1990. A Text Book of Zoology. Vol. I and II. Low Price Publication India.
6. Ghosh, R.K. 2006. Primary veterinary anatomy; Current books international, Kolkata, 4th edition
7. Storer, T. I. General Zoology. Tata Megraw Hill Pub. Co. Ltd. India.
8. Young, J. 1981. Life of Vertebrate, OUP, USA.
9. Frost, S.W., Economic Zoology.
10. Srivastava , P.D. Economic Zoology.

Course Title: Introduction to Animal Science Lab

Course No.: GEB 124 Credits: 1 Contact Hours: 2 hours/week

Course: GEB-124: Introduction to Animal Science Lab	**Credit Hour: 01**	**Year: 1st**	**Semester: I**
Rationale: The course Introduction to Animal Science Lab is to present basic facts and principles that are essential for human use and care and rare animals.			
Course Objectives: The course will provide practical knowledge of wildlife, internal anatomy of different invertebrates and vertebrates, as well as practical commercial applications, such as disease prevention, artificial insemination. Labs and field trips will provide opportunities to gain practical knowledge and to understand the animals better.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Know the scientific importance and physical requirements associated with aspects of animal handling, breeding, feed, maintenance, and minor surgical procedures. • Know the morphology of different invertebrates and vertebrates, internal anatomy of			

different invertebrates and vertebrates. • Develop the ability to handle a variety of animal species, including the collection of material from these specimens
Teaching Strategy: Lecture, Projector display, Animation, Experiment in the lab, Visit, etc.
Assessment Strategy: Q/A, Quiz Test, Short question, MCQ, Lab report and Viva
Course Contents
1. Terrestrial ecology and wild life study
2. Field visit, sample collection and preservation
3. Spot identification including whole animals, parts of animals and slide of different invertebrates and vertebrates
4. External morphology of different invertebrates and vertebrates
5. Internal anatomy of different invertebrates and vertebrates (Dissection, drawing, and labeling)
6. Study of parasites
7. Study of articulated bone
8. Slide mounting
9. Invertebrate culture including *Drosophila* and *C. elegance* in a laboratory setup
10. Lab report
11. Viva Voce

Recommended References:

1. Practical Zoology (part 1,2,3)- S.S. Lal, India
2. উচ্চতর ব্যবহারিক প্রাণিবিদ্যা (প্রথম ও ২য় খন্ড)-প্রফেসর পরিমল দেবও অন্যান্যা মল্লিক ব্রাদার্সা

Course Title: Basic Plant Science

Course No.: GEB 125 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-125: Basic Plant Science	**Credit Hour: 03**	**Year: 1st**	**Semester: I**
Rationale: The purpose of this course is to prepare students with specific competencies they need for a fundamental understanding of plant biology, their production, management, and economic importance			
Course Objectives: • Communicate in both oral and written forms about fundamental scientific concepts related to plant anatomy, plant genetics, plant physiology, soils, and crop production practices to different audiences to inform them about issues of concern related to agricultural production. • Understand management practices (e.g., soil, water, nutrients, rotations, crop and variety selection, overall plant production system) and interpret how they affect plant production. • Learn the basic principles of plant cells and tissues; plant organs; plant physiology; plant reproduction and diversity; and plant ecology. • Assess future agricultural production needs and opportunities to identify potential career paths in the agricultural sciences.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Explain the structure and function of cells, tissues, organs and their organization in the whole plant. • Understand the plant production systems and the impacts they have on the ecosystems they occupy. • Describe the diversity of plant form and function, expression and inheritance of traits			

• Understand the economic importance of cereals, vegetables, fruits, and medicinal plants. • Communicate the importance of plant science in addressing significant challenges facing society, including examples of how plant scientists have "solved" such problems
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Field visit, etc.
Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Question etc.
Course Contents
Introduction: The Plant Kingdom, the concept of plant life, the importance of plant science. Basic ideas of agronomy, horticulture, pomology, olericulture, etc.
External Morphology: The seed and seedling, The plant body – The shoot, the root, the inflorescence and bracts, the flower, the leaves, the buds, Pollination, Fertilization, embryology, the fruits, disposal of fruits and seeds
Plant Anatomy- An outline of the plant body: The axis, the primary body, the secondary body
The Plant Cell: Cells structure and its components, The cell wall, Cell formation- mitosis, amitosis, meiosis, the significance of meiosis, comparison of mitosis and meiosis.
Tissue and tissue system: definition and types of tissue, permanent tissue, meristematic tissue- types, apical meristem, characteristics, differentiation of tissues, the importance of studying tissue and tissue system in Biotechnology.
The primary and secondary structure of root and stem: General and anatomic characteristics of root and stem, the anatomy of dicotyledonous and monocotyledonous root and stem.
Embryology: Definition, the study of microsporogenesis and microgametogenesis, megasporogenesis and megagametogenesis, fertilization, and development of the embryo.
Economic Study of Plants: Introduction and scope of economic plants, scientific name, local name, useful parts and economic importance of cereals, fibers, oils, fruits, rubber, beverage, sugar, fodder, pulse, timber and narcotic yielding plants, cultivation and processing of tea and rubber plants
Plant Diseases: Definition, causative agents, symptom, importance and control measures of viral, bacterial and fungal diseases of rice, wheat, sugarcane, jute, pulses, potato, tomato, and banana. Insect pests of different crops.
Pharmacognosy: Importance of medicinal plants, available components and their application in different diseases.

Recommended References:

1. B.P. Pandey, Economic Botany
2. Ganguli and Das, College Botany
3. Gupta R.K. Text book of systemic botany
4. Bilgrami K.S. Fundamentals of Botany

Course Title: Basic Plant Science Lab

Course No.: GEB 126 **Credits: 01** **Contact Hours: 2 hours/week**

Course: GEB-126: Basic Plant Science Lab	Credit Hour: 01	Year: 1st	Semester: I
Rationale: This course is designed to provide practical experiences in anatomy, physiology and reproduction system of plants as well as their economic importance in human lives.			
Course Objectives: Upon completion of this course, students will have the practical knowledge and skills in plant identification, morphology, anatomy, reproduction, propagation, controlled environment production and diseases, and economic importance.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Understand the organization of plants from the level of cells through tissues, tissue systems, and organs. • Identify the economic and medicinal plants. • Identify the different diseases of plants.			
Teaching Strategy: Lecture, Animation, Field visit and Experiment in the lab.			
Assessment Strategy: Short question, Quiz, MCQ, Assignment and Lab report.			
Course Contents			
1. Identification of laboratory specimen and detailed plant cell structure, organelles, etc.			
2. Identification of plant body, flower, and fruit plants, etc.			
3. Details morphology study of Rice, Wheat, Sugarcane, Tobacco, Lentil, Nut, Cotton, Jute, etc.			
4. Identification of economic and medicinal plants, their essential parts, isolated compounds role, etc.			
5. Identification of different diseases in Rice, Wheat, Sugarcane, Tobacco, Lentil, Nut, Cotton, Jute, etc.			
6. Slide preparation and study of the different pathogenic structure of Rice, Pulse crops, Oil crops, Wheat, Jute diseases.			
7. Some problems related to pesticide, fungicide and insecticide formulation.			

Recommended References:

1. Gupta R.K. Text book of systemic botany
2. Bilgrami K.S. Fundamentals of Botany

Course Title: Basic Microbiology

Course No.: GEB 127 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB 127: Basic Microbiology	Credit Hour: 03	Year: 1st	Semester: I
Rationale: The course will provide basic knowledge on microorganisms, but will emphasize bacteria. This course will help to familiar with the fundamental scientific concepts and basic skills utilized in microbiology to enable students to expand their knowledge of the microscopic world.			
Course Objectives: • Demonstrate an understanding of basic microbiological principles. • Microscopy of different types of microbes. • Taxonomy, metabolism, sterilization, disinfection, growth, and culture methodology.			
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to • Understand the structural similarities and differences among microorganisms and the unique structure/function relationships of bacterial cells and viruses. • Appreciate the diversity of microorganism and microbial and communities and learn scientific nomenclature of different microbes.			

• Learn concepts and theoretical knowledge in the use of different microscopes used in the study of microorganisms. • Learn about different control measures and aseptic technique to perform routine maintenance and handle cultures safely and effectively. • Explain growth and common methods used to measure bacterial growth and use culture media properly.
Teaching Strategy: Lecture, Discussion, Exercise, Q and A, etc.
Assessment Strategy: MCQ, Test, Assignment, Quiz etc.
Course Contents
Introduction: Definition of microorganism and microbiology; Place of microorganisms in the living world; A brief history of the development of microbiology – early observation of microorganisms, the debate over spontaneous generation, the germ theory of disease, vaccination and discovery of antibiotics; Modern developments in microbiology; Scope of microbiology.
Classification of Microorganisms: Salient features of major types of microorganisms: bacteria, archaebacteria, rickettsia, mycoplasma, actinomycetes, fungi, algae, protozoa, virus, viroids, prions; Classification based on temperature, pH, oxygen, salinity, nutrients, and pressure.
Bacteria: Morphology; Structure - Capsule, flagella, pili, cell-wall, cytoplasmic membrane, inclusion bodies, ribosome, pigments, and endospore; Classification; Multiplication; Economic importance.
Cultivation of Microorganisms: Culture medium – simple, defined, complex, selective, differential and enrichment media; Batch and continuous culture; Anaerobic culture methods; Culture preservation and management.
Growth of Microorganisms: Nutritional and physical requirements for growth; Growth equation; growth curve; Measurement of growth.
Control of Microbial growth: Sterilization- Principles of sterilization, methods of sterilization; Effect of anti microbial agents.
Microbial Ecology: Ecology and ecosystem; Biotic and abiotic factors; Microorganisms in the soil, air, and water; Microbial interaction – neutralism, synergism, mutualism, commensalism, antagonism, parasitism, and predation.
Isolation and identification methods of Microorganisms: Isolation of microorganisms; Morphological, cultural, biochemical, serological and molecular techniques for the identification of microorganisms.

Recommended References:

1. Pelczar, M. J.; Chan, E. C. S, and Kreig, N. R. (1993). Microbiology. McGraw Hill Inc. USA.
2. Tortora, G. J.; Funke, B. R. and Case, C. L. (1982). Microbiology: An Introduction.
3. Stainer, R. Y.; Adelberg and Ingraham, I. J. General Microbiology. MaCmillan USA.
4. Jawetz, E. J.; Melnick, J.L. and Adelberg, E. (1991). Medical Microbiology.
5. Chowdhury, R. (1990). Modern Medical Microbiology. BishawParichay, Dhaka, Bangladesh.

Course Title: Basic Microbiology Lab

Course No.: GEB 128 **Credits: 01** **Contact Hours: 2 hours/week**

Course: GEB 128: Basic Microbiology	**Credit Hour:01**	**Year: 1st**	**Semester: I**

Lab			
Rationale: This course is designed to provide knowledge on basic microbiology, microscopic identification of microbes, and their response to antimicrobial agents.			
Course Objectives: Students will acquire basic microbiology principles and techniques.			
Intended Learning Outcomes (ILOs): At the end of the course, students will- • Understand the use and care of microscope • Explain smears and different staining techniques • Know bacterial culture characteristics, use of general media for isolating pure cultures • Learn techniques to measure bacterial growth • Understand antibiotic susceptibility testing			
Course Contents			
1. Handling and use of microscopes. 2. Sterilization techniques: i) Dry heat sterilization ii) Moist heat sterilization iii) Filtration sterilization 3. Enumeration of bacterial counts in a sample by spread plate and pour plate techniques. 4. Obtaining of pure culture by streak plate technique. 5. Observation of cultural characteristics of nutrient agar media, selective media, and differential media. 6. Gram staining technique.			

Recommended References:

1. Pelczar, M. J.; Chan, E. C. S, and Kreig, N. R. (1993). Microbiology. McGraw Hill Inc. The USA.
2. Tortora, G. J.; Funke, B. R., and Case, C. L. (1982). Microbiology: An Introduction.
3. Stainer, R. Y.; Adelberg and Ingraham, I. J. General Microbiology. Macmillan USA.
4. Jawetz, E. J.; Melnick, J.L. and Adelberg, E. (1991). Medical Microbiology.
5. Chowdhury, R. (1990). Modern Medical Microbiology. BishawParichay, Dhaka, Bangladesh.

Course No. CHE 101J
Course Title: Chemistry
Credit: 03, Contact Hours: 03 Hours/week

Course No. CHE 102J
Course Title: Chemistry Lab
Credit: 01, Contact Hours: 02 Hours/week

Course No. ENG 101J
Course Title: English Language
Credit: 02, Contact Hours: 02 Hours/week

Course No. ENG 102J
Course Title: English Language Lab
Credit: 01, Contact Hours: 02 Hours/week

Course Title: Basic Biochemistry

Course No.: GEB 131 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB 133: Basic Biochemistry	Credit Hour: 03	Year: 1st	Semester: II

Rationale: This course aims to provide an advanced and excellent understanding of the principles and topics of Biochemistry and their experimental basis by lecture-based classes, and to enable students to acquire a specialized knowledge to understand molecular biology, biotechnology and genetic engineering.

Course Objectives:

The course is designed to provide information about biochemically important aspects of the chemistry of proteins, carbohydrates, nucleic acids and lipids, using appropriate examples. Key emphasis is placed on understanding the structural principles that govern reactivity/physical properties of biomolecules as opposed to learning structural detail.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Know about the life and its components, features of life etc.
- Understand the structure/conformational freedom of biomolecules, e.g. proteins, DNA/RNA, carbohydrates and key metabolites/co-factors, e.g., be able to draw and recognize key structures such as the 20 amino acids, 5 nucleotides etc.
- Understand and demonstrate how the structure of biomolecules determines their chemical properties and reactivity
- Acquire knowledge on different diseases related to the deficiency of vitamins

Teaching Strategy: PPT Lecture, Projector Display, Audio Visual, etc.

Assessment Strategy: Q/A, Short Essay, MCQ, Assignment, Exercise, Short Answer, Short Question, Seminar, etc.

Course Contents

Introduction: Biochemistry, its definition, and scopes, the relation between biochemistry with biology, medicine and agriculture, the concept of life and living processes, the identifying characteristics of a living matter.

Biomolecules-

i) **Water:** Physical and chemical properties of water, pH, buffer, Henderson Heschel equation.

ii)**Carbohydrates:** Occurrence, nomenclature, biological importance, chemical characteristics, and classification of carbohydrates. Monosaccharides and disaccharides: structure, properties, characteristic tests, amino sugars, and glycosides. Polysaccharides: occurrence, compositions, structure and properties of starch, glycogen, cellulose, other polysaccharides of biological interest, their chemical tests and biological importance, analysis of carbohydrates.

iii) **Lipids:** Definition, classification and biological importance.

iv) **Amino acids, peptides and proteins:** Amino acids: definition, source, classification and structure of naturally occurring amino acids and their physical, chemical and optical properties, essential and non-essential amino acids, concept of residue, peptide bonds, oligopeptide and polypeptide, identification of N-terminal and C-terminal residue of a peptide, synthesis of peptides. Proteins: definition, classification, and biological importance.

v) **Nucleic acid:** General structure of nucleosides and nucleotides, the chemistry of DNA, base pair rule, double helical structure, the chemistry of RNA, types, and functions of RNA, physiochemical properties, denaturation and renaturation of nucleic acids.

vi) **Vitamins and Hormones:** Definition, classification, their functions and importance in

Biochemistry.

Recommended References:

1. Lehninger, Albert, L., Nelson David, L., Cox, Michael, M., Principles of Biochemistry, 1st Indian Edition, 1993. CBS Publisher's and Distibutors.
2. Strayer, Lubert, 1988. Biochemistry, 3rd Edition, Q. H. Freeman and company, NewYork.
3. Murray, R. K., Granner, D. K., Mayes P. A. Rodwell, V. W. 1988. Harper's Biochemistry. 22nd edition, Prentice Hall International.
4. Conn, E. E., Stumpf, P. K., 1994, Outlines of Biochemistry, 4th Edition, Wiley Eastern Limited, new age International Limited.
5. A. C. Dev, Fundamentals of Biochemistry.

Course Title: Basic Biochemistry Lab

Course No.: GEB 132 Credits: 01 Contact Hours: 02 Hours/week

Course: GEB 134: Basic Biochemistry Lab	**Credit Hour: 01**	**Year: 1st**	**Semester: II**
Rationale: This course aims to provide a fundamental understanding of the biomolecules in an experimental way to enable students to acquire a specialized knowledge to understand the basics of biochemistry.			
Course Objectives: The course is aimed to teach the students to identify and quantify the different components of biomolecules like different carbohydrates, lipids, amino acids, vitamins etc in an lab based experimental way.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Identify and quantify carbohydrates • Quantify different lipids (Cholesterol, HDL, LDL) in blood • Quantify ascorbic acid in biological/plant sample			
Teaching Strategy: Lecture, Animation, Field visit, Experiment in lab			
Assessment Strategy: Quize, Q/A, MCQ, Assignment, Lab report			
Course Contents			
1. Identification of Carbohydrates			
2. Estimation of ascorbic acid content of biological samples.			
3. Determination of lactose content of milk.			
4. Estimation of glucose from supplied sample.			
5. Estimation of cholesterol from supplied sample.			
6. Estimation of iodine number of fats and oil.			
7. The estimation of iron content of Mohr's salt by dichromate method.			
8. Identification of amino acid by paper chromatography.			
9. Estimation of calcium by titration with potassium permanganate.			
10. Estimation of protein by Lowry method.			

Recommended References:

1. Murray, R. K., Granner, D. K., Mayes P. A. Rodwell, V. W. 1988. Harper's Biochemistry. 22nd edition, Prentice Hall International.
2. Conn, E. E., Stumpt, P. K., 1994, Outlines of Biochemistry, 4th Edition, Wiley Eastem Limited, new age International Limited.
3. A. C. Dev, Fundamentals of Biochemistry.

Course Title: Cytology

Course No.: GEB 133 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-133: Cytology	Credit Hour: 03	Year: 1st	Semester: II

Rationale: This course is most important for biotechnology due to all biological activities is in a cell while the cell is a structural and functional unit of life.

Course Objectives:

The course is designed to teach the students about the cell, cell components and their function, to know the chromosomes and genetic materials with different types of chromosomal disorders with solving strategies, to know how to study a cell or tissue.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Know the basic cytological methods, cell structures, and instrumental laboratory methods
- Develop laboratory work ability
- Know the documentation of microscopic observation
- Know the methods which deal with specimen preparation

Teaching Strategy: PPT Lecture, Projector Display, Audio Visual, etc.

Assessment Strategy: Q/A, Short Essay, MCQ, Assignment, Exercise, Short Answer, Short Question, Seminar, etc.

Course Contents

Introduction: Historical background of the cell, cell discovery, and organelles. Definition and modern concept of a cell, protoplasm theory. Cell types and structure: Eukaryotic and prokaryotic cells. The typical structure of the eukaryotic and prokaryotic cell and their functions.

Cellular Organelles: Major cellular organelles, composition, structure and function. Cell wall membrane, plasma membrane, nucleus, endoplasmic reticulum, golgi bodies, mitochondria, chloroplast, ribosome, lysosome, cytoskeletal structure.

Nucleus and Chromosome: Structure and function of the nucleus, types of chromosome, morphology, and chemistry of chromosome, the function of chromosome

Cytogenetics: Definition, karyotyping, banding patterns of chromosomes, chromosomal disorders, nucleic acids.

Structural Changes of Chromosomes: *Deletion*- definition, types, phenotypic effect, genetic effect, *Duplication*- definition, types, Phenotypic effect, Bridge-breakage-fusion Cycle, Meiosis, and breeding behavior. *Inversion*, types, cytology, Identification of parasitic inversion. *Translocation*; Definition, types, origin, meiotic behavior,

Numerical Changes of Chromosome: Euploidy, Aneuploidy, polyploidy, Autopolyploidy and Allopolyploidy.

Cell Division: Types of cell division, steps of mitosis and meiosis, the difference between the two processes, Abnormalities in mitosis and meiosis, causes and significance. Spermatogenesis and Oogenesis

Techniques in Cell Biology: Different techniques used in cell studies.

Recommended References:

1. DeRobertis, E.D.P., and Derobertis.Jr.E.M.F.(1989).Cell and Molecular Biology. 8th Edition, Info. Med. Ltd. Hong Kong.
2. Smith and Wood (1996).Cell Biology 2nd edition. Chapman and Hall Co. Ltd. UK.
3. Gupta P.K., Cytogenetics
4. কোষ ও আনবিক জীববিদ্যা- প্রফেসর ড. মোহাম্মদ ফারুক মিয়া ও অন্যান্য। মল্লিক ব্রাদার্স, ঢাকা।

Course Title: Cytology Lab

Course No.: GEB 134 Credits: 01 Contact Hours: 02 Hours/week

Course: GEB 134: Cytology Lab	Credit Hour: 01	Year: 1st	Semester: II

Rationale: This course is designed to provide practical knowledge of cells- cell membrane, cell organelles and inclusions, cytophysiology.

Course Objectives:

On completion of the course, the student should have practical knowledge in cell divisions, chromosomal analysis, cell preparation in the cytologic investigation and other fields of application in cytology.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Recognize the sub-cellular structures, cell types, tissues, and organs
- Relate microscopic morphology to cell/tissue/organ function
- Appreciate the effects of cell preparation on morphology
- Appreciate the use of histological knowledge and techniques

Teaching Strategy: Lecture, Animation, Field visit, Experiment in lab

Assessment Strategy: Quize, Q/A, MCQ, Assignment, Lab report

Course Contents

1. Study of mitosis in onion root tip cells.
2. Study of meiosis in the pollen mother cells of onion/maize.
3. Effect of colchicine treatment on onion/garlic root tip chromosomes.
4. Effect of gamma - ray irradiation on onion/garlic root tip chromosomes.
5. Study of Giant chromosomes of 3rd instar larvae of *Drosophila melangaster* .
6. Study of chromosomal aberrations in the Chromosomes of *Musca domestica.*
7. Effect of different herbicides on salivary gland chromosome in *Musca domestica*.
8. Effect of different plant extracts on oocyte chromosome salivary gland chromosome in *Musca domestica*.

Recommended References:

1. Smith and Wood (1996).Cell Biology 2nd edition. Chapman and Hall Co. Ltd. UK.
2. Gupta P.K., Cytogenetics

Course Title: Principles of Genetics

Course No.: GEB 135 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-135: Principles of Genetics	Credit Hour: 03	Year: 1st	Semester: II

Rationale: This course covers genetics, the science of heredity, from its basic principles to the most recent advances in the field.

Course Objectives:

- To learn the basic principles of genetics from Mendel and his works, thy will know how sex is determined in plants and animals.
- Describe various types of genetic crosses and indicate when/why they would be used by a geneticist.
- To explain more complex modes of inheritance and compare the effects of linkage and crossing over on genetic outcomes and assess data.
- To define and identify the various types of mutations those occur at the DNA and protein levels, and students will also understand the relationship between modern and ……

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Describe human genetic diversity and its dynamics based on the principles of population genetics.
- Apply the principles of inheritance as formulated by Mendel.
- Apply the principles of extensions to Mendelian inheritance, including multiple allelism, lethal alleles, gene interactions, and sex-linked transmission.
- Describe normal chromosome number, structure, and behavior in human cells, and understand the cause and effect of alterations in chromosome number and structure.
- Understand how to identify and classify mutations in DNA.
- Explain deviations from fundamental genetics in eukaryotes

Teaching Strategy: Lecture, Discussion, Exercise, Q and A, etc.

Assessment Strategy: MCQ, Test, Assignment, Quiz etc.

Course Contents

Introduction*:* Historical background of genetics. The modern concept of genetics, Scope and branches, Application and Importance of genetics in human society. Some important genetical terms. Heredity and variation.

Mendelian Genetics*:* The Life history of Mendel. Discovery of Mendel works. The experiment of Mendel work. Mendel's law of segregation and independent assortment. *The exception of Mendelism:* Modification of Mendelian ratios. Lack of dominance, co-dominance, over dominance, Epistasis, interaction, lethal gene.

Multiple Alleles: Multiple allelism, Characteristic features, inheritance pattern of a multiple of rabbit coat color, pleiotropism human and plants. Blood groups inheritance in man and plasma protein polymorphism in man.

Linkage and Crossing over Linkage, crossing over, different kinds of linkage and crossing over and their significance, linkage groups. Factor affecting the strength of linkage, cytological demonstration of crossing over. Linkage maps of Drosophila, chromosome map.

Sex Determination*:* Cytological and genetic basis of sex determination. Different mechanism of sex determination in plants, animals and its implication.

Mutation*:* Definition, types of mutagen and mutation, characteristics, causes and effects of gene mutation and mechanism.

Cytoplasmic Inheritance: Extra nuclear inheritance in prokaryotes and Eukaryotes, Plasmid, Mitochondrial and Chloroplast DNA, Maternal inheritance.

Recommended References:

1. Verma, P.S. and Agarwal, V.K 1985.Genetics *(6th edn*) S. *Chand and Co. Ltd. New Delhi.*
2. Gardner, E.J., Simmons, M.J. andSnustad. D.P. 1991. : *Genetics (18th ed*) John Wiley and Sons. New York.
3. Strickberger, M.W. 1968. : *Genetics.* McMillan, New York.

Course Title: Plant Physiology

Course No.: GEB 137 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-137: Plant Physiology	**Credit Hour: 03**	**Year: 1st**	**Semester: II**

Rationale: The learning of the major physiological processes which occur during plant growth and development and their interaction with the external environment.

Course Objectives:

This course provides an introduction to basic principles of plant function, primarily covering physical processes in plants, metabolism, secondary products, different physiological

processes, and introducing principles of growth and development.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- state the importance of photosynthesis, factors affecting photosynthesis, the photosynthetic pigment, and describe the biochemistry of photosynthesis;
- define respiration and itemize detailed processes of cell respiration and gaseous exchange in flowering plants;
- list and describe the transpiration, absorption and movement of mineral salts and water through the leaf: apoplast pathway, symplast pathway and vascular pathway, list the environmental factors that have a significant effect on transpiration;
- list and describe the features of phloem translocation;
- draw the different types of growth curve from growth parameters list the different types of patterns of growth and give specific examples of each;
- list and describe the plant growth hormones(PGRs), Vitamins and photoperiodism etc;
- itemize and describe the important physiological factors affecting crop yield;
- Understand the effect of different parameters on the flowering of plants;

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc.

Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Plant life related physicochemical phenomenon: Inhibition, diffusion, osmosis, osmotic pressure, plasmolysis, imbibition, colloid state and root pressure.

Water Retention: Mechanism of absorption of water, active and passive absorption, external factors affecting absorption, conduction and translocation.

Loss of Water: Transpiration, guttation, type, significance, mechanism of opening and closing of stomata, factors affecting transpiration.

Essential Elements: Source, the general function of micro and macro elements in plant growth and development, deficiency symptom.

Mineral Nutrition: Mechanism of mineral salt absorption and translocation.

Photosynthesis: General account and modern concept, pigments in prokaryotes and eucaryotes, light and chemical reactions, photophosphorylation, factors affecting photosynthesis, pathways of carbon-di-oxide reduction in C_3, C_4 and CAM plants, source and sink relationship, significance.

Respiration: Respiration of plant and microbes, types, respiratory substances, different pathways, fermentation, efficiency of respiration, production of high energy compound and ATP, photorespiration.

Growth: Definition, basic concepts of growth and development, measurement, vegetative and reproductive growth, phages of growth, factors affecting growth and development, principle and problem of cell differentiation and morphogenesis in plants, senescence, type and causes of senescence.

Growth-Regulating Chemicals (Hormones): Definition, occurrence, classification, nature and effect of growth regulating chemicals on plant growth and development with special emphasis on auxin, gibbrellin, cytokinin/ kinin, abscisic acid, ethylene, and plant growth retardants.

Physiology of Flowering: Mechanism of flowering, florigen and its role in flowering, light

image, and flowering,
Photoperiodism and Vernalization: Definition, types, importance, etc
Seed: Viability, causes of losses of seed viability, germination of seeds, causes and artificial breaking of dormancy.
Light and Plant Life: Light sensing by plants, photomorphogenesis, phytochrome and blue light photoreceptors, the effect of UV light on the biological system, the significance of biological clocks.

Recommended References:

1. Datta, S. C. 1994. Plant Physiology. Wiley Eastern Ltd. New Delhi.
2. Devlin, M. R., and Witham, H. F. 1986. Plant Physiology. CBS Publishers and Distributors, New Delhi.
3. Hess, D. 1975. Plant Physiology. Springer International Student Edition.
4. Pandey, S. N., and Sinha, B. K. 1990. Plant Physiology. Vikash Pub. House Pvt. Ltd.

Course Title: Title: Plant Physiology Lab

Course No.: GEB 138 Credits: 01 Contact Hours: 02 Hours/week

Course: GEB-138: Plant Physiology Lab	**Credit Hour: 01**	**Year: 1st**	**Semester: II**
Rationale: This course consists of a series of laboratory exercises to familiarize students with main concepts and techniques in plant physiology.			
Course Objectives: To learn some aspects of plant physiology like- diffusion, osmosis, osmotic pressure, transpiration, photo-periodisom by hands-on experience and to become acquainted with techniques and methods often used in those areas of plant physiology.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • learn some common research techniques used in plant physiology • increase their appreciation for plants and their complex, integrated nature • increase their understanding of how plants grow, develop and sense their environment • learn to prepare a short research proposal			
Teaching Strategy: Lecture, Animation, Field visit, Experiment in lad			
Assessment Strategy: Quiz, Q/A, MCQ, Assignment, Lab report			
Course Contents			
1. Experiments on diffusion, osmosis, osmotic pressure, plasmolysis, imbibition process.			
2. Experiments on the determination of the presence of starch on a plant leaf and seed.			
3. Experiments on Transpiration, guttation.			
4. Determination of essential elements			
5. Seed germination and seed viability test.			
6. Test of photo periodical.			

Recommended References:

1. Devlin, M. R., and Witham, H. F. 1986. Plant Physiology. CBS Publishers and Distributors, New Delhi.
2. Pandey, S. N., and Sinha, B. K. 1990. Plant Physiology. Vikash Pub. House Pvt. Ltd

Course No. CSE 203J
Course Title: Introduction to Computer Languages
Credit: 02, Contact Hours: 02 Hours/week

Course No. CSE 204J
Course Title: Introduction to Computer Language Lab
Credit: 02, Contact Hours: 02 Hours/week

Course No.: MAT 201J GEB
Course Title: Mathematics
Credit: 02, Contact Hours: 02 Hours/week0.

Course Title: Introductory Animal Sciences

Course No. GEB 201I (For BMB) Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-201I (For BMB): Introductory Animal Sciences	**Credit Hour: 03**	**Year: 1st**	**Semester: II**

Rationale: To develop the students' appreciation, understanding, and practical capability in all aspects of Animal Science

Course Objectives:

The course Introduction to Animal Science is therefore designed to provide students with fundamental knowledge and skills in the fields of Animal behaviors, handling of animals, Physiology, Nutrition, Breed and breeding, Animal health, Ecology and management of various species of domestic animals.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Apply concepts of classification, breeding, physiology, nutrition, herd-health, economics and management into practical and profitable animal production programs.
- Understand the role of nutrition in animal production.
- Explain the mechanisms and role of reproductive physiology in livestock production.
- Demonstrate critical thinking and problem-solving skills as they apply scientific principles to a variety of animal production systems.
- Understand how the application of modern animal production technologies and management practices impact their production facilities, their communities, and the world.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit, etc.

Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Short Answer, Short Question, PS (Problem-solving), etc.

Course Contents

Classification: General classification of a major phylum of Animal Kingdom.

Anatomy of higher Animals: Comparative anatomy (Skeletal, circulatory, digestive, respiratory, excretory and reproductive systems) of higher animals (Human, Cattle, Goat etc).

Type study of Animals: Type study including habitat, distribution, external morphology, organ system, economic and biotechnological significance of the following: Arthropoda (*Macrobrachium rosenbergii*), Mollusca (*Lamellidens* sp.), Pisces (*Labeo rohita*), Aves

(*Gallus domesticus*) and Mammalia.
Laboratory Animals: Different animals used in laboratory for practical and research purposes.
Animal Ecology: Definition, branches, ecosystem, relationship of ecology with other discipline. Effect of environment and human habitation on animal adaptation and their relationship with civilization.
Economic study of Animals: Apiculture, sericulture, poultry and dairy farming including technical, commercial and financial aspects.
Major diseases of Animals: Major Microbial (Viral, bacterial, fungal), Parasitic (protozoan, helminth) Metabolic and Nutritional diseases of poultry birds, dairy animals with their causal agents, aetiology, pathogenisis, clinical symproms , diagnosis, treatment and control measures.

Recommended References:

1. Getty, R. : Sisson and Grossman's The anatomy of the Domestic animals, 5th edition, W.B. Saunders and Co. Philadelphia (USA).
2. Hairston, N. G. 1994. Vertibrate Zoology- An Experimental Field approach. CUP.
3. Jardan, E. I. and Verma, P. S. Invertibrate Zoology. S. Chand and Com. Ltd. New Dilhi
4. Jardan, E. I. and Verma, P. S. Chordate Zoology. S. Chand and Com. Ltd. New Dilhi.
6. Parker, T. J. and Haswell, W. A. 1990. A Text Book of Zoology. Vol. I and II. Low Price Publication India.
5. R.K. Ghosh. Primary veterinary anatomy; Current books international, kolkata, 4th edition (2006)
8. Storer, T. I. General Zoology. Tata Megraw Hill Pub. Co. Ltd. India.
9. Young, J. 1981. Life of Vertebrate. OUP, USA.
10. Frost, S.W., Economic Zoology.
11 Srivastava, P.D. Economic Zoology.

Course Title: Introductory Animal Sciences Lab

Course No: GEB 202I (For BMB) Credits: 02 Contact Hours: 02 Hours/week

Course: GEB-202I (For BMB): Introductory Animal Sciences Lab	**Credit Hour: 02**	**Year: 1st**	**Semester: II**
Rationale: The course Introduction to Animal Science Lab is to present basic facts and principles that are essential for the human use and care of animals.			
Course Objectives: The course will provide practical knowledge of wild life, internal anatomy of different invertebrates and vertebrates, as well as practical commercial applications, such as disease prevention, artificial insemination. Labs and field trips will provide opportunities to gain practical knowledge and to better understand the animals.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Know the scientific importance and physical requirements associated with aspects of animal handling, breeding, feed, maintenance, and minor surgical pGEB3312rocedures. • Know the morphology of different invertebrates and vertebrates, internal anatomy of different invertebrates and vertebrates. • Develop the ability to handle a variety of animal species, including the collection of material from these specimens			
Teaching Strategy: Lecture, Animation, Field visit, Experiment in lad			

Assessment Strategy: Quiz, Q/A, MCQ, Assignment, Lab report
Course contents
1. Terrestrial ecology and wildlife study
2. Field visit and sample collection
3. Spot identification including whole animals, parts of animals and slide of different invertebrates and vertebrates
4. External morphology of different invertebrates and vertebrates
5. Internal anatomy of different invertebrates and vertebrates (Dissection, drawing and labeling)
6. Study of articulated bone
7. Slide mounting
8. Invertebrate culture including Drossophila in laboratory setup

Recommended References:

1. Parker, T. J. and Haswell, W. A. 1990. A Text Book of Zoology. Vol. I and II. Low Price Publication India.
2. Jardan, E. I. and Verma, P. S. Invertibrate Zoology. S. Chand and Com. Ltd. New Dilhi.

Course Title: Animal and Human Physiology

Course No.: GEB 211 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-211: Animal and Human Physiology	**Credit Hour: 03**	**Year: 2nd**	**Semester: I**
Rationale: This course is designed for detailed study of the physiological processes of all body systems of the human body and different economical important animals on an appropriate level (knowledge, comprehension, application and analysis). It also provides fundamental principles of physics and chemistry to the understanding of the body's function and regulatory mechanisms.			
Course Objectives: • To learn about how the human and higher animal body works. • To understand the role of body systems and mechanisms in maintaining homeostasis and how the activities of organs are integrated for maximum efficiency. • Describe the fundamental mechanisms underlying normal function of cells, tissues, organs, and organ systems of the human body, commensurate with the requirements for a physician providing primary care to patients. • To train student to solve physiology and related common clinical problems by applying physiologic principles.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Understand the physiological processes that regulate body functions and the regulation of an organ system from the molecular all the way to the whole animal level • Describe interactions between different organ systems (homeostasis) • Know the anatomy of different physiological systems and their specific functions • Understand how changes in one system may impact a different system • Be able to apply knowledge of a physiological mechanism to explaining how a whole animal physiological process occurs.			
Teaching Strategy: Class Lecture, Projector Display, Animation, Discussion, Visit etc.			
Assessment Strategy: Q/A, Quiz, Assignment, MCQ, Short essay			
Course Contents			

General Physiology*:* Introduction, definition, branches of physiology, glossary and terminology related to physiology.
Circulation and Transport: Definition and different composition of blood and plasma proteins, their structure, functions, development and fate. Blood coagulation mechanism, blood groups, lymphoid system. Structure and properties of cardiac muscle, generation and conduction of cardiac impulse. E.C.G, events of cardiac cycle and cardiac outputs, factor affecting heart rate, haemodynamics, blood pressure and its regulation, fetal circulation and maternal circulation.
Respiration*:* Different parts of respiratory system, functions and pulmonary circulation, mechanisms of respiration. O_2 and CO_2 transport in the body, regulation of respiration-nervous and chemical.
Excretion: Functions of kidney, renal circulation, Nitrogenous excretory substances of different animals. urine formation in mammals, birds, reptiles. Filtration, reabsorption of different components of tubular fluid, excretion, concentration of urine, concept of plasma clearance, acidification of urine.
Osmoregulation: Osmoregulation of aquatic organisms in freshwater and marine environment.
Digestion: Functions of digestive system, digestive enzymes, mechanisms of secretions of gastric juice, physiology of digestion and absorption of food (carbohydrates, proteins and fats).
Reproduction: Physiology of reproductive systems, puberty, estrous and menstrual cycle, physiology of gestation and milking.
Endocrine Function: Endocrine and exocrine glands of male and female, growth and sex hormones, structure, functions and mechanisms of regulation of hormones.
Co-ordination and reflex action: Classification of nervous system, structure and functions of neuron, synapse, neurotransmitter and transmission of nerve impulse, control of sensory and motor function. Organization of nervous system, cerebral cortex, brain stem, cerebellum and spinal cord.
Physiology of Special Senses: Physiology of special sensory organs concern with vision, sound perception, taste, and smell and touch.

Recommended References:

1. Ganong, W. F., :*Review of Medical Physiology.*
2. Guyton, A. C. and Hall, J.E.,:*Textbook of Medical Physiology*
3. Hafez, E.S.E: Reproduction In Farm Animals
4. Swenson, M.J. : Duke's Physiology of Domestic Animals.

Course Title: Animal and Human Physiology Lab

Course No.: GEB 212 Credits: 01 Contact Hours: 2 hours/week

Course: GEB-212: Animal and Human Physiology Lab	**Credit Hour: 01**	**Year: 2nd**	**Semester: I**
Rationale: Animal and Human Physiology Lab is a course that will provide practical knowledge on body functions, general anatomy, and physiological processes of the animal and human body.			
Course Objectives:			

Knowledge and understanding of the anatomical body structures and organs and how these are combined into organ systems within the body. Knowledge and understanding of the physiological processes associated with the body and how they interact and function.
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Know the parts of the body are linked into a functioning whole • Acquire practical knowledge of physiological techniques • Write about physiological topics.
Teaching Strategy: Lecture, Animation, Field visit, Experiment in lad
Assessment Strategy: Quiz, Q/A, MCQ, Assignment, Lab report
Course Contents
1. Study of injecting procedure
2. Blood collection
3. Preparation of blood smears
4. Morphology and enumeration of blood cells
5. Sedimentation rate of blood (ESR)
6. Estimation of Packed Cell Volume (PCV)
7. Estimation of Hemoglobin
8. Determination of blood group
9. Measurement of pulse rate and blood pressure
10. Measurements of blood sugar
11. Determination of serum lipid profile
12. Intra-peritoneal glucose tolerance test
13. Measurement of urine protein
14. Plasma protein electrophoresis
15. Study of animal tissue histology

Recommended References:

1. Guyton, A. C. and Hall, J.E.,: *Textbook of Medical Physiology*
2. Stacy, R. W., : Modern College Physiology.

Course Title: Molecular Biology

Course No.: GEB 213 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-213 : Molecular Biology	**Credit Hour: 03**	**Year: 2nd**	**Semester: I**
Rationale: This course intends to provide a substantial introduction to modern cellular and molecular biology.			
Course Objectives: The major learning objectives of this course are: • The development of an understanding of basic knowledge of DNA, genomes, genes, transcription, RNA, translation, gene expression and gene regulation. • Understand fundamental knowledge of molecular and cellular processes: epigenetics, protein synthesis, protein targeting and trafficking, and cell signaling • and the familiarization of students with the experimental approaches used in molecular biology.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Exhibit a knowledge base in genetics, cell and molecular biology, and anatomy and physiology • Demonstrate the knowledge of common and advanced laboratory practices in cell and			

molecular biology • Exhibit clear and concise communication of scientific data • Engage in review of scientific literature in the areas of molecular biology
Teaching Strategy: Class Lecture, Projector Display, Animation, Discussion etc.
Assessment Strategy: Q/A, Quize, Assignment, MCQ, Short question, Short essay
Course Content
Introduction: Chemistry of nucleic acids, structure, physico-chemical properties, molecular weight determination of nucleic acids, structure and physico-chemical properties of DNA and RNA, hybridisation kinetics, homoduplex, different configuration of cruciform structure.
Central dogma of Molecular Biology- **i) DNA Replication:** Mode of replication, types of replication, DNA synthesis, mechanism and control of DNA replication, inhibitors of replication, DNA polymerase and other replication proteins, RNA viruses, replication of RNA genome.
ii) Transcription: RNA polymerase, promoter, enhancers and terminators, mechanism of transcription, reverse transcriptase, regulation of transcription, operon model and RNA spicing, genetic codes, its characteristics, specificity, Redundancy and Wobble hypothesis, gene and protein structure.
iii) Translation: Ribosome structure, initiation, elongation and termination of protein synthesis, compare of protein synthesis in eukaryotes and prokaryotes, inhibitors of protein synthesis, post-translational modification.
Molecular Mutation: Molecular basis of mutation, in vitro mutagenesis, and site directed mutagenesis, transposable elements, repair mechanism in mutation.
Regulation of Gene Expression: Gene from different kinds of RNA, RNA polymerase, positive and negative control of gene expression, gene expression of somatic cell hybrids.
Molecular Biology of Organelle: Genomes of the mitochondria and plasmid, interaction with nucleus, duel control of its synthesis.
Dynamic Genome: The dynamic genome, mobile genetic elements in eukaryotes – relevant to plants, studies in maize.

Recommended References:

1. Adams, R.L.P., Burden, R.H., Camphel, L.D.P., Smelline,R.M.S.(1981). The Biochemistry of the Nucleic acids. 9th edition, Campbell and Hall.
2. De Robertis, E.D.P. and De robertis Jr. E.M.E.(1988). Cell and Molecular Biology.8th edition ,Info-Med.
3. Lehninger, Albert, L., Nelson David, L., Cox, Michael, M., Principles of Biochemistry, 1st Indian Edition, 1993. CBS Publisher's and Distibutors.
4. Strayer, Lubert, 1988. Biochemistry, 3rd Edition, Q. H. Freeman and company, NewYork.
5. Murray, R. K., Granner, D. K., Mayes P. A. Rodwell, V. W. 1988. Harper's Biochemistry. 22nd edition, Prentice Hall International.
6. Conn, E. E., Stumpt, P. K., 1994, Outlines of Biochemistry, 4th Edition, Wiley Eastem Limited, new age International Limited.
7. A. C. Dev, Fundamentals of Biochemistry.

Course Title: Enzymology

Course No.: GEB 217 Credits: 02 Contact Hours: 2 Hours/week

Course: GEB-217: Enzymology	**Credit Hour: 02**	**Year: 2nd**	**Semester: I**
Rationale: This course provides the basic knowledge and information on enzymology. It will emphasize on enzyme based catalytic models, enzyme kinetics and factor affecting enzyme catalysis rate and enzyme inhibition. Students will be introduced theoretically with mechanisms based on which therapeutic drugs are used on enzyme mediated metabolic			

pathways.

Course Objectives:

- Give basic concepts of enzymes and inhibitors.
- Explain the function and action of enzymes.
- Illustrate enzyme regulation and inhibition and their application in industries like drug, agriculture etc

Intended Learning Outcomes (ILOs):

At the end of the course the students will be able to-

- Enrich basic knowledge of enzyme
- Describe enzyme kinetics, regulation and inhibition
- Know the use of enzymes in drug industries, agricultural industries and other sectors.

Course Contents

Introduction: Brief history, enzymes as biological catalysts, classification, nomenclature, enzyme assay, specific activity, enzyme activity units.

Factors Affecting the Rate of Enzymatic Reactions: substrate concentration, enzyme concentration, pH, temperature, coenzyme and cofactor.

Enzyme Kinetics: Monosubstrate reactions, Michaelis-Menten equation and its linear transformations, K_m, V_{max}: definition, determination and significance. Double reciprocal plot or Lineweaver-Burk equation, kinetics of enzymatic reactions having two or more substrates.

Enzyme Inhibition: Reversible inhibition, competitive, non-competitive and uncompetitive inhibition. Irreversible inhibition, specific examples.

Specificity of Enzymes: absolute specificity, broad specificity, intermediate specificity, and stereospecificity.

Enzyme Regulation: Allosteric enzymes, cooperativity special characteristics, Monod and Koshland models, covalent modification of enzymes, specific examples (Ribonuclease, ATPase, phosphorylase, and dehydrogenase).

Mechanism of Enzyme Action: Chymotrypsin, Ribonuclease A, Lysozyme etc.

Recommended References:

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

Course Title: Animal Reproduction and Embryology

Course No.: GEB 221 Credits: 02 Contact Hours: 2 Hours/week

Course: GEB-221: Animal Reproduction and Embryology	**Credit Hour: 02**	**Year: 2nd**	**Semester: I**

Rationale: The overall aim of the module is to enable students to understand the physiology of reproduction and the underlying principles and application of the methods used to artificially control reproduction and achieve genetic improvement.

Course Objectives:

The module combines basic understanding of the various aspects of reproduction in animal and the stages of embryogenesis of a range of organisms (from lower vertebrates to mammals) with an introduction to modern experimental analysis of developmental mechanisms. Topics covered include oogenesis, fertilization, cleavage, gastrulation,

neurulation and organogenesis in vertebrate and invertebrate species; developmental strategies in determinate and regulative embryos;

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- discuss the comparative structure and function of the male and female reproductive systems
- discuss the physiology of gametogenesis, embryogenesis, pregnancy, parturition and lactation
- explain the endocrine, neuroendocrine and environmental factors regulate reproduction
- explain how to apply this information to strategies for the management of reproduction and fertility in human and animals; including the application of assisted reproductive technologies
- critically evaluate the advantages/disadvantages of current and developing reproductive technologies
- locate and critically evaluate scientific literature and experimental studies relating to reproduction and be able to effectively communicate the findings in oral and written form

Teaching Strategy: Lecture, Projector display, animation, Group discussion etc

Assessment Strategy: Q/A, Quize, Test, Short essay, MCQ, Assignment

Course Contents

Introduction: Definition and Scope of animal reproduction, relationship of reproduction with genetics, breeding and as well as biotechnology, types of reproduction in various species of animals, adaptive mechanisms of individuals with respect to reproductive ability, factors responsible for reproduction, fundamental characteristics of reproduction, present status and future outlook of animal reproduction.

Reproductive System: Male and female reproductive system of economically important animals (cattle, buffalo, sheep, goat, pig and poultry).

Reproductive Endocrinology: Hormone and receptors related to animal reproduction, classification, properties function and mode of action of reproductive hormones, endocrine regulation system governing male and female reproduction, hormone assay, hormone like substances- growth factor and prostaglandins. Relationship between Genetics and endocrinology, endocrine and nervous system. Use of synthetic and placental hormone. Transport and survival of gametes and embryos in vivo.

Germ Cells: Primordial germ cells, life history of the germ cells, oogenesis, biochemical aspects of oogenesis, ovulation, follicular atresia, the structure of the egg, spermatogenesis, sperm transport in the male and female genital tract, egg 'pick-up', movement of egg along the fallopian tube.

Reproductive Cycle and Sexual Behavior: Puberty, modern concept of the attainment of puberty in male and female, practical application of puberty, estrous cycle, endocrine mechanism of sexual behavior, endocrine, physiologic and behavioral changes during estrous in different farm animals, breeding season and its effect on reproduction.

Fertilization, Pregnancy and Parturition: Fertilization, preparation of gametes, acrosome reaction, interaction of spermatozoa with the zona pellucida, gamete fusion, activation of the egg, cleavage, blastocyst formation, implantation, embryonic and fetal development, act of parturition.

Reproductive Diseases and Reproductive Failure: Common diseases of reproduction in both sexes of farm animals, reproductive disorders, recommended practices for improving fertility.

Reproductive Efficiency: Measures of reproductive efficiency, factors responsible for efficient reproduction, means of improving reproductive efficiency.

Developmental Biology: The origins of developmental biology, Concepts in development– Developmental signals in cell division and differentiation, Role of gene expression in development, Identifying developmental genes, Cell commitment and differentiation, Determination and induction of cell fate, Concept of morphogen and positional information, Cell differentiation and its model, molting and metamorphosis.

Recommended References:

1. Austin C.R and Short, R.V.: Reproduction in mammals: Book 2. Embryonic and fetal development.
2. Austin C.R and Short, R.V.: Reproduction in mammals: Book 3. Hormonal control of reproduction.
3. Hafez, E.S.E.: 1993. Reproduction in farm animals. (6^{th} edn) Lea and Febiger, Philadelphia.
4. Lamming , G.E : Marshall's Physiology of Reproduction. 1990 (4^{th} edn) Churchill Livingstone, London.
5. Austin C.R and Short, R.V. : Reproduction in mammals: Book 1, Germ cells and fertilization.
6. "Developmental biology" by Scott Gilbert

Course Title: Biofertilizer and Renewable Energy

Course No.: GEB 223 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-223: Biofertilizer and Renewable Energy	**Credit Hour: 03**	**Year: 2nd**	**Semester: I**

Rationale: This course will give an overview of different types of biofertilizers used in Bangladesh and worldwide and their production procedure and to introduce students to renewable energy resources availability, potential and deplorability as a substitute for conventional energy resources in future energy demand.

Course Objectives:

- The students would be able to know the scientific method of biofertilizer production, application and the broad spectrum of renewable energy technologies.
- Describe the principles of operation of the broad spectrum of biofertilizer production technologies.
- They also get knowledge of the most important renewable energy sources, like solar heating, solar photovoltaic, biomass energy, hydro power and wind power and different types of renewable energy made from biological agents and their feasibility to meet the energy demand in perspective of Bangladesh.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Develop competency in identifying biofertilizer and renewable energy resources availability and utilization.
- Develop competency in rating different renewable energy technologies
- Students demonstrate competency in renewable systems analysis, independently.

Teaching Strategy: PPT lecture, Lecture, Animation, Group discussion, Problem solving etc

Assessment Strategy: Q/A, Short question, MCQ, Short essay, Assignment etc

Course Contents

Introduction: Definition, types of biofertilizer,, importance of biofertilizer for different crops, mass cultivation, Soil fertility,

Nitrogen Cycle and Nitrogen Fixation: Sources of nitrogen, N2-cycle, forms of soil nitrogen, amount of nitrogen-fixed. Factors affecting nitrogen fixation. Methods discharge of electricity, activity of symbionts, activity of free fixers, manufacture of synthetic nitrogen. Interactions of O2 with N2- fixation; supplies of electrons; energy requirement for N2 fixation. Mechanism of penetration of Rhizobium into roots, signal exchange before cell

infection, interaction at the root hair surface infection, infection thread development and nodulation; function of the nodule; measurement of N2 fixation. Factors affecting nodule development.
Nitrogenase: Discovery, nature and mode of action and mechanism of nitrogen-fixation.
The Nif genes: Nif+ and Nif- ; genetics of Nif in Klebsiella pneumoniae; structure and regulation of Nif genes in K. penumoniae, Rhizobium and Anabeana.
Isolation, Identification and Classification of Microorganisms used as Biofertilizers: Rhizobium, Azotobacter, Azospirillium, Frankia and Mycorrhizae.
Production of Biofertilizers: a) *Rhizobium*: 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.
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, pay off from BGA inoculant.
General Discussion on- Azolla, green manure, algae and soil reclamation, organic matter composting and phosphate solubilizing microorganisms, benefits from biofertilizers.
Renewable Energy: Introduction: Sources of energy, types of energy.
Biomass: Sources of biomass, composition of biomass, terrestrial and aquatic biomass, formation of biomass.
Solar Energy: Photosynthesis, solar energy as a fuel replacement, production of hydrocarbon from plants.
Biomass as Fuel Energy: Methods of biomass for energy, different types of fuels, biomass fuel fields, Hydrolysis, municipal solid waste.
Biomass Conversion: Non-biological process and biological process.
Gaseous Fuel: Biogas and Hydrogen, Procedure for biogas making and its utility, production of Hydrogen from biomass.
Liquid Fuel: Alcohol- ethanol production from biomass, future prospects of industrial alcohol bio diesel, bio butanol etc.
Biomass and Environment: Environmental impacts and remedies, other important issues.

Recommended References:

1. Carl. W. Hall, 1981. Biomass as an Alternative Fuel. Govt. Institutes, Inc. USA.
2. Dubey, R. C. 2004. A text Book of Biotechnology. S. Chand and Co. Ltd. New Delhi-110055
3. Gary Stacey, Robert H. Burris and Harold J. Evans. 1997. Biological Nitrogen Fixation. First Indian edition, CBS Publishers and Distributors, New Delhi, India.
4. Klass, Donald E., Emert, George 11, 1981.Fuels from Biomass and Waste. Ann Arbor Science Pub. Ins. USA.
5. Mital, K. M. 1996. Biomass System-Principles and applications. New Age international (P) Ltd. India
6. Postagate J. R. 1982. The Fundamentals on Nitrogen Fixation. First Edition, Cambridge University Press, Cambridge CB21RP

Course Title: Biofertilizer and Renewable Energy Lab

Course No.: GEB 224 Credits: 01 Contact Hours: 2 hours/week

Course: GEB-224: Biofertilizer and Renewable Energy Lab	**Credit Hour: 01**	**Year: 2nd**	**Semester: I**
Rationale: The main purpose of this course is to introduce students to biofertilizer and			

renewable energy resources availability, potential and deplorability as a substitute for future demand.
Course Objectives: Advanced knowledge about potential of using biofertilizer and renewable energy technologies as a complement and to the extent possible;
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Analysis on importance of biofertilzer and renewable energy solutions for sustainable development • Able to identify sustainable energy solutions for sustainable development
Teaching Strategy: PPT lecture, Lab experiment, visit etc
Assessment Strategy: Short question, MCQ, Lab report, viva etc
Course Contents
1. Isolation, characterization and identification of the following microorganisms: Rhizobium, spp. Azotobacter spp. and BGA.
2. Nodulation experiments.
3. Biofertilizer preparation and seed treatment
4. Study on algalization technique.
5. Study on Azolla spp. mass cultivation of Rhizobium etc.
6. Organic matter composting processes.

Recommended References:

1. Gary Stacey, Robert H. Burris and Harold J. Evans (1997). Biological Nitrogen Fixation. First Indian edition, CBS Publishers and Distributors, New Delhi, India.
2. R.C. Dubey, A Textbook of Biotechnology (2007). S. Chand and Company Ltd., New Delhi-110055.

Course Title: Microbial Genetics

Course No.: GEB 225 Credits: 03 Contact Hours: 36 Total Marks: 100

Course GEB-225: Microbial Genetics	**Credit Hour: 03**	**Year: 2nd**	**Semester: I**
Rationale: This course is designed to introduce different aspects of microbial genetics. It starts with basic mechanisms of microbial and phage genetics which extends to their particular applications.			
Course Objectives: • To familiarize with fundamental organization and processes of microbial genome, plasmids and gene transfer. • To introduce phage genetics and applied microbial genetics in practice.			
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to- • Learn about microbial genome, plasmids, and gene transfer processes e.g. conjugation, transduction and transformation. • Familiar with phage genetics, transposable elements and use of molecular cloning.			
Teaching Strategy: PPT lecture, Lecture, Animation, Group discussion, Problem solving etc			
Assessment Strategy: Q/A, Short question, MCQ, Short essay, Assignment etc			
Course Contents			
Introduction: The evolution of microbial genetics, early concepts of bacterial variation; adaptation, mutation and selection; dominance and recessiveness of characters, difference with eukaryotic genetics.			
Regulation of Bacterial Gene Expression: General aspects of prokaryotic gene regulation;			

regulation of the metabolism of lactose-the *LAC* operon; catabolite repression; regulation of the biosynthesis of tryptophan-the *TRP* operon; two-component regulatory system.
Genetics of Bacteria: Bacterial conjugation, transformation, transduction, chromosomal transfer; interrupted mating experiments.
Plasmids: Types, transfer, replication, detection and construction of recombinant plasmid vectors.
Genetics of Fungi: Special study of Yeast genetics.
Genetics of Viruses: Genetics of bacteriophage; cosmid and phagemid vectors.
Yeast Genetics: Mating type genetics of yeast, yeast plasmid, mitochondrial inheritance of yeast.

Recommended References:

1. Avers, C. J. (1990). Genetics. Freeman and co. NY.
2. Broce, T. D. Madigan, M. T. Martinco, J. M. and Parker, J. (1990). Biology of Microorganism.
3. Hardy, K. M. (1986). Bacterial Plasmid. published by American Society of Microbiology.
4. Strickberger, M. W. (1990). Genetics. Macmillan pub. Co. NY.
5. Suzuki, Griffith and Miller. (1986). Introduction to Genetic Analysis. W. H. freeman and Co. USA.
6. Gardner, Simmons and Snustad (1991). Priciples of Genetics. John Wiley and Sons.
7. Tortora, Funke and Case (1998). Microbiology- An introduction, Wiley.

Course Title: Metabolism I

Course No.: GEB 231 Credits: 02 Contact Hours: 2 Hours/week

Course: GEB-231: Metabolism I	**Credit Hour: 02**	**Year: 2nd**	**Semester: II**
Rationale: The course is designed to develop student's knowledge and understanding of biochemical and molecular studies into metabolic pathways and processes occurring in living cells with a focus on human metabolism in health and disease.			
Course Objectives: The learning objectives of this course are: • The development of an understanding of basic knowledge of the biochemical conversions and molecular pathways of metabolism that are essential for the maintenance of living cells. • Understand the metabolic fates (synthesis/degradation/modification) of carbohydrate, lipid and protein in monogastric and ruminant species • Demonstrate an understanding and explain the central mechanisms of molecular regulation and control in normal metabolism and abnormal metabolism that leads to important metabolic diseases.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Demonstrate an understanding of the metabolic pathways - the energy-yielding and energy-requiring reactions in life. • Demonstrate an understanding of the diversity of metabolic regulation, and how this is specifically achieved in different cells. • Describe how these biochemical processes are not isolated but tightly integrated, with specific control sites and key junctions of biochemical reactions.			
Teaching Strategy: PPT lecture, Lecture, Animation, Group discussion, Problem solving etc			
Assessment Strategy: Q/A, Short question, MCQ, Short essay, Assignment etc			
Course Contents			
Introduction: General aspects of metabolism and experimental approaches to the study of			

metabolism, metabolic and energy transfer pathways, basic concept of the control of metabolism.
Carbohydrate Metabolism: i) Glycolysis (the glycolysis pathway, aerobic and anaerobic fate, regulation of glycolytic pathway, physiological importance of aerobic and anaerobic glycolysis). ii) Tricarboxylic acid cycle and its regulation. iii) Pentose phosphate pathway, glyoxalate pathway and their regulation. iv) Glycogen metabolism: Glycogenolysis, glycogenesis, and control of glycogen metabolism. v) Biosynthesis of carbohydrate: Gluconeogenesis, and its regulation, biosynthesis of dioligo and polysaccharides, glycoproteins, proteoglycan, sugar interconversions
Lipid Metabolism: Degradation of triglycerides and phospholipids, oxidation of fatty acids, propionate metabolism, ketone bodies (formation and utilization), utilization of fatty acids for energy production, oxidation and functional role of polyunsaturated fatty acids.
Protein Metabolism: Outline of metabolism of amino acids decarboxylation, oxidative deamination, transamination, urea cycle and toxicity of ammonia.
Biosynthetic Pathways: One carbon metabolism or biosynthesis of fatty acids (saturated and unsaturated), cholesterol, B-carotene, triglycerides, steroid hormones, prostaglandins, prostacyclin, thromboxane, phospholipids.

Recommended References:

1. Lehninger, Albert, L., Nelson David, L., Cox, Michael, M., Principles of Biochemistry, 1st Indian Edition, 1993. CBS Publisher's and Distibutors.
2. Strayer, Lubert, 1988. Biochemistry, 3rd Edition, Q. H. Freeman and company, NewYork.
3. Murray, R. K., Granner, D. K., Mayes P. A. Rodwell, V. W. 1988. Harper's Biochemistry. 22nd edition, Prentice Hall International.
4. Conn, E. E., Stumpt, P. K., 1994, Outlines of Biochemistry, 4th Edition, Wiley Eastem Limited, new age International Limited.
5. A.C. Dev, Fundamentals of Biochemistry.

Course Title: Plant Breeding

Course No.: GEB 235 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-235: Plant Breeding	**Credit Hour: 03**	**Year: 2nd**	**Semester: II**
Rationale: This course will serve as a general introduction to the principles of plant breeding, information pertaining to modification and improvement of a wide range of crops, including both agronomic and horticultural crop species important in temperate and tropical areas.			
Course Objectives: The course is designed: • To educate students in applying genetic techniques, statistical methods, breeding principles and methods to efficiently create and advance populations of plants from which there is a high probability of selecting superior cultivars or hybrids. • To provide knowledge of pollination, fertilization, and reproduction of plants and selection parameter, heritability, double haploid, fertility gene manipulation and genetic gain concept for plant improvement			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Understand pollination biology as it relates to plant breeding methods • Understand the concept of genotype x environment interaction, its impact on plant breeding programs and how to manage it • Determine the breeding methodology appropriate for different plant species and traits			

• Identify the regulations surrounding plant breeding, seed production and variety development • Be familiar with a private breeding program • Critically analyze journal articles related to plant breeding methods and approaches • Perform calculations related to plant population dynamics and Communicate aspects of plant breeding theory and practice to their peers
Teaching Strategy: Lecture, Projector display, Animation, Group discussion, visit etc
Assessment Strategy: Q/A, MCQ, Assignment, Quiz etc.
Course Contents
Introduction: Definition, history, scope and objectives of plant breeding. Genetic basis of plant breeding. Contribution of national research institutes for the development of improved varieties of important crops.
Plant Genetic Resources: Definition and classification of germplasm, Gene pool Concept, genetic erosion.
Self-incompatibility: Definition, cause, Classification on the basis of the interaction between Pollen grain and pistil, Heteromorphic and Homomorphic system of self-incompatibility, Mechanism, elimination and temporary suppression of self-incompatibility.
Apomixis: Definition, Ideal features of Apomictic system, Classifications, Genetics of Apomixis, Development of apomictic lines, Application of Apomixis, advantage and Problems in utilization of Apomixis.
Male Sterility: Definition, classifications, phenotypic expression, Genetic Male sterity, molecular mechanism of ms action. Types of genetic male sterility, TGMS and PGMS lines, Transgenic genetic male sterility and their utilization in plant breeding.
Hybridization Techniques and Consequences: Definition, objectives, prerequisites, advantages and disadvantages of hybridization. Selfing and crossing techniques, difficulties and precaution, rising of the F1 generation, techniques in field traits.
Heterosis and Inbreeding Depression: Heterosis; Types, scope, genetic, physiological and biochemical basis, use of heterosis in plant breeding. Inbreeding depression; Genetic effects of inbreeding depression (in plant, animals, human and fishes) practical application of inbreeding, genetical basis of heterosis and inbreeding depression.
Methods of Breeding: Self-pollinated crop; Mass selection, pure line selection, pedigree method, backcross methods and bulk method of selection and single seed discent method. Cross pollinated crop; Variety concept, mass selection, recurrent selection, inbreed lines and evaluation of inbreed lines (general combining ability and specific combining ability), synthetic variety.
Release and Evaluation of New Varieties: Distribution of improved seeds from laboratory to farmers. Production of hybrid and synthetic varieties.

Recommended References:

1. Allard, R. W. 1999. Principles of Plant Breeding. John Willey and Sons. New York.
2. Chopra, V. l. 1989. Plant Breeding. Oxford and IBH publishing Com. Ltd. New Dilhi.
3. Dana, S. 2001. Plant Breeding. Naya Udyog. Calcatta.
4. Singh. B. D. 1995. Plant Breeding – Principles and Methods. Kalyani Publishers. New Dilhi

Course Title: Plant Breeding Lab

Course No.: GEB 236 Credit: 01 Contact Hours: 2hours/week

Course:GEB-236: Plant Breeding Lab	**Credit Hour: 01**	**Year: 2nd**	**Semester: II**
Rationale: Obtaining of knowledge of theoretical and practical nature, which serves to deepen the knowledge, skills and competencies basic course in general genetics specifications and practical applications in plant.			

Course Objectives:

The aim of the subject is to provide practical knowledge about ways of propagation of basic crops with regards to their modes of reproduction. Students will learn the up-to-date methods and techniques applicable for development of various types of cultivars.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Apply the basic principles of genetics and plant breeding for genetic improvement of plants
- Discuss how to use selection parameter, heritability, and genetic gain concept for plant improvement
- Describe how mode of pollination, fertilization, and reproduction impacts the ability to manipulate genetic variation.
- Discuss how special breeding techniques like double haploid, fertility gene manipulation, etc and how to use those for genetic improvement of plants.
- Describe various selection techniques and methods that can be used in genetic improvement of self and cross pollinated crops.
- Describe various molecular breeding techniques and methods those could be used for genetic improvement of crops

Teaching Strategy: Lecture, Lab experiment, Field visit etc

Assessment Strategy: Q/A, MCQ, Assignment, Lab report, Viva etc

Course Contents

Hybridization techniques:

a) Floral biology, pollination system and crossing techniques in crop plants, such as rice, wheat maize, tomato, beans, peas, groundnut, mustard and jute.

Demonstration of field experiments:

a) Demonstration of parental, hybrid and segregating populations and data collection.
b) Demonstration of breeding research activities in the GPB experimental farm.

Statistical analysis of plant breeding and genetic experiments:

a) Data analysis for variety testing and other experiments, using a RCB design-anova, test of significance and mean separation.
b) Plant characters' association –correlation and regression analysis.
c) Estimation of heterosis, heritability and no. of genes controlling quantitative characters.

Recommended References:

1. Chopra, V. l. 1989. Plant Breeding. Oxford and IBH publishing Com. Ltd. New Dilhi.
2. Dana, S. 2001. Plant Breeding. Naya Udyog. Calcatta.

Course Title: Animal Breeding

Course No.: GEB 237 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-237: Animal Breeding	Credit Hour: 03	Year: 2nd	Semester: II

Rationale: The course is designed to provide knowledge for the optimal use of genetic and genomic resources in animal production and the optimal approaches to changing those genetic resources in livestock.

Course Objectives:

Animal Genetics and Breeding program is to develop graduates with the capacity to apply advanced scientific, technological knowledge and skills of Animal Breeding in designing and managing breeding improvement program for various livestock species under various production systems.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Understand and be able to consider the tools available to maximise response to genetic selection in a variety of animal species
- Understand inbreeding and crossbreeding effects related to production and conservation of species
- Understand complex inheritance
- Assess animal's genetic potential/ worth/ merit
- and make selection decisions based on that merit
- Set breeding goals based on national breeding policy
- Design a breeding program

Teaching Strategy: Lecture, Projector display, Animation, Group discussion, visit etc

Assessment Strategy: Q/A, MCQ, Assignment, Quize etc.

Course contents

Introduction: Need for animal products, concept of animal genetics, application of genetics in livestock and other economical animals. Concept of animal breeding. Its development and application, domestication of farm animals, development of breed association. Population, breeds and breed structure, design of breeding programs, breed evolution.

Application of Mendelian genetics: Principles of inheritance- the law of segregation and the law of independent assortment, modification of Mendelian ratios – lack of dominance, lethal genes, epistasis, linkage and crossing over.

Sex Determination and Sex linkage: Mechanism of sex determination, free martin, intersexes and super sexes, sex linked, sex influenced and sex limited characters.

Gene Expression: Functions of gene, genetic control of metabolism, protein synthesis in animal body. Mutation: The molecular basis of mutation, phenotypic effects of mutation, practical application of mutation in the field of livestock.

Chromosomal Aberration: Deletion and duplication. Aneuploidy and polyploidy in animals, chromosomal abnormality syndromes in animals. Karyotype and Genetic maps: linear arrangement of gene in chromosome, linkage maps of Drosophila chromosomes, maps of human chromosome, Giant chromosomes in the salivary glands of flies.

Genetic Diversity: Diversity in animal agriculture, animal genetic resources (AnGR), status of genetic resources- extinct, critical, endangered, at risk, reasons for loss of genetic resources, management of genetic diversity, conservation and improvement of AnGR.

Genetics Constitution of Population: Gene and genotype frequencies, hardy-Weinberg law, factors changing genetic properties and gene frequency.

Phenotypic Variation: Values and means, discrete and continuous variation, normal distribution, components of phenotypic and genetic variation, genotype-environment interaction, average effect of genes.

Population Parameters: Heritability, repeatability and genetic correlation- definition, methods of estimation and their uses. Restricted maximum likelihood (REML) approach. Breeding value: Definition, estimation and uses, most probable producing ability (MPPA), transmitting ability, best linear unbiased prediction (BLUP), Quantitative trait loci (QTL).

Selection: Natural and artificial selection, selection objectives and selection criteria, mass selection, pedigree selection, family selection, progeny testing, sib testing, methods of selection for more than one traits. Selection for correlated traits. Single gene effect in animal breeding, Nucleus breeding system, accuracy of selection.

Response to Selection: Selection program for livestock improvement, prediction and estimation of selection response, selection limit.

Mating System: Inbreeding, inbreeding depression, crossbreeding and Heterosis, selection for combining ability, formation of synthetic breeds, grading-up and species hybridization, breed conservation.

Breeding plan formulation: Improvement goal, existing genetic resources, improvement policy, breeding policy formulation for livestock, rabbit and zoo animals.

Recommended References:

1. Verma, P.S. and V.K Agarwal 1985. : Genetics (6th edn) S. Chand and Co. Ltd. New Delhi.
2. Gardner, E.J., M.J. Simmons and D.P. Snustad. 1991.: Genetics (18th edn) John Wiley and Sons. New York.
3. Strickberger, M.W. 1968. : Genetics. McMillan, New York.
4. Warwick, E.J. and Legates. 1987. Breeding and Improvement of farm animal (7th Ed.) McGraw Hill Book Co. Inc., New York.
5. Lasely, J.F. 1978. : Genetics of Livestock Improvement (3rd edn.) Prentice Hall of India, New Delhi.
6. Malcolm B. Willis. 1991. Dalton's Introduction to practical animal breeding (3rd Ed) Blackwell Sci. London.

Course Title: Animal Breeding Lab

Course No.: GEB 238 Credit: 01 Contact Hours: 2 Hours/week

Course: GEB-238: Animal Breeding Lab	**Credit Hour: 01**	**Year: 2nd**	**Semester: II**
Rationale: The course is designed to familiarize the students with practical use of genetic markers in animal selection and hybridization, including the latest techniques such as genomic selection.			
Course Objectives: The aim is to teach students the methodology of Mendelian genetics and lingkage, genotype frequency, measurement of variance and covariance, heritability, inbreeding co-efficient, breeding value, selection differential, selection response and selection index.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Understand the main concepts in animal breeding. • Apply genetic models and tools to predict the breeding value of animals. • Predict genetic change and/or inbreeding in populations. • Dissemination of genetic progress in different animals			
Teaching Strategy: Lecture, Lab experiment, Field visit etc			
Assessment Strategy: Q/A, MCQ, Assignment, Lab report, Viva etc			
Course Contents			
1. Solving problems on Mendelian Genetics and linkage in farm animals.			
2. Study on records and record keeping for successful animal breeding program.			
3. Calculation of gene and genotype frequency in an animal population.			
4. Measurement of variance and covariance using full and half sib data.			
5. Estimation of heritability, repeatability and genetic correlation.			
6. Measurement of relationship and inbreeding co-efficient.			
7. Estimation of breeding value, transmitting ability, most probable producing ability.			
8. Estimation of selection differential, selection response, selection index.			

Recommended References:

1. Falconer, D.S. 1989 (3rd edn), Introduction to Quantitative Genetics. Longman, London.
2. Chapman, A.B. : General and Quantitative Genetics. World Animal Science, A4 Elsevier Scientific publications, B.V. Amsterdam 1985.
3. Van Vleck., L.D. Pollak, E.J. and Oltenacu, E.A.B., Genetics for animal Science. 1987. W.H Freeman and Co., New York, USA.
4. Nicholas, F.W. : Veterinary Genetics. 1987. Oxford Scientific Publications, London.

Course Title: Biostatistics

Course No.: STA 211J Credits: 03 Contact Hours: 36 Total Marks: 100

Course: STA-211J: Biostatistics	Credit Hour: 03	Year: 2nd	Semester: II

Rationale: This course provides an introduction to the design and analysis of clinical trials, epidemiological studies, and methods for the analysis of biostatistical data

Course Objectives:

The purpose of the course is to give students an introduction to the discipline, an appreciation of a statistical perspective on information arising from the health arena and basic critical appraisal skills to assess the quality of research evidence.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Select from, use and interpret results of, descriptive statistical methods effectively;
- Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation;
- Select from, use, and interpret results of, the principal methods of statistical inference and design;
- Communicate the results of statistical analyses accurately and effectively;
- Make appropriate use of statistical software.
- Read and learn new statistical procedures independently

Teaching Strategy: Lecture, PPT Lecture, Problem solving etc.

Assessment Strategy: Q/A, Short Question, Quize, MCQ, Assignment etc

Course Contents

Introduction: Definitions of Statistics, the role of statistics in biological field (Medicine, biology), scope of biostatistics, Research and experimentation.

Variables and Frequency Distribution: Populations and parameters, samples and statistics, variables, statistical characterization of samples, Frequency distributions, Graphical Representation of frequency of distribution, statistical concepts pertaining to interpretation and decision.

Measures of Central Tendency: Definition, Characteristics of an ideal measures of central tendency, Different measures of central tendency: Mean, Median, Mode and Quantiles, Graphical determination of Mode and Quantiles.

Measures of Dispersion: Characteristics of an ideal measure of dispersion, Absolute and Relative measures of dispersion, Calculation of the mean, variance and standard deviation, Estimation of the standard deviation from the range, Standard deviation and confidence limits of the mean, Machine method of calculating the variance and standard deviation. Moments, Skewness and Kurtosis.

Test of Hypothesis: Type-I and Type-II errors, Level of Confidence. The t-test in paired and unpaired experiments, Selection of the appropriate method of calculating, Confidence limits of a difference between means.

Analysis of Variance (ANOVA): The F-test: ANOVA of Single, Multiple classification data and single classification data with subgroup.

The chi-square ($\chi 2$) test: $1 \times n$ and $2 \times n$ tables, the use of $\chi 2$ with occurrence- nonoccurrence data, $\chi 2$ analysis of a 2×2 or four fold tables, Alternate method of calculating $\chi 2$ test, Tests of significance when cell frequencies are small.

Correlation and Regression: Definition, Relation between variables in a bivariate distribution, Correlation coefficient, linear regression, the "least square" regression line, Test for linearity of a regression, confidence limits of the regression coefficient, Significance of a difference between regression coefficients.

Probability: Definitions, Elementary theory of probability, Operations and Algebra laws of probability, Random variables, Properties and uses of Binomial, Poisson and normal

distribution to observed data. Confidence limits of the mean, Significance of a difference between rates.
Nonparametric Tests
Design of Experiments: Introduction, Important steps of design of experiments, Models and Analysis of Variance, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD). Multiple comparison tests, Factorial experiments.

Recommended References:

1. Steel, R.D.G and Torry, J.H (1960). : *Principles and procedures of statistics*. *McGraw Hill Book Co. Inc. NewYork*
2. Mian, M.and Miyan, Alimullah, M. (1984). : *Introduction to Statistics.*
3. Cochraan . W.G and Cox. G. M., : *Experimental Designs.*
4. Shill and R Debnath*; Introduction to Statistics*
5. Mostafa M. N., Method of statistic, Bangladesh
6. Islam M.N Introduction to statistic and probability, 3rd edition.

Course Title: Environmental Biotechnology

Course No.: **GEB 239** **Credits: 03** **Contact Hours: 36** **Total Marks: 100**

Course: GEB-239: Environmental Biotechnology	**Credit Hour: 03**	**Year: 2nd**	**Semester: II**

Rationale: The course will give global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of life including native biodiversity.

Course Objectives: The course is designed to

- Describe the applications of various fields including chemistry, biochemistry, molecular biology and/or microbiology, in understanding and addressing the above issues, as well as exploring environmental resources for new technologies.
- Address important topics with respect to modern trends in biotechnology, such as treatment and disposal of biosolids, biotreatment of sludge and reuse, Industrial Wastewater treatment, ecologically based technologies, heavy metal removal and recovery, bioenergy production, bioremediation, phytoremediation and microbial fuel cell.
- Describe the principles and techniques underpinning the application of biosciences to the environment and describe existing and emerging technologies that are important in the area of environmental biotechnology.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Explain the importance of microbial diversity in environmental systems, processes and biotechnology as well as the importance of molecular approaches in environmental microbiology and biotechnology
- Describe existing and emerging technologies that are important in the area of environmental biotechnology
- Describe the principles and techniques underpinning the application of biosciences to the environment
- Describe biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling
- Analyze case-studies representative of key areas of environmental biotechnology
- Implement a range of practical approaches relevant to environmental microbiology and biotechnology and record, report and discuss data

Teaching Strategy: Lecture, PPT Lecture, Discussion, Problem solving etc.
Assessment Strategy: Q/A, Short Question, Quize, MCQ, Assignment etc
Course Contents
Ecology and Ecosystem: Fundamentals of ecology, the nature of ecosystem, soil, ocean and freshwater ecosystem, the flow of energy in ecosystem.
Biogeochemical cycles: The water cycle, carbon cycle, nitrogen cycle, sulphur cycle, other biogeochemical cycles.
Pollution Control Biotechnology: Definition pollution and their types, use of commercial blends of microorganisms and enzymes in pollution control, immobilized cells in pollution control, novel biotechnological approaches-use of genetic manipulation, enzymes and specialized bacteria.
Sewage Treatment: Primary treatment, BOD, secondary treatment, disinfections and release, activated sludge, septic tanks, oxidation ponds, tertiary treatment.
Metal Pollutions and Microorganisms: sources of metals, metal bioavailability in the environment, mechanisms of microbial metal resistance and detoxification, effects of metal microbes interactions.
Biosensors and VBNC: application of biosensors for the detection of environmental pollutants, isolation and enrichment of organisms capable of detoxifying environmental pollutants.
Biodeterioration: Basic concepts and factors, biodeterioration of leather, wool, fur, feather, stones, plastics and rubber, control of biodeterioration- physical, chemical and biological methods.
Xenobiotics in the Environment: Persistence and biomagnification, recalcitrant industrial wastes, structure-recalcitrance relationship, factors affecting microorganisms to degrade xenobiotics.
Biodegradation and Metabolism: Biodegradation and metabolism of pesticides, phenols, organic dyes, synthetic organic chemicals, petrochemicals.
Bioremediation: Definition, approaches to bioremediation-environmental modification for bioremediation, microbial seeding and bioengineering approaches, DNA and RNA based methods

Recommended References:

1. Atlas RM and Bartha R. Microbial Ecology.
2. Klung and Reddy. Current prospects in microbial ecology.
3. R.Mitchell. Introduction to environmental Microbiology.
4. Glazer AN and Nikaido H. Microbial Biotechnology.
5. Wiley GB. Waste Water Microbiology, 2nd edition.
6. Wise DL. Biotreatment systems: vol.2.
7. Pickup RW and Saunders IJR. Molecular approaches to Environmental Microbiology.
8. I. Foin. Ecological systems and the environment.
9. J.M. Lynch and Poole. Microbial ecology- A conceptual approach.

Course Title: Environmental Biotechnology Lab

Course No.: GEB 240 Credit: 01 Contact Hours: 2 hours/week

Course: GEB-240: Environmental Biotechnology Lab	**Credit Hour: 01**	**Year: 2nd**	**Semester: II**
Rationale: Environmental biotechnology deals with theories and fundamental principles of biotechnological approaches involved in waste processing and management. It is a vital			

scientific and engineering toolkit for environmental engineers to address environmental problems and apply appropriate biotechnological applications to solve real-life problems
Course Objectives: The aim of this course is to enable students to acquire comprehensive knowledge of state-of-the-art environmental biotechnological processes for wastewater treatment, land filling, sludge treatment and bioremediation, bioenergy production and metal recovery, etc.
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Demonstrate skills in laboratory and theoretical aspects of environmental biology. • Demonstrate knowledge about the application of biotechnology or environmental risk assessment and remediation. • Demonstrate the ability to use various instruments used in microbial biotechnology, their operating principles and application. • Show awareness of bioethics and policies.
Teaching Strategy: Lecture, PPT lecture, Animation, Practical class, Experiment, Field visit etc
Assessment Strategy: Short Question, MCQ, Quize, Assignment etc
Course Contents
1. Identification of pollutants
2. Isolation of heavy metals and their degradation
3. Application of biosensors
4. Observation of metal microbes interactions
5. Sewage treatment for safe environment

Recommended References:

1. R. Mitchell. Introduction to environmental Microbiology
2. Wiley GB. Waste Water Microbiology, 2nd edition

Course No.: GEB 200
Course Title: Seminar and Oral
Credit: 01, Contact Hours: 02 Hours/week

(Based on the Courses taught in 2nd Year)

Course Title: Plant Tissue Culture

Course No.: **GEB: 311** **Credits: 03** **Contact Hours: 36** **Total Marks: 100**

Course: GEB-311: Plant Tissue Culture	**Credit Hour: 03**	**Year: 3rd**	**Semester: I**
Rationale: The course is designed to provide a key knowledge in *in vitro* techniques of plant cell and tissue culture. In this regards, plant cell and tissue culture provide a new insight to produce commercially important variety within very short period through the culture of cell or tissue/organs in aseptic condition.			
Course Objectives: • To give a clear knowledge on micropropagation of different plant parts like protoplast, somatic embryo, ovule, pollen, and anther etc. for the production of important commercial variety. • To provide a basic concept on secondary metabolites production, cryopreservation of endangered plants, somaclonal and gametoclonal variation and their application in			

agriculture.

- Finally, to develop the graduate capabilities of knowledge ability, comprehension and applications of plants in cell and tissue culture systems, and how cell and tissue culture contributes to global sustainability.

Intended Learning Outcomes (ILOs):

At the end of the course the students will be able to-

- Formulation and preparation of various culture media
- Perform in vitro propagation of different plant parts in sterile condition.
- Demonstrate an understanding of the factors controlling the maintenance and differentiation of plant cells and tissues in sterile culture.
- Develop an understanding of the effects of major environmental factors on plant growth and development and of the mechanisms which control plant responses and adaptations of these external factors.
- Demonstrate knowledge of, and experience in, current methodologies in plant biotechnology.
- Demonstrate an understanding of the major classes and roles of secondary plant products and their production processes.
- produce synthetic seeds, production of somatic embryos, rescue of embryo

Teaching Strategy: Lecture, PPT Lecture, Discussion, Problem solving etc

Assessment Strategy: Q/A, Short Question, Quize, MCQ, Assignment etc

Course Contents

Introduction to Plant Tissue Culture: Definition, types of culture and historical development, purposes of cell, tissue and organ culture, cellular totipotency, cell and tissue growth process, characteristics and measurement method, laboratory organization: Lab design, small and large equipment with their functions.

Laboratory Organization and aseptic Techniques: Lab, facilities, design, operation and management, aseptic technique for plant tissues, chemicals, instruments, glass wares, personal hygiene and laboratory safety management etc..

Laboratory Equipments and Sterilization: Major equipment, minor equipment's, sterilization types, procedure etc.

Culture Media and Plant growth regulators: Components, composition, functions of components, preparation of media. Solidification, media selection and maintenance of media.

Aseptic techniques: Plant tissues, chemicals, instruments, glassware's and personal hygiene.

Micro propagation: Definition, direct and indirect method of different plant, factors of shoot and root multiplication.

Protoplast Culture: Isolation, purification and culture of protoplast, development and application of somatic hybrids and cybrids.

Production of disease free plants: Methods of virus elimination, virus indexing, eradication of pathogens other than virus, application and limitations.

Somatic embryo genesis and suspension culture: Initiation of somatic embryo: callus and suspension culture, maintenance of callus and suspension culture, production and management of somatic embryo and its application, plant formation from somatic embryo.

Culture of Anther/pollen, Ovule, Embryo, Endosperm and Their Uses: Rice, wheat, barley, maize, brinjal.

Somaclonal Variation: Production and selection of somaclonal and gametoclonal variation, utilization of somaclone and gametoclone in agriculture, *in vitro* selection of disease resistant and stress tolerant plants.

***In-vitro* Conservation of Plant Materials**: methods and factors affecting *in vitro* conservation, maintenance of frozen culture.

Industrial Application of Plant Tissue Culture: Secondary metabolites derived from plants and their uses. Techniques of selecting cell lines for high production of secondary products. Mass cultivation of plant cells, scale-up, isolation, immobilization and purification and limiting factors.

Recommended References:

1. Bhojwani, S. S. (1990). Plant Tissue Culture. Oxford, NY. Gamborg, O. L. and G. C. Phillips (1996).
2. Plant Cell, Tissue and Organ Culture: Fundamental Methods. Narosa Publishing House, New Delhi, India.
3. Razdan, M. K. (1993). An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta. India.
4. Reinert, J and Y. P. S. Bajaj (1995). Plant Tissue and Organ Culture: Applied and fundamental aspects. Narosa publishing House, New Delhi, India.
5. Vasil, I. K. and Thorpe. T. A. (1994). Plant Cell and Tissue Culture.Kluwer Academic Publishers.The Netherlands.

Course Title: Plant Tissue Culture Lab

Course No.: GEB: 312 Credit: 01 Contact Hours: 2 Hours/week

Course: GEB-312: Plant Tissue Culture Lab	**Credit Hour: 01**	**Year: 3rd**	**Semester: I**

Rationale: Plant tissue culture is the science of growing plant cells, tissues or organs isolated from the mother plant, on artificial media. The purpose of this course is to give students a practical experience in techniques in plant tissue culture and crop development.

Course Objectives:

- This course seeks to familiarize students to the basic principles of plant tissue culture and its applications.
- To provide hands-on experience of the most common of these techniques in labs and demonstrations of more advanced or uncommon techniques.
- To understand a procedure that is often used to propagate many plants of the same genetic background.
- To understand the importance of sterile techniques.

Intended Learning Outcomes (ILOs):

At the end of the course the students will be able to-

- Prepare culture medium from reagent grade chemicals and stock solutions, routinely transfer cultures without contamination.
- Sterilize instruments, lab wares, culture media and explants
- Design and prepare various culture media, stock solutions of inorganic salts, growth regulators
- Identify appropriate explant and learn inoculation techniques into suitable culture media under sterile condition.
- Determination of appropriate stages of anther and pollen useful for anther/pollen culture

Teaching Strategy: Lecture, PPT Lecture, Lab experiment etc

Assessment Strategy: Q/A, Short Question, Quiz, MCQ, Assignment, Viva etc

Course Contents

1. Laboratory, personal safety, precaution and uses/operation of instruments available at the Lab.
2. Sterilization techniques of glassware, instruments, media and explants.
3. Techniques of media preparation and their stock solutions.
4. Selection and pre-treatment of different kinds of explants.
5. Detection of contamination of media and cultures.
6. Initiation of callus and regeneration.

7. Microscopic analysis of callus for cytodifferentiation.
8. Determination of appropriate stages of anther and pollen.
9. Protoplast Isolation and hybridization
10. Exploration, selection, collection and growing of donor/mother plants: Banana, orchids, strawberry, gerbera, rice, barley, maize etc.
11. Hardening techniques of plantlets.

Course Title: Food Biotechnology

Course No.: GEB 317 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-317: Food Biotechnology	**Credit Hour: 03**	**Year: 3rd**	**Semester: I**
Rationale: Biotechnology is becoming increasingly important to food. Biotechnology has been used in food production for thousands of years (e.g. brewing, yoghurt, pickling, etc). The new Biotechnology has a high potential in food production and processing. This course will cover the applications of new biotechnology in food production or processing.			
Course Objectives: To furnish a student with knowledge and understanding of the basic biological and chemical processes of living cells and enzymes and how these are harnessed into industrial processes and technologies for the production, processing and preservation of food and related products			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Appreciate the positive role and benefits of microorganisms and enzymes in food production, processing, and preservation. • Understand basic biological and chemical processes of living cells, enzymes, and microbial nutrition in relation to fermentation processes • Understand principles of inoculum /starter culture development for industrial fermentations and fermentor /reactor design, control and operation • Understand both upstream and downstream unit operations and technologies used for substrate preparation and recovery and purification of fermentation products • Know the flowchart unit operations in the processing and production a number of fermented products such as wine, beer, cheese, yoghurt and others • Know about effluent treatment and conversion of food and agricultural wastes			
Teaching Strategy: Lecture, PPT Lecture, Video Animation , Discussion, Q and A etc			
Assessment Strategy: Q/A, Quiz, Short Essay, MCQ, Test etc			
Course contents			
Introduction: Microorganisms (molds, yeasts, bacteria) important in food biotechnology, major biotech food products.			
Biotechnology of Milk and Milk Products: Composition and food value of milk. Adulteration of milk. Pasteurisation of milk. Definition, composition and manufacture of Butter and butter products. Definition, classification, manufacturing and processing of different types of domestic and foreign cheese. Composition and manufacturing process of condensed and powder milk.			
Biotechnology in Fermented Dairy Products and Dairy Based Products: Starter culture, dhahi, yogurt, cultured butter milk, acidophilus milk and kefir. Classification of ice-cream, manufacturing, hardening and storage of ice-cream.			
Biotechnology in Fruit Processing: Preparation of squash from fruit, juice, non alcoholic fruit drinks, sour kraut, pickles, jam, jellies, and marmalades. Enzyme treatments and preservation of fruit products,			
General Principles of Fish and Meat Preservation: General Principles of food preservation with special emphasis on fish and meat. Proximate composition and nutritive value of fish and meat.			

Freshness test of fish and Meat: Organoleptic, microbial and chemical test. Post mortem changes of fish and animals and its importance in fish and meat processing.
Preservation of Fish and Meat: Chilling of fish and meat with ice and preservative ice. Methods of freezing. Factors affecting the quality during chilling and freezing. Preservation by irradiation, effect of irradiation on the keeping quality.
Drying and Dehydration: Basic mechanism of fish and meat drying. Country method of meat drying. Different methods of drying/ dehydration of fish and other aquatic animals. Quality aspects of dried fish and meat.
Smoking: Smoking as preservation and processing method of fish and meat.
Salting: Types of salting, technological aspects of salting, salting process and characteristic features of salting with special emphasis on Hilsa fish processing.
Canning: Principles of canning, preparation of raw material, canning operation, types of can materials, examination of can, prospect of canned food industry in Bangladesh.
Fermented and Semi Fermented Products: Shidol, fish pest, fermented squid gut etc.
Value Added Products: Surimi: Surimi as a special fish product, methods of surimi preparation, factors affecting surimi preparation. Minced fish, fish meal, fish silage, FPC, FPI, fish oil etc.
Food Processing Technology: Food additives, packaging of food, storage, transportation, merchandising of various products with added value, food spoilage and food regulation, quality control of food processing.

Recommended References:

1. Clusas, I. J. 1985. Fish Handling, Preservation and Processing in the tropics. Patr I and II. Tropical Development and Research Institute, London.
2. Brogstrom, G. (Editor). 1965. Fish as Food vol. I IV. Academic Press London.
3. Govinda, T. K. 1985. Fish Processing Technology. Oxford and IBM Publishing Co., New Dilhi.
4. Stansby, M. E. 1963. Industrial Fishery Technology. Rehinold Pub. Co. New York.
5. Tanikawa, E. 1985. Marine Products in Japan. Koseisha Koseikaku Co. Ltd.., Tokyo.
6. Wheaton, F. W. and Lawson, T. B. 1985. Processing of aquatic Food Products. Wiley Inter Science, New York.

Course Title: Food Biotechnology Lab

Course No.: GEB 318 Credit: 01 Contact Hours: 2 hours/week

Course: GEB-318: Food Biotechnology Lab	**Credit Hour: 01**	**Year: 3rd**	**Semester: I**
Rationale: This course will cover the practical applications of biotechnology in food production and processing.			
Course Objectives: To provide the practical knowledge in production of fermented foods like Dahi, Cheese, Ghee, Butter, Ice-cream etc and biotechnological aspects of food processing of vegetable and animal origin.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Understand the basic food safety issues in the food market • Develop and evaluate quality of new food products using objective and subjective methodologies Understand the basic concepts in food chemistry and food analysis.			
Teaching Strategy: Lecture, Problem Solving, Experiment, Visit etc			
Assessment Strategy: Short Question, MCQ, Quiz, Essay, Lab Reports, Viva etc			
Course Contents			
1. Sampling of milk: Sampling procedures, individual sample, composite sample and preservation of samples			

2. Determination of fat by Babcock and Gerber method
3. Detection of adulteration in milk
4. Quality test: Sediment test, acidity test, methylene blue reduction test, resazurin test, phosphatase test
5. Laboratory pasteurization, homogenization and bottling of milk
6. Direct Microscopic count (DMC) in milk product
7. Coliform count from milk and milk products
8. Judging of dairy products
9. Preparation of Dahi
10. Preparation of Cheese
11. Preparation of Ghee, Butter
12. Preparation of Ice-cream
13. Methods of preservation of meat
14. Determination of protein, fat and ash contents of meat

Recommended References:

1. Brogstrom, G. (Editor). 1965. Fish as Food vol. IV. Academic Press London.
2. Govinda, T. K. 1985. Fish Processing Technology. Oxford and IBM Publishing Co., New Dilhi.
3. Stansby, M. E. 1963. Industrial Fishery Technology. Rehinold Pub. Co. New York.
4. Tanikawa, E. 1985. Marine Products in Japan. Koseisha Koseikaku Co. Ltd.., Tokyo.

Course Title: Techniques in Molecular Biology

Course No.: **GEB 319** **Credits: 03** **Contact Hours: 36** **Total Marks: 100**

Course: GEB-319: Techniques in Molecular Biology	**Credit Hour: 03**	**Year: 3rd**	**Semester: I**

Rationale: The course will provide the student with practical and theoretical experience in molecular techniques used in the field of genetic engineering and biotechnology.

Course Objectives:

- To demonstrate proficiency in advanced molecular biology techniques including advanced background information and theory, applications, limitations, advantages and disadvantages, common problems and troubleshooting.
- To fully understand lab safety issues associated with toxic chemicals, radioisotopes, infectious agents, and manipulation of DNA.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Accurately, safely and appropriately use all the equipment regularly used in Molecular Biology (DNA manipulation, including balances, pipettes, electrophoresis and centrifuges).
- Prepare chemical solution and reagents to the precision appropriate to the task
- Demonstrate knowledge of the biochemical basis underpinning the molecular biology techniques
- Independently clone any gene into a plasmid vector (from RNA extraction, reverse transcription, polymerase chain reaction, ligation, bacterial transformation, to DNA extraction, DNA mapping and primer design)
- Transfect plasmids and silencing RNAs to over-express or knock down protein expression in a primary cell line, extract protein, assess and quantify expression using Western blotting

Teaching Strategy: Lecture, PPT Lecture, Video Animation , Discussion, Q and A etc

Assessment Strategy: Q/A, Quiz, Short Essay, MCQ, Test etc

Course Contents
Centrifugation Techniques: Principle of sedimentation, centrifuges and their use, density gradient centrifugation and ultracentrifuge.
Chromatographic Techniques: Principle of chromatography; column, thin-layer and paper chromatography; adsorption, gas liquid, ion-exchange, exclusion, affinity and high performance liquid chromatography.
Electrophoretic Techniques: Principle; factors affecting electrophoresis; gel electrophoresis, determination of restriction fragments by agarose gel electrophoresis. SDS-PAGE; isoelectric focusing; isotechnophoresis and preperative electrophoresis.
Radioisotope Techniques: Nature, detection and measurement of radioactivity; application of radioisotopes in the biological sciences; safety aspects of the use of radioisotopes.
Molecular Methods for Structure Determination: Ultraviolet (UV), Infra-red (IR), Nuclear magnetic resonance (NMR), Electron spin resonance (ESR) and mass spectroscopy.
DNA and RNA isolation and Purification: DNA and RNA isolation and purification, quantification of nucleic acid by spectrophotometry, fractionation of genomic DNA, plasmid DNA, mRNA, tRNA and rRNA.
Southern, Northern and Western Blotting: Southern, Northern and Western blot hybridization, restriction endonuclease digestion of plasmid DNA.
PCR: Basic principles, methods and applications of PCR, RT-PCR, Primer design-degenerated and gene specific primers, forward and reverse primers, factors considering in the construction of primers.
Sequencing: Different methods of DNA sequencing.

Recommended References:

1. Comprehensive Biotechnology, vol. 2: Murray Moo-Young.
2. A Biologist's Guide to Principles and techniques of Lab. biochemistry, 3rd edition: K. Wilson and K. H. Goulding.
3. Basic biochemical methods, 2nd edition: R. R. Alexander and J. M. Griffiths.
4. An introduction to Lab. Biochemistry, 2nd edition: D. T. Plummer.
5. Lab. Skills in Biomolecular Sciences: Rob Reed, David Holmes, Jonathan.
6. Spectroscopic Methods in Organic Chemistry: Williums and Flemming, 1980.
7. Techniques in Molecular Biology: Walker, 1987.
8. Short Protocols in Molecular Biology: Ausubel, 1995.

Course Title: Techniques in Molecular Biology Lab

Course No.: GEB 320 Credits: 01 Contact Hours: 2 hours/week

Course: GEB-320: Techniques in Molecular Biology Lab	**Credit Hour: 01**	**Year: 3rd**	**Semester: I**
Rationale: Techniques in Molecular Biology Lab is a laboratory course designed to provide practical knowledge in molecular biology techniques which help the students to get the opportunity to experience what it is like to work on an unsolved scientific problem.			
Course Objectives: A course designed to present the scientific theory of molecular biology combined with the experimental laboratory practices of: • Techniques like- Electrophoresis, PCR, RT-PCR, Southern, Northern and Western Blotting, and Chromatography. • Isolation, Analysis and Visualization of DNA and protein structures • Genomic analysis (AFLP, RFLP etc).			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Carry out the experiments of molecular biology and interpret the results, designing a			

strategy to circumvent potential experiments
Teaching Strategy: PPT Lecture, Lab Experiment, Problem Solving etc
Assessment Strategy: Short Question, MCQ, Test, Assignment, Lab Report etc
Course Contents
1. Studies on centrifugation using bench top, refrigerated high speed centrifuge machine.
2. Studies on nucleic acid and protein separation using Agarose, Starch gel, and SDS-PAGE electrophoresis.
3. Studies on spectrophotometer for optical density measurement and nucleic acid quantification
4. Genomic DNA, plasmid DNA isolation from plant and animal cell and purification, quantification of nucleic acid by spectrophotometry
5. Studies on PCR, RT-PCR, Construction of primer.
6. Studies on AFLP, RFLP.
7. Studies on DNA sequencing.
8. Southern, Northern and Western Blotting apparatus.
9. Thin-layer and paper chromatography and high performance liquid chromatography etc.

Recommended References:

1. A Biologist's Guide to Principles and Techniques of Lab. Biochemistry, 3rd edition: K. Wilson and K. H. Goulding.
2. Lab. Skills in Biomolecular Sciences: Rob Reed, David Holmes, Jonathan.

Course Title: Animal Cell Technology

Course No.: GEB 323 Credits: 02 Contact Hours: 24 Total Marks: 100

Course: GEB-323: Animal Cell Technology	**Credit Hour: 02**	**Year: 3rd**	**Semester: I**
Rationale: The course is designed to provide concepts and principles in Animal Cell culture and related technologies for cell culture and cell culture products for therapeutics and commercial interest.			
Course Objectives: • Describe the basic principle and concepts about mammalian cell culture and cell culture technologies. • Comprehend the practical applications of animal cell culture and production of therapeutics for human and animal.			
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to- • Recognize the fundamentals of animal cell culture and the technologies used for cell culture. • Familiar with different cell cultures and cell lines. • Choose the cell line for expression of recombinant proteins for commercial and therapeutic applications.			
Teaching Strategy: Lecture, PPT Lecture, Video Animation , Discussion, Q and A etc			
Assessment Strategy: Q/A, Quiz, Short Essay, MCQ, Test etc			
Course Contents			
Introduction to Animal Tissue Culture: Definition, type and history and development, Importance of cell, tissue and organ culture.			
Background of Animal Cell Culture*:* Animal cell cultures new understanding, new developments. Animal cell culture technology in the 21st century.			

Laboratory Organization*:* Facilities, design, operation and management. *Media:* Components, composition, functions of components, preparation and media selection. Solidification and maintenance of media.
Equipping the Laboratory: Essential, beneficial and useful additional equipments consumable items.
Contamination, Laboratory Safety and Biohazards: Types of microbial contamination, detection of microbial contamination, cross contamination, general safety, fire, radiation and biohazards.
Preparation and Sterilization: Principles of sterilization of apparatus, reagents and media.
The Cell Culture Environment: Substrate, gas phase, medium and temperature. The substrate: plastic and glass wares; tissue culture flasks, culture vessels. The gas phase: Oxygen, carbon dioxide, Medium and Supplements: physical properties, constituents of media, serum, serum-free media; selection of medium and serum, other supplements, incubation temperature.
Isolation of Tissue and Primary Culture: Culture of Mouse embryos and hen's embryo cell.
Culture of Specific Cell Types: epithelial cells, mesenchymal cells, neuroectodermal cells, hemopoietic cells. Culture of tumor tissue- general method, selective culture.
Three-Dimensional Culture System*:* Organ culture, histotypic culture, filter wells.
Preparation of Cell Line: Isolation of different types of animal tissue; fibroblast, liver, kidney, bone marrow and their uses, Physical methods of cell separation.
Maintenance of Cultured Cells: Routine observation and maintenance; cloning and selection of specific cell-types.
Quantitation and Experiment with Animal Cell: selection of cell line; experimental design; growth phase: cell counting, preparation of samples for enzyme assay and immune assay, preparation of samples for extraction of DNA and RNA.

Recommended References:

1. Butler, M. (2005). Animal Cell Culture and Technology, second Edition, Taylor and Francis Group, NY, USA.
2. Beuvery, Griffiths and Zeijlemaker (1995). Animal Cell Technology. Kluwes Academic Publishers, Dordrecht, Boston, London.
3. Glyn Stacey and John Davis (2007). Medicines from Animal Cell Culture. John Wiley and Sons Ltd, West Sussex, England.
4. Ian, R. Fresshney, (1998). Culture of Animal Cells. Third Edition, Wiley-Liss, A Hohn Willey and Sons, Inc. Publication, NY, Chichester, Brisbane, Toronto, Singapore.
5. Jack G. Chirikjian (1995). Biotechnology: Theory and Techniques. Volume I. Jones and Bartlett Publishers, Boston, London, Singapore.

Course Title: Metabolism-II

Course No.: **GEB 325** **Credits: 02** **Contact Hours: 24** **Total Marks: 100**

Course: GEB-325: Metabolism-II	**Credit Hour: 02**	**Year: 3rd**	**Semester: II**
Rationale: The course is designed to develop student's knowledge and understanding of biochemical and molecular studies into metabolic pathways and processes occurring in living cells with a focus on human metabolism in health and disease			
Course Objectives: The objectives of this course is to provide theoretical experience in			

- The basic metabolic pathways;
- Inborn errors of metabolism and the application of DNA technology to their study;
- The control and integration of metabolism

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Describe the principles of metabolism and the differences between anabolism and catabolism;
- Outline the metabolic pathways involving glucose, fatty acids and amino acids;
- Describe the various types of genetic mutation and inborn errors of metabolism
- Describe the methods for detecting and correcting inborn errors of metabolism
- Outline the hormonal regulation of metabolism and discuss the role of protein phosphorylation in this context;
- Describe the regulation of metabolism in physiological and pathological situations (e.g. exercise, starvation and diabetes);
- Demonstrate that you have acquired skills in data interpretation and report writing

Teaching Strategy: Class Lecture, Projector Display, Animation, Discussion etc**.**

Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment etc.

Course Contents

Amino Acid Metabolism: Glucogenic and ketogenic amino acids, oxidative degradation of amino acids to specialized products, amino acid biosynthesis, regulation of amino acid metabolism, metabolism of folic acid, glutathione, methylmalonate, clinical correlations: phenylketonuria, alkaptonuria, folic acid deficiency.

Nucleotide Metabolism: Overview metabolic functions of nucleotide, synthesis of purine and pyrimidine nucleotides, formation of deoxyribonucleotides, regulation of nucleotides biosynthesis. nucleotide degradation, biosynthesis of nucleotide coenzyme, nucleotide metabolizing enzymes as a function of cell cycle and rate of cell division, antimetabolites of purine and pyrimidine nucleotide metabolism, Lesch-Nyhan syndrome, orotic aciduria.

Metabolism of porphyrins, Heme, and bile pigments

Mineral Metabolism: Ca, Fe, Cu, Mg, I, Mn, Zn- metabolism, calmodulin, hemosiderosis, deficiency of minerals, enzymes and metabolic reactions activated/regulated by Mn, Mg, Zn, Cu, Fe, Ca.

Metal Toxicities: Toxicity of Hg, Pb, As, Cd

Recommended References:

1. Lehninger, Albert, L., Nelson David, L., Cox, Michael, M., Principles of Biochemistry, 1st Indian Edition, 1993. CBS Publisher's and Distibutors.
2. Strayer, Lubert, 1988. Biochemistry, 3rd Edition, Q. H. Freeman and company, NewYork.
3. Murray, R. K., Granner, D. K., Mayes P. A. Rodwell, V. W. 1988. Harper's Biochemistry. 22nd edition, Prentice Hall International.
4. Conn, E. E., Stumpt, P. K., 1994, Outlines of Biochemistry, 4th Edition, Wiley Eastem Limited, new age International Limited.
5. A.C. Dev, Fundamentals of Biochemistry.

Course Title: Immunology

Course No.: GEB 327 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-327: Immunology	**Credit Hour: 03**	**Year: 3rd**	**Semester: II**
Rationale: The Immunology course is designed to provide a foundation on the basic			

concepts and terminology of immunology.

Course Objectives:

- To introduce the concepts of immune system, their integral components and the interplay among host immunity
- To deliver the knowledge of fine coordination of immune components, problems associated with their absence of it and therapeutic approaches
- To overview different immunopathological states and the techniques of deciphering immunological reactions

Intended Learning Outcomes (ILOs):

At the end of the course the students will be able to-

- To acquire a fundamental working knowledge of the basic principles of immunology;
- To understand how these principles, apply to the process of immune function; and
- To develop the ability to solve problems in clinical immunology by making use of the available resources and communicating with colleagues.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc**.**

Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Answer, Short Question etc.

Course Contents

Introduction to Immune System: Adaptive and innate immunity, cells of the immune system, soluble mediators of immunity, cytokine, antigens, haptens and carriers, immune responses, inflammation, opsonization, chemotaxis, phagocytosis, defense against intracellular and extracellular pathogens.

Cells and Organs Involved in Immune Responses: lymphocytes (T-cells, B cells, NK cells), mononuclear phagocytes, polymorphonuclear granulocytes, mast cells, platelets, antigen presenting cell, primary and secondary clonal expansion of lymphocytes.

The Humoral Immune Response: Antigen-antibody interactions, affinity and avidity; antibodies, classification, structure, function and mechanism of action; interferons and their functions.

The cell-mediated Immune Response: Recognition of antigen by T cells, antigen presentation, the major histocompatibility complexes or MHC molecules, the role of cytokines and the regulation of immune responses.

Complements: 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, biological effects of complement.

Immunity to Infection: Immunity to intracellular and extracellular bacteria, viral infections, and parasitic infections.

Antigen Recognition: antigen-antibody binding, antibody affinity and avidity, antibody specificity and cross reactivity, antigen processing and presentation, T-cell antigen recognition.

Cell Cooperation in the Antibody Response: cooperation between different cell types, cell activation, antigen specific triggering of lymphocyte, antibody responses in vivo, affinity maturation, immunological memory.

Immunopathology and Psychoneuroimmunology: Immunodeficiency (AIDS), hypersensitivity, autoimmune disease, immune-neuroendocrine network, endocrine-immune modulation, neuro-immune modulation, neuroendocrine and immune effect of psychosocial stress, effect of psychosocial stress on infection, allergy, cancer, AIDS and autoimmunity, immune activity and psychopathology, immune function enhancement.

Immunological Techniques:

Recommended References

1. Roitte, Brostoff, Male; (2012). Immunology. 8th edition; Publisher: Mosby.
2. Roitte, I. Essential Immunology. 8th edition; Blackwell scientific Publication, London.
3. Janis Kuby; Immunology, 3rd edition; W.H. Freeman and company
4. Abbas, A. Lightman, A. Pillai, S; Cellular and Molecular Immunology, 8th edition; Elsevier.
5. Staines, N. Brostoff, J. James, K; Introduction to Immunology, 2nd edition; Mosby Publication.
6. Male, D. Champion, B. Cooke, A; Advanced Immunology; Mosby Publication
7. Jorge H. Daruna; Introduction to Psychoneuroimmunology, 2nd editon, 2012; Academic Press Inc, Elsevier.
8. Ader, R. Felten, D. Cohen, N; Psychoneuroimmunology 2nd edition; Academic Press Inc.
9. Koenig H.C, Cohen H. J; Psychoneuroimmunology and Faith Factor: The Link between Religion and Health; Oxford University Press 2002.
10. Schedlowsky, M. Tewes, W; Psychoneuroimmunology 1st edition; Library of Congress.
11. Cochet Olivier, Jean-Luc Teillaud; Immunological Techniques Made Easy; Publisher: John Wiley and Sons.

Course Title: Cell Signaling

Course No.: GEB 331 Credits: 03 Contact Hours: 36 Total Marks: 100

Course GEB-331: Cell Signaling	**Credit Hours: 03**	**Year: 3rd**	**Semester: II**

Rationale: A comprehensive study of signaling pathways of cells as they relate to functional processes cells. The topics covered in this course include the principles of cell signaling, signaling through G-protein-linked cell surface receptors, signaling pathways that depend on regulated proteolysis and environmental approaches of signal-induced responses.

Course Objectives:

- To demonstrate proficiency in advanced the principles of cell signaling.
- To understand and comply with standards of cell surface receptors.
- To fully understand signaling pathways that depends on regulated proteolysis and environmental approaches of signal-induced responses.

Intended Learning Outcome:

At the end of the course the students will be able to-

- To acquire a fundamental working knowledge of the basic principles of cell signaling,
- To begin to understand how these principles apply to the process of cell signaling; and
- To develop the ability to solve problems in pathways that depends on regulated proteolysis and environmental approaches of signal-induced responses by making use of the available resources and communicating with colleagues.

Teaching Strategy: Lecture, PPT Lecture, Video Animation , Discussion, Q and A etc

Assessment Strategy: Q/A, Quize, Short Essay, MCQ, Test etc

Course Contents

General Principles of Cell Signaling: Extracellular signal molecule and their receptors, Operation of signaling molecules over various distances, Sharing of signal information, Cellular response to specific combinations of 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 proteins, Intracellular signaling proteins as molecular switches, Interaction between modular binding domain and signaling proteins, Remembering the effect of some signal by cells.

Signaling Through G-protein-linked Cell Surface Receptors: cAMP and G protein

signaling, role of cAMP-dependant protein kinase (PKA) in mediating effects of cAMP, Inositol phospholipids signaling pathway, Ca2+ as an intracellular messenger, role of Ca2+/calmodulin-dependantprotein kinases in mediating actions of Ca2+, desensitization of G-protein-linked receptors.
Signaling Through Enzyme-linked Cell Surface Receptors: Receptor tyrosine kinases, docking sits for proteins, Activation of Ras, Ras cycles between active and inactive states, signals from activated Ras to a cascade of protein kinases including MAP-kinases, PI 3-kinase/ protein kinase B signaling pathway, Insulin receptor acts through PI 3-kinase pathway, Cytokine receptors and the JAK-STAT pathway, Two component signaling pathway of bacterial chemotaxis.
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 NF-kB dependant signaling pathway.
TGFß Signaling Receptors: Activated type I TGFß receptors phosphorylate Smad transcription factors, Smad signaling via negative feedback loop, TGFß signaling and abnormal cell proliferation.
Environmental Approaches of Signal-induced Responses*:* Evolutionary conservation and proliferation of genes encoding signals and regulators. Protein microarrays for monitoring cell responses, Cellular response by oxygen deprivation.
Prokaryotic LPS activation

Recommended References:

1. Molecular Biotechnology. Glick, B.R. and Pasternak, J.J. 2003. ASM Press, USA.
2. DNA cloning 1 and 2. Glover, D.M. and Hames, B.D. 1995. IRL Press (Oxford University Press, USA).
3. Molecular Biology of the Cell (4th edition). Alberts, Johnson, Lewis, Raff, Roberts and Walter.
4. Molecular Cell Biology (5th edition). Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipersky and Darnell.
5. Lehninger Principles of Biochemistry (4th edition). Nelson and Cox.
6. Molecular Biology of the Gene. Watson, Baker, Bell.

Course Title: Fermentation Technology

Course No.: **GEB 335** **Credits: 03** **Contact Hours: 36** **Total Marks: 100**

Course: GEB-335: Fermentation Technology	**Credit Hour: 03**	**Year: 3rd**	**Semester: II**
Rationale: This course design to understand the variety of fermentation and subsequent processing approaches available for the manufacture of biological products and the design and operation of these systems an appreciation of the regulatory framework under which the industry operates.			
Course Objectives: To make students acquainted with principles of using of microorganisms in fermentation process. Attain knowledge of production equipment in fermentation industry, application of microorganisms and enzymes in technological operation, substrate preparation and control of fermentative process and isolation of products. Substantial time is devoted to particular fermented products - spirits industry, yeast industry, brewing industry, production of microbial biomass and selected organic acids.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Get acquainted with the industrial aspect of the field of Microbiology, and also learn about growth pattern of microbes in different industrial systems. • Acquire experimental knowhow of microbial production of various industrial products such as alcohol, exopolysaccharides, enzymes, etc.			

• Develop an understanding of process control, upstream and downstream process.
Teaching Strategy: Class Lecture, Projector Display, Video animation, Discussion etc
Assessment Strategy: Q/A, Short essay, MCQ etc.
Course Contents
Introduction: Definition, scope, importance of fermentation technology, major areas of fermentation technology
Phases of Fermentation: Basic concepts on three core components of fermentation process and details about development of industrially important strains and their preservation.
Media Formulation and Sterilization Process: Media composition, types, factors influencing media formulation, mechanism of sterilization, of media, killing kinetics, determination of lethal effect and lethal units.
Inocula Preparation and Development: Criteria used for inocula preparation, different processes of preparation, bacterial and fungal inocula preparation and development.
Fermentation Kinetics: rate equation for cell growth, substrate utilization, products formulation,
Classification of Fermentation Process: Batch, fed-batch and continuous fermentation process, advantages and disadvantages of these process

Recommended References:

1. Fermentation: a Lab. approach-B. MacNeiland Harvey, IRL Press, Oxford
2. Principle of Fermentation Technology-P.F. Stanburyand Whitaker.

Course Title: Fermentation Technology Lab

Course No.: GEB 336 Credit: 01 Contact Hours: 02 hours/week

Course: GEB-336: Fermentation Technology Lab	**Credit Hour: 01**	**Year: 3rd**	**Semester: II**
Rationale: To make students acquainted with principles of using of microorganisms in fermentation process.			
Course Objectives: Attain practical knowledge of production equipment in fermentation industry, application of microorganisms and enzymes in technological operation, substrate preparation and control of fermentative process and isolation of products.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Become familiar with the operation of fermentation and bottling machinery • Gain experience and attained a basic level of competence in routine cellar operations • Understand the necessity for routine chemical, sensory and microbiological analyses • Gain experience in cellar safety procedures			
Teaching Strategy: Lecture, Video animation, Lab Experiment, Visit etc			
Assessment Strategy: Short question, Quize, Problem silving, Assignment, Viva			
Course Contents			
1. Isolation of bacteria by enrichment technique.			
2. Seed culture preparation for fermentation.			
3. Inoculum development for fermentation in bioreactor.			
4. Production of enzymes by fermentation in shake flask and bioreactor			

Course Title: Recombinant DNA Technology

Course No.: GEB 337 Credits: 03 Contact Hours: 36 Total Marks: 100

Course GEB-337: Recombinant DNA Technology	**Credit Hours: 03**	**Year: 3rd**	**Semester: II**

Rationale: This course presents an overview of the techniques and underlying theory of Recombinant DNA Technology, PCR amplification and Genetic transformation, research and commercial applications, and issues/challenges in the area of Genetic Engineering.
Course Objectives: Provide knowledge and understanding genetic engineering, the basic principles of recombinant DNA technology, gene manipulation and genetic transformation and their application to plant, animal and microbes improvement and their conservation
Intended Learning Outcome: At the end of the course the Graduates of the Bachelor of Science in biotechnology and genetic engineering program will be able to: • Display a broad understanding of genetic engineering concepts including recombinant DNA technology, PCR technology and gene manipulation and gene transformation techniques
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc**.**
Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Answer, Short Question etc.
Course Contents
Introduction: Concepts of Recombinant DNA technology, importance, scope and opportunities etc
Biological Tools of Recombinant DNA Technology: Different vectors, Enzymes modification of gene, different methods and mechanism of gene transfer, application of virus and bacteria in recombinant DNA production, competent cells, hosts for cloning and expression of recombinant DNA, different enzymes involved in production of recombinant DNA. RE and their types, functions, naming.
Genetic Engineering: Definition of genetic engineering, steps and strategies of genetic engineering, prospects and problems of genetic engineering.
Cloning Vectors: Characteristics of good cloning vectors, types, structure of different cloning vectors, synthesis and cloning of cDNA, Decapping of mRNA, isolation of full-length cDNA, 3´-RACE, 5´-RACE, formation of genomic DNA, preparation of vector DNA, recipient DNA, formation of hybrid DNA through genetic engineering.
Gene Library and Cloning of Foreign Gene: Construction of cDNA library, genomic library, different approaches for finding the target gene from cDNA and gene libraries.
Creation of Transgenic Microbs, Plants and Animals through Genetic Engineering: Identification and isolation of gene, nuclear, chloroplast and mitochondrial DNA, preparation of selected DNA, gene transfer methods in to host cells, expressing of the transfer genes.
Confirmation of Transgene Expression: Transgenesis, Gene from different kinds of RNA, RNA polymerase, positive and negative control of gene expression, gene expression of somatic cell hybrids.

Recommended References:

1. Foster, G.D. and Twell, D.(1997). Plant Gene Isolation: Principle and Practice. Jhon Wiley and Sons. Singapore.
2. Khush, G.S. and G.H. Toenniessen (1991). Rice Biotechnology. IRRI, CAB International, U.K.
3. Watson (1997). Recombinant DNA Technology, McMillan Pub. Co.

Course Title: Aquaculture and Fish Genetics/Fish Molecular Ecology

Course No.: GEB 341 Credits: 3 Contact Hours: 36 Total Marks: 100

Course: GEB-341: Aquaculture and	**Credit Hour: 03**	**Year: 3rd**	**Semester: II**

Fish Molecular Ecology			
Rationale: This course is most important for the development of fisheries sector in Bangladesh while Bangladesh is aquatic resources rich country and earns lots of foreign currency.			
Course Objectives: The objectives of this course are to know the diversity of aquatic bio resources, to know the biology, ecology, socioeconomy, business etc. which will be most important for future biotechnological applications in fisheries sector of Bangladesh for sustainable production, to know the genetics for breeding and conservation of fish and shellfish in Bangladeshi nature.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Master the knowledge behind the genetic modifications and improvements • Understand the genetic approaches and technologies currently applied in aquaculture • Review and summarize the most updated genetic applications for fish and aquaculture • Apply the knowledge from this course for their own research and extension projects • Develop critical thinking for the fast-developing genetic modifications in aquaculture			
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Farm visit etc**.**			
Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Answer, Short Question etc.			
Course Contents			
Aquaculture: **Introduction:** Taxonomy of fin fish and shellfish, Definition and aims of aquaculture, Brief description of different aquaculture system and management practices, Present status of aquaculture and mari1-culture in Bangladesh.			
Freshwater Aquaculture: Culture of Carp, Catfish, Tilapia, Prawn.			
Integrated Fish Culture: Paddy cum fish culture, Poultry/duck cum fish culture.			
Mariculture: Culture of shrimp, Oyster, Crab.			
Ornamental Fish Culture: Important indigenous and exotic aquarium fish species and their culture method, breeding of aquarium fish.			
Reproductive and Endocrine System of Fish: Reproductive systems of freshwater and marine fishes, Endocrine systems and their realizing hormone of freshwater and marine fishes.			
Sex-determination: Different sex determining system of fish.			
Population Dynamics: Fish nutrition; Food and feeding; Stocking density and mortality; Age and growth of fish.			
Breeding of Fish and Shrimp: Natural and artificial breeding of Carp, Tilapia, Catfish, Prawn and Shrimp.			
Diseases of Aquatic Animals and Control Methods: Major Protozoan, Microbial (Viral, Bacterial, fungal), environmental and nutritional deficiency diseases of fish and shellfish and their control method.			
Fish Genetics: Qualitative genetics: Different types of genetic interactions.			
Quantitative genetics: Genetics of quantitative traits, quantitative genetics related to fish breeding, heritability and artificial selection, Inbreeding, inbreeding problem, Genetic drift.			
Population Genetics: Hardy Weinberg equilibrium, genetic variation, domestication.			

Recommended References:

1. Al- Hajj. A. B. and Farmer, A. S. D. 1984. Shrimp Hatchery Manual. Safut. Kuit Institute for scientific Research.

2. Bardach, E. J., Ryther, J. H. and McLarney, W. O. , Aquaculture. USA.
3. Doyle *et al*. (Editors). 1996. Genetics in Aquaculture [UTF-8?]"V. Elsiver Science Publishers.
4. Gall *et al*. (Editors). 1993. Genetics in Aquaculture [UTF-8?]"IV. Elsiver Science Publishers.
5. Hussain, M. G. and Mozid., M. A. 2000. Breeding Plans, Stock Improvement and Conservation of Carp Genetic Resources in Bangladesh. ICLARM, Dhaka.
6. Purdom, C. E. 1992. Genetics and Fish Breeding. Chapman and Hall. London, NY, Tokyo, Melborne, Mardas.
7. Fast, A. W. and Lester, L. J. 1992. Marine Shrimp Culture: Principles and Practices.
8. Tave, D. 1993. Genetics for Fish Hatchery Managers. Second Edition. Van Nostrand Reinhold Publisher, New York.
9. Tave, D. 1995. Selective Breeding Programs for Medium Size Fish Farms. FAO Fisheries Technical Paper.
10. Griffiths, W. J., Miller, J. H., Suzuki, D. T., Lewontin, R. C. and Gelbart, W. M. (2000). An introduction to genetic analysis. New York, ISBN 0-7167-3520-2
11. Lutz C. G. (2001). Practical genetics for aquaculture. Fishing News Books Ltd., ISBN 08523-8285-5

Course Title: Aquaculture and Fish Genetics Lab

Course No.: GEB 342 Credits: 01 Contact Hours: 02 Hours/week

Course: GEB-342: Aquaculture and Fish Genetics Lab	**Credit Hour: 01**	**Year: 3rd**	**Semester: II**
Rationale: This course will introduce the student to the biology of the non-vertebrate marine and aquatic animals that humans harvest or culture. Invertebrate animals (e.g. mollusks, crustaceans, echinoderms) comprise most of the described animal species.			
Course Objectives: This course will examine the biology of marine and freshwater invertebrates that are important as fisheries or in aquaculture. Topics will include taxonomy, morphology, distribution and habitat, nutrition, significant ecological interactions, and life cycles. Non-food fisheries, such as commercial sponges and pearl oysters, will also be included.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Understand and apply scientific principles in an aquaculture and fish genetics context, and work effectively, cooperatively and productively within a team • Retrieve and present scientific information aquaculture and fish genetics, including communicating effectively with a variety of audiences in written and spoken form • Critically analyse and evaluate information relevant to aquaculture and fish genetics and solve problems • Appreciate the multidisciplinary aspect of marine sciences and engage positively with people and ideas beyond their discipline area • Work effectively and productively within teams			
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Farm visit etc**.**			
Assessment Strategy: Quiz Test, Short Essay, MCQ, Assignment, Viva			
Course Contents			
1. Field visit and sample collection			
2. Spot identification of aquatic animals including fish, crustacean, molluscs etc.			
3. Taxonomic study of fish, molluscs and crustacea			

4. Sexual dimorphism of fish molluscs and crustacean
5. Induced breeding
6. External morphology of fish molluscs and crustacea
7. Internal anatomy of different aquatic animals (Dissection, drawing and labeling)
8. Study of freshwater animals
9. Cost analysis for fish culture
10. Study of pond ecosystem
11. Determination of age and growth of fish
12. Study of fish parasites
13. Study of articulated bone of fish
14. Diagnostic procedures by direct microscopy of wet mounts, hematology and tissue smears (Histopathology/Tissue Histology-HandE staining), or by routine histopathology (Blood smears-Leishmen staining)
15. Farm visit
16. Lab report
17. Viva Voce

Course Title: Bioprocess Engineering

Course No.: GEB 343 Credits: 02 Contact Hours: 24 Total Marks: 100

Course: GEB-343: Bioprocess Engineering	**Credit Hour: 02**	**Year: 3rd**	**Semester: II**

Rationale: The course is designed to enable graduate to incorporate in-depth relevant knowledge in processes and techniques for using biological agents such as cells, enzymes or antibodies for the production of chemicals, food, biofuels and pharmaceuticals, and waste treatment

Course Objectives:

- Emphasize the basic principles of bioreaction and bioprocess engineering, which includes: fluid mechanics and microbial growth, batch and continuous cell growth kinetics, products formation and nutrient utilization, bioreactor systems, mass transfer, sterilization processes and bioprocess controlling factors viz. agitation, mixing temperature, evaporation.
- Discuss several methods of cell disruption with principles
- processes involved in production of chemicals, food, biofuels and pharmaceuticals using biological agents and design and operation of bioreactors
- unit operations and processes for product recovery and economics of bioprocesses

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Technologically manage industrial biotechnological production systems
- Convey biotechnological process into larger (industrial) scale (scale up) and test them in smaller scale (scale down)
- Plan and conduct experiments (scale up and scale down) in different fields of biotechnology, present and critically interpret results, make meritory conclusions
- Do complex jobs in microbiological and biochemical laboratories
- Apply ethical principles, legal regulations and standards related to specific requirements of the profession

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc**.**

Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Answer,

Short Question etc.
Course Contents
Introduction: Concepts of bioprocess engineering, importance and application of bioprocess engineering, development of bioprocess engineering.
Fluid Flow Phenomena: Static fluid property, pressure and pressure gauge, management of fluid pressure, one dimensional flow, velocity profile and velocity gradients, viscosity and boundary layer, linear and turbulent flow.
Disruption of Microbial cells: Introduction, analysis of disruption, laboratory scale and large scale of disruption techniques.
Agitation and Mixing of Liquids: Introduction, classification of agitation, scope and objectives of agitation, equipments, factor affecting of agitation, applications.
Heat Transfer: Conduction, convection, radiation, natural forced convection, overall heat transfers co-efficient, dimensionless numbers.
Evaporation: Heat transfer in evaporators, classification and application of evaporators in food, pharmaceuticals and cosmetics industries, multiple effects of Evaporators,
Biocomposting Processes: Introduction; composting processes; succession of microorganisms; applications.

Recommended References:

1. Biotechnology 2nd edition.vol.3. Bioprocessing Rehm H-j and Reed G.
2. Hand book of indigenous fermented foods. K.H Steinkraus.
3. Food, feed and fuel from biomass; Chahal DS.
4. Biotechnology and renewable energy,Moo-Young M. Biotechnology of industrial antibiotics. Vandamme E.J.
5. Prescott and Dunn's industrial microbiology-G-Reed.

Course Title: Oncology and Virology

Course No.: GEB 347 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-315: Oncology and Virology	**Credit Hour: 03**	**Year: 3rd**	**Semester: I**
Rationale: The course will provide basic knowledge on cancer and viruses. It will emphasize on cell cycle regulation angiogenesis, genetic and epigenetic changes involved in cancer, replication of viruses and relationship between virus and cancer. Students will be introduced theoretically with how cancer and viral cells survive in human body escaping immune system.			
Course Objectives: • Demonstrate an understanding of basic oncology and virology principles. • Microscopy of different types of cancer cells and viruses. • Taxonomy, growth, and culture of cancer cells methodology.			

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Explain the concepts and pathophysiology of cancer development
- Apply the concepts of epidemiology in relation to cancer and cancer prevention and screening
- Apply a knowledge base of therapeutic goals, approaches, indications, nursing implications, mechanisms, and action and safety issues for cancer treatment modalities to patient care.
- Discuss the use of complementary therapies by patients with cancer
- Describe and analyze issues related to cancer survivorship and the experience of cancer as a chronic disease.

Teaching Strategy: Lecture, Power point presentation, Animation , Discussion, Q and A etc

Assessment Strategy: Q/A, Quize, Essay, MCQ, Group discussion etc

Course Contents

Oncology

Introduction: Definition, Terminologies, Benign and Malignant Tumour, Tumour cell growth, Kinetics of tumour cell growth, host factors affecting tumour cell growth.

The Spread of Tumours: Pathway and Mechanism Tumour Invasion, Dissemination of tumour cells, Pattern of tumour cells spread, Metastasis, tumour Mechanism of metastasis.

The Molecular Cytogenetic and Immunology basis of Cancer: Mechanism of Oncogenes activation, Viral ontogenesis, Oncogene and their products. Chromosomal abnormalities are cancer. Immune surveillance, Immune facilitation, Immunodeficiency Syndromes and tumour formation.

Carcinogenesis: Definition and carcinogenesis classification, identification of susceptible individual, classification of carcinogens, geastoxic carcinogenes, epigmetic carcinogens, tumour promotes, oncogenes.

Diagnosis and Management of Cancer: Principals of cancer diagnosis, approaches of cancer, methods of cancer diagnosis, cancer Screening, cancer prevention nutritional care, hospice care.

Treatment of Cancer: Surgical oncology, radiation oncology, Medical oncology.

Virology

Introduction: Brief history, nomenclature and classification, virion structure.

Pathogenesis of Viral Diseases: specific examples: Influenza, EBV, Hepatitis, HIV, Dengue and Tumour viruses.

Cellular Oncogenes and Oncogenic Viruses: factors affecting the development of cancer, relation of oncogenes and oncogenic viruses for development of cancer, use of retroviruses as a vector for gene therapy and genetic engineering.

Plant and Animal Virus Replication: Replication and gene expression of DNA and RNA viruses-TMV, adenovirus, hepadnavirus, poxvirus, orthomyxoviruses, reoviruses, retroviruses.

Bacteriophages: Genome organization and replication of DNA and RNA bacteriophages-T_2, T_4, φX174, MU.

Immunity, Prevention and Treatment of Viral Diseases: Interferon interference, induction and activation, antivirals and viral vaccines.

Viroids and Prions: General characteristics, virulence properties.

Recommended References:

1. Brock, T.D. Biology of Microorganisms.
2. Fields. Fundamentals of Virology
3. Jawetz E. J. *et al.* Review of medical microbiology

Course Title: Immunology and Virology Lab

Course No.: GEB 348 Credit: 01 Contact Hours: 2Hours/week

Course: GEB-348: Immunology and Virology Lab	**Credit Hour:01**	**Year: 3rd**	**Semester: II**
Rationale: The course is designed to provide hand-on training to the students especially on various immunological techniques and assays.			
Course Objectives: • To know antigen-antibody interactions • To understand immune assay techniques viz. immunofluorescence, radioimmuno, complements and enzyme-linked assay.			
Intended Learning Outcomes (ILOs): At the end of the course students will be able to- • Understand antigen antibody interaction and precipitation reaction in gel. • Explain the procedure of haemaglutination fixation and complement fixation test. • Perform various assay techniques such as Radioimmunoassay, Enzyme-linked Immunosorbent assay and Effectors' Cell Assay. • Isolate pure antibodies and Lymphocyte population.			
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab etc**.**			
Assessment Strategy: Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Answer, Short Question etc.			
Course Contents			
1. Antigen-Antibody Interactions			
2. Precipitation reaction in Gels			
3. Haemaglutination and haemaglutination fixation test			
4. Complement fixation			
5. Direct and Indirect Immunofluorescence			
6. Radioimmunoassay			
7. Enzyme-linked Immunosorbent Assay			
8. Immunoblotting and Immunoprecipitations			
9. Isolation of pure antibodies			
10. Assay for Complements			
11. Isolation of Lymphocyte population			
12. Effectors' Cell Assay			

Recommended References:

1 Roitt, Brostoff, Male; (1996). Immunology. 4th edition,; Publisher: Dianne Zack; Mosby.
2 Rott, I. (1994). Essential Immunology. 8th edition, Blackweell scientific Publication. London.
3 Benjamini, E. SineyLeskowitz; (1992). Immunology- A short course 2nd edition; Wiley-Liss, John Wiley and Sons, Inc publications, New York, Singapore.
4 Male, D. Champion, B., Cooke, A. (1987). Advanced Immunology, J. B. Lippincott Company Philadelphia.
5 Janeway, Traverse; Immunobiology; (1994); Blackweell scientific publications.
6 Janis Kuby; Immunology, 3rdeidtion; W. H. Freeman and company.

7 Divid Male; Immunology- an Illustrated Outline, 2nd edition; Mosby publication.
8. Staines, N; Brostoffm, J; James. K.; Introduction to Immunology. 2nd edition; Mosby Publication.

Course Title: Bioenergetics

Course No.: GEB 349 Credits: 02 Contact Hours: 24 Total Marks: 100

Course: GEB-349: Bioenergetics	**Credit Hour: 02**	**Year: 3rd**	**Semester: I**

Rationale: The understanding of metabolism provides the directions to better understand how muscles generate energy, and how and why the body responds to exercise the way it does.

Course Objectives: Students would be able to understand the importance of order (organization) of living systems, the concept of energy related to the concept of entropy to the laws of thermodynamics, free energy and its relationship to chemical equilibria, the factors that make ATP as a suitable energy store, identification of two general types of coupled reactions, explanation of the chemiosmotic hypothesis of ATP synthesis.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Account for the structure and topology of energy converting membrane protein complexes.
- Explain thermodynamic principles if biological energy conversion.
- Account for common redox components and - processes of electron transport proteins
- Account for the mechanisms of different kinds of energy converting systems in living organisms.
- Show how the energy released by catabolism is recouped by substrate level and oxidative phosphorylation;
- Use spectroscopic and other physical and analytical methods for studying membrane processes as well as biological redox processes.
- Use modern methods to study molecular mechanisms in respiration, photosynthesis.

Teaching Strategy: Lecture, PPT Lecture, Video Animation , Discussion, Q and A etc

Assessment Strategy: Q/A, Quiz, Short Essay, MCQ, Test etc.

Course Contents

Bioenergetics: High energy compounds, the ATP cycle, structure, occurrence and properties of ATP, ADP and AMP, ATP transfer of phosphate group, ATP as the source of energy, the role of ATP and pyrophosphate, and other high energy compounds.

ATP synthesis: Coupling with respiratory electron flow, the chemiosmotic model, mitochondrial oxidation of cytosolic NADH, energetics of electron transport, uncoupling and inhibition of electron transport regulation of oxidative phosphorylation.

Oxidative phosphorylation and dephosphorylation

Biological oxidation and reduction reaction

Mitochondria: Structure, enzyme localization, mitochondrial electron flow, electron carriers, uncouples and inhibitors of oxidative phosphorylation.

Recommended References:

1. Lehninger, Albert, L., Nelson David, L., Cox, Michael, M., Principles of Biochemistry, 1st Indian Edition, 1993. CBS Publisher's and Distibutors.
2. Strayer, Lubert, 1988. Biochemistry, 3rd Edition, Q. H. Freeman and company, NewYork.
3. Murray, R. K., Granner, D. K., Mayes P. A. Rodwell, V. W. 1988. Harper's Biochemistry. 22nd edition, Prentice Hall International.
4. Conn, E. E., Stumpt, P. K., 1994, Outlines of Biochemistry, 4th Edition, Wiley

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Course No. GEB 300
Course Title: Industrial Visit and Seminar
2 Hours/week, 1 Credit

Course Title: Proteomics, Genomics and Bioinformatics
Course No.: GEB 411 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-411: Proteomics, Genomics and Bioinformatics	**Credit Hour: 03**	**Year: 4th**	**Semester: I**

Rationale: This course aims to guide students in the use of bioinformatics applications available for the use of the information derived from the study of genomics and proteomics to generate knowledge and make discoveries based on informed interpretation.

Course Objectives:

- Introduce the broad scope of applying bioinformatics to collect, store, organize, manage, distribute and retrieve genomic data (DNA/RNA and protein sequences) and model biological molecules.
- Discuss the theory and practice of computational methods used in the field of genomics, proteomics and demonstrate the various databases and basic programming tools available through the internet.
- Make students aware of how scientific hypotheses on structure-function of biological molecules and systems can be tested/interpreted using computational analysis and modeling and help to generate new knowledge.

Intended Learning Outcomes (ILOs):
After completion of the course, the students will be able to-

- Describe the development of Omics technologies, with emphasis on genomics and proteomics;
- Synthesize information to discuss the key technological developments that enabled modern genomic and proteomic studies;
- Describe advanced genomics and proteomics technologies and the ways in which their data are stored;
- Use bioinformatics techniques to query examples of genomic and proteomic databases to analyse cell biology;
- Describe the different types of genome variation and their relationship to human diseases;
- Discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc**.**

Assessment Strategy: Q/A, Quiz Test, Short Essay, MCQ, Assignment, Viva, Short Answer, Short Question etc.

Course Contents

Introduction to Bioinformatics: The fundamentals of protein and nucleic acid Sequence analysis, Database searching, pair wise alignments, database searching including BLAST, Sequence analysis with PERL, Multiple sequence alignments, phylogenetic analysis, Profile searches of databases, revealing protein motifs, 3D structural comparisons, predictions and modeling.

Genomics: What is genomics, Genetics to genomics, Whole genomes sequencing. Genome Sequence Acquisition and Analysis, Genome analysis and annotation, Evolution and Genomes, Biomedical Genome Research: genomic sequences to make new vaccines, new types of antibiotics, new types of medications.
Genomic Variations: Variation in the human genome, known examples of SNPs that cause diseases, Pharmacogenomics, Ethical Consequences of Genomic Variations.
Expression Data Analysis: DNA/RNA Microarrays, The oligo microarray/chip technology, Affymetrix protocol and data generation, The spotted microarray technology, cDNA and oligo spotted arrays, Biomedical applications; Cancer and genomic microarrays. Nanotechnology, Gene therapy.
Proteomics: Introduction, Protein 3D Structures, Protein identifications (2-hybrid system, 2-D gel electrophoresis, mass spectrometry/MALDI-TOF, other arrays). Statistical models and stochastic processes in Proteomics, Signal Processing for Proteomics, Protein Interaction Networks, measureing protein interactions, Large-scale databases of information for protein sequences, structures, functions and interactions; mining of protein databases, applications to human disease studies.
Networks in Bioinformatics/Proteomics: Communication Networks, Biological networks (Protein Interaction Networks, Gene regulation networks, Metabolism, Biochemical reactions), Databases and search tools for biological network analysis. Genomic Circuits: in Single Genes, Complex integrated Genomic Circuits, Modeling Whole-Genome Circuits: Genomics vs. Proteomics Case study Yeast Protein Interaction Network (random network, Scale free network, Hierarchical network)
Structural and Functional Genomics Studies **Plant genome:** Arabidopsis genome covering identification and characterization of genes controlling flowering, vernalization, photoperiod, circadian clock.

Recommended References:

1. Discovering Genomics, Proteomics, and Bioinformatics. Campbell and Heyer (2003) Pearson Education, ISBN: 0-8053-4722-4
2. Bioinformatics, Methods of Biochemical Analysis Series Vol. 43, Baxevanis and Ouellette (2001) John Wiley and Sons, ISBN 0-471-38391-0
3. Computational Molecular Biology. Pevzner, P.A. (2000) MIT Press, ISBN: 0262161974
4. Bioinformatics: A Lab. Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis and B. F. Francis Ouellette (2004). 3rd Edition. Wiley and Sons, ISBN: 0-471-47878-4

Course Title: Proteomics, Genomics, Bioinformatics Lab

Course No.: GEB 412 Credit: 01 Contact Hours: 2 Hours/week

Course: GEB-412: Proteomics, Genomics, Bioinformatics Lab	**Credit Hour: 02**	**Year: 4th**	**Semester: I**
Rationale: Introduce students to the current bioinformatics algorithms/concepts and their implementations.			
Course Objectives: This course is designed to introduce students to bioinformatics tools and analysis methods. Upon completion of the course, students should be more comfortable working with the vast amounts of biomedical and genomic data and online tools that will be relevant to their work in the coming decades.			
Intended Learning Outcomes (ILOs):			

After completion of the course, the students will be able to- • Design and evaluate research methodology in advanced genetics and bioinformatics • Analyse and interpret data, and assemble and evaluate information in advanced genetics and bioinformatics • Construct and evaluate estimates of phylogenetic relationships • Create new ideas and methods in advanced genetics and bioinformatics
Teaching Strategy: Class Lecture, Projector Display, , Experiment in the lab etc
Assessment Strategy: Quiz Test, Short Essay, MCQ, Assignment, Viva
Course Contents
1. Introducing and handling of web based tools used in proteomics and genomics.
2. Similarity searching by using different BLAST programs.
3. Multiple alignments.
4. Construction of phylogenetic tree.
5. Building up of 3D models.
6. Molecular docking.
7. Gene expression analysis by using publicly available transcriptonic data.

Course Title: Medical and Pharmaceutical Biotechnology

Course No.: GEB 413 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-413: Medical and Pharmaceutical Biotechnology	**Credit Hour: 03**	**Year: 4th**	**Semester: I**
Rationale: This course will help the graduates to find employment in a range of areas including the pharmaceutical, pathology and biomedical industries, biotechnology companies, research institutes, hospitals and universities.			
Course Objectives: This course specifically aims to equip students with the knowledge of medicine, biopharmaceutical products, polyclonal and monoclonal antibodies, test and techniques used for good pharmaceutical product, gene therapy, biomedical research and biotechnology, social and ethical issues and its scientific basis, and developed skills.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Learn about the general principles of drug discovery and development. • Know different new types of biotechnological drugs. • Know biotechnology and medical applications of specific biotech products categories. • Understand technological procedures for the commercial production of some microbial and non microbial products (insulin, interferon, vaccines, therapeutic enzymes, blood products, monoclonal antibodies).			
Teaching Strategy: Class Lecture, Projector Display, Animation, Discussion etc			
Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, etc.			
Course Contents			
Introduction: History, definition, application, development and production of medicinal and pharmaceutical products through biotechnology.			
Good Manufacturing Practices (GMP): Concept of GMP, quality control, quality assurance and in-process control in pharmaceutical industry.			
Genetic Diseases: Diagnosis, mechanism and treatment of common genetic diseases in Bangladesh, genetic counselling, prenatal diagnosis, personalized medicine and pre-marriage decision.			

Biotechnology in Medicine: Production of human peptide hormones- insulines, somatotropin, somatostatin, human interferon, different types of vaccines, blood products and antibiotics.
Production of Biopharmaceutical Products: Biopharmaceutical products from plants, animals and microbes; animal products through cell culture; pharmaceutical products through transgenic technology; blood substrates through transgenic animals.
Production of Polyclonal and Monoclonal Antibodies: Hybridoma technology, purification of polyclonal and monoclonal antibodies.
Test and Techniques Used for Good Pharmaceutical Product: Sterility testing, potency of antibiotics and vaccines, pyrogen test-LAL and rabbit test.
Gene Therapy: Detection of human disease causing genes, functional and potential gene cloning, *ex vivo* and *in vivo* gene therapy, viral gene delivery systems, pro-drug activation therapy.

Recommended References:

1. Assays in applied Microbiology, Edited by J. R. Noris and M. H. Richmond. Jhon Wiley and Sons.
2. K.A. Malik, A. Nasim and A.M. Khalid (1995). Biotechnology for sustainable development. Published by NIBGE, Faisalabad Pakistan.
3. Pharmaceuticals Microbiology. Edited by – W.B. Huge and A.D. Russel, 1993.
4. Modern Biotechnology: Primrose.
5. Microbial Conversion of Steriod and Alkaloids: Lizuka, 1981.

Course Title: Stem Cell Technology

Course No.: GEB 417 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-417: Stem Cell Technology	**Credit Hour: 03**	**Year: 4th**	**Semester: I**
Rationale: The course is designed to provide concepts and principles in Stem cell related technologies for cultured products for therapeutics and commercial interest.			
Course Objectives: • Describe the basic principle and concepts about mammalian cell culture and cell culture technologies. • Comprehend the practical applications of animal cell culture and production of therapeutics for human and animal.			
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to- • Recognize the fundamentals of animal cell culture and the technologies used for cell culture. • Familiar with different cell cultures and cell lines. • Choose the cell line for expression of recombinant proteins for commercial and therapeutic applications.			
Teaching Strategy: Class Lecture, Projector Display, Animation, Discussion etc			
Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.			
Course Contents			
Introduction: Definition of stem cells, types and sources of stem cells, Preliminary findings and research possibilities, focusing on human embryonic stem (ES) cells, Stem cell biology, nuclear reprogramming and induced pluripotent stem cells, therapeutic applications of stem cells.			

Embryonic Stem Cells: Embryonic stem cells, properties of mouse embryonic stem cells, self-renewal of embryonic stem cells, differentiation of mouse and human embryonic stem cells, mouse embryonic stem cell modification and expression systems.
Transcription Factor for Stem Cells Studies: Transcription factor functional determination in murine embryonic stem cells, forward differentiation of murine embryonic stem cells by ectopic expression of defined factors, reverse differentiation of murine embryonic stem cells by ectopic expression of defined factors.
Function of MicroRNA-145 in Human Embryonic Stem Cell Pluripotency: Human Embryonic Stem Cell for Self-Renewal and Pluripotenc, Molecular Delineation of Key Regulators in Human Embryonic Stem Cells, Transcription Factors and Reprogramming MicroRNAs, MicroRNA Expression in Embryonic Stem Cells, MicroRNA Processing, MicroRNA-145: Regulator of Stem Cell Fate, Identification of miR-145 as a Temporally Regulated MicroRNA During Human Embryonic Stem Cell Differentiation, Defining Targets of miR-145: OCT4, SOX2, and KLF4 Endogenous miR-145, Directly Targets OCT4, SOX2, and KLF4 3¢ Untranslated Regions in Human Embryonic Stem Cells, Effect of miR-145 on Endogenous OCT4, KLF4, and SOX2 in Human Embryonic Stem Cells, Induced miR-145 Regulates Human Embryonic Stem Cell Self-Renewal miR-145, Promotes Differentiation of Human Embryonic Stem Cells Necessity of miR-145 During Human Embryonic Stem Cell Differentiation, A Novel Feedback Loop of miR-145 and Transcription Factors, Connection of miR-145 and Pluripotency Network.
Stem Cells for Therapeutic Applications: Introduction, History and Definition, Origins, Isolation, and In Vitro Culture Characterization, Multipotent Differentiation, Therapeutic Applications. Tissue Regeneration Through Multilineage Differentiation, Paracrine Factors and Immunomodulatory Effects, Genetically Engineered MSCs, *Advantages of Using MSC as Therapeutic Cells, Challenges of MSC-Based Therapy and Safety Concerns.*
Nuclear Transfer Embryonic Stem Cells as a New Tool for Basic Biology: Introduction, Animal Cloning, Nuclear Transfer Embryonic Stem Cells, Establishment of Nuclear Transfer Embryonic Stem Cell Lines from Individuals, Normality of Nuclear Transfer Embryonic Stem Cells, Ethical Issues in Using Nuclear Transfer Embryonic Stem Cells, A General Attempt to Avoid Ethical Problems, Improving the Differentiation Potential of Parthenogenetic Embryonic Stem Cells by Nuclear Transfer, Establishing Nuclear Transfer Embryonic Stem Cell Lines from Aged Mouse Oocytes, Applications of Nuclear Transfer Embryonic Stem Cell Techniques, Therapeutic Medicine, A New Tool for Basic Biology, Producing Offspring from Individual Mice, Preserving Unique but Infertile Mutant Mouse Genes, The Possibility of Resurrecting an Extinct Animal.
Induced Pluripotent Stem Cells for Clinical Applications: Introduction, Induced Pluripotent Stem Cells, Offer Great Therapeutic Potential, Induced Pluripotent Stem Cells, Ethical Obstacles Presented by Embryonic Stem Cells, Induced Pluripotent Stem Cell–Derived Cell Types Have Promising Therapeutic Potential, Induced Pluripotent Stem Cells Offer Good Models for Personalized Medicine, Characteristics of Induced Pluripotent Stem Cells, *In Vitro Studies of Induced Pluripotent Stem Cells,* General Properties of Induced Pluripotent Stem Cells and Embryonic Stem Cells, Genetic and Epigenetic Properties of Induced Pluripotent Stem Cells, In Vivo Functional Studies of Induced Pluripotent Stem Cells, *Formation and Chimera Generation*, Complementation Induced Pluripotent Stem Cells, Summary and Prospects.

Recommended References:

1. Butler, M. (2005). Animal Cell Culture and Technology, second Edition, Taylor and Francis Group, NY, USA.
2. Beuvery, Griffiths and Zeijlemaker (1995). Animal Cell Technology. Kluwes Academic Publishers, Dordrecht, Boston, London.

3. Glyn Stacey and John Davis (2007). Medicines from Animal Cell Culture. John Wiley and Sons Ltd, West Sussex, England.
4. Ian, R. Fresshney, (1998). Culture of Animal Cells. Third Edition, Wiley-Liss, A Hohn Willey and Sons, Inc. Publication, NY, Chichester, Brisbane, Toronto, Singapore.
5. John, Davis (2012). Animal Cell Culture, first edition, Wiley and Blackwell Publishers.
6. Animal Cell Technology: From Biopharmaceuticals to Gene Therapy (2008). Edited by Leda, R.C., Angela M.M., Elisabeth, F.P.A. and M. Butler, Taylor and Francis Group, NY, USA.
7. Twyman, R.M. (2005). Transfer to Animal Cells. BIOS Scientific Publications, Hampshire, UK.

Course Title: Bioreactor and Downstream Processing

Course No.: **GEB 419** **Credits: 02** **Contact Hours: 24** **Total Marks: 100**

Course: GEB-419: Bioreactor and Downstream Processing	**Credit Hour: 02**	**Year: 4th**	**Semester: I**
Rationale: The course will cover processes and techniques for using biological agents such as cells, enzymes or antibodies for the production of chemicals, food, biofuels and pharmaceuticals, and waste treatment. The course will include stoichiometry and kinetics of reactions that employ biological agents; design, analysis and operation of reactors and product recovery and purification (downstream processing).			
Course Objectives: To develop concepts and mathematical tools required to understand and analyze the design and operation of reactors using biological agents, processes involved in production of chemicals, food, biofuels and pharmaceuticals using biological agents. Unit operations and processes for product recovery and economics of bioprocesses.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Know the main unit operations of product recovery. • Master the fundamentals of bioreactors. • Understand the principles of product recovery. • Design a bioprocess as a sequence of unit operations.			
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment, Discussion etc			
Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.			
Course Contents			
Concepts of Bioreactors: Historical background, bioreactor process, factors for growth in bioreactors, types of bioreactors, bioreactor design, contamination and sterilization			
Process Development: Shake-Flash fermentation, scale up of the process, bioreactors operation, bioreactor media			
Metabolic Production: Shikonin, rosmarimic acid, indole alkaloids, anthacyanine, recombinant protein, acetone-butanone, industrial alcohol, enzymes production, vaccine genes farming, drugs in bioreactors, commercialization of bioreactors products.			
Instrumentation and Control: Control system, types of control, air flow monitoring, measurement of power input and temperature, foam and pH control			
Downstream Processing: Upstream and downstream processing, separation of particles, disintegration of cells extraction, concentration, purification, drying.			
Recovery and Purification of Fermented Products: Methods of recovery and purification			
In Situ Recovery of Products: use of vacuum, two phase systems, dialysis, applications.			

Recommended References:

1. Fermentation: a Lab. approach-B. MacNeiland Harvey, IRL Press, Oxford
2. Principle of Fermentation Technology-P.F. Stanburyand Whitaker.

3. Dubey, R.C. (2005) A Textbook of Biotechnology, S. Chand and Company Ltd. New Delhi

Course Title: Microbial Biotechnology

Course No.: GEB 421 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-421: Microbial Biotechnology	**Credit Hour: 03**	**Year: 4th**	**Semester: I**

Rationale: The course is designed to develop student's knowledge and understanding of microbial use in traditional fermentation processes, strain selection as well as the development of recombinant microbes for industrial, commercial, environmental, pharmaceutical and medical applications.

Course Objectives: The course will introduce the students to the historical development, scope and features of microbial biotechnology; biotechnology in commercially important products production like therapeutic agents, vaccines, economically important primary and , secondary metabolites, bioplastics and synthesis of commercial products by recombinant micro-organisms, biorecombination and biomass utilization.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Critically evaluate the role of micro-organisms in specific biotechnological processes
- Explain the complex processes behind the development of genetically manipulated organisms
- Demonstrate a clear understanding of how biochemical pathways relate to biotechnological applications
- Conduct a comprehensive search for original research literature pertinent to a selected area of microbiology and biotechnology
- Communicate complex scientific principles and ideas effectively

Teaching Strategy: Class Lecture, Projector Display, Animation, Discussion etc

Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Microbial production of therapeutic agents:

- Pharmaceutical isolation of interferon cDNA; Engineering of human interferon and human growth hormones; optimizing gene expression.
- Enzymes DNAase I and alginate lyase against cystic fibrosis.
- Monoclonal antibody as therapeutic agents-production of antibodies in E. coli and yeast. HIV thereapeutic agents.

Vaccines: Subunit vaccine- herpes simplex virus, tuberculosis, peptide vaccine, genetic immunization, attenuated vaccine, vector vaccine.

Synthesis of Commercial Products by Recombinant Micro-organisms: Restricted endonuclease; Small biomolecules- L-ascorbic acid, amino acids; antibiotics-cloning antibiotic genes, synthesis of novel antibiotics, peptide antibiotics; Biopolymers-Xanthan gum production, malanin biosynthesis, adhesive,rubber

Biorecombination and Biomass Utilization: commercial production of fructose and alcohol, silage fermentation; utilization of cellulose.

Economically Important Primary and Secondary Metabolites: Production of single cell protein from carbohydrates, n-alkanes, methane and methanol for use in food and feed.

Bioplastic: Definition, Application of bioplastic; Types, Environmental Impact; biodegradation of bioplactic and Industry and market demand.

Recommended References:

1. Modern Biotechnology: Primrose.
2. Microbial Enzymes and Biotechnology: Fogerty, 1983.
3. Basic Biotechnology: Bullock, 1987.
4. Microbial degradation of organic compounds: Gibson, 1994.
5. Microbial Conversion of Steriod and Alkaloids: Lizuka, 1981.
6. Enzymes and Immobilized Cells in Biotechnology: Laskin, 1985.
7. Single Cell Protein: Davis, 1976

Course Title: Plant Biotechnology

Course No.: GEB 423 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-423: Plant Biotechnology	**Credit Hour: 03**	**Year: 4th**	**Semester: I**

Rationale: The aim of this course's learning objectives is to give participants a broad exposure to molecular techniques behind the improvement of plants/crops for yield and quality.

Course Objectives: To understand students the current status, improvement techniques and future prospects of plant biotechnology in Bangladesh.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Explain the basics of the physiological and molecular processes that occur during plant growth and development and during environmental adaptations
- Understand how biotechnology has been used to develop knowledge of complex processes that occur in the plant
- Use basic biotechnological techniques to explore molecular biology of plants
- Understand the processes involved in the planning, conduct and execution of plant biotechnology experiments
- Explain how biotechnology is used for plant improvement and discuss the ethical implications of that use
- Communicate effectively using oral and written means for both scientific and non-technical audiences
- Cooperate and work effectively as a member of a team to solve problems
- Critically evaluate scientific research papers and develop research proposals to address identified gaps

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc

Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Introduction: Definition, concept of plant biotechnology, scope, importance applications of biotechnological products from plant, tools used for plant genetic engineering.

Plant Derived Biochemical Production: Primary and secondary metabolites, types of metabolites, application, and bio-chemicals from cultured plants.

Gene Construct and Trans-gene Expression in Plant: Transient and stable gene expression, marker gene, reporter gene, selectable marker. Mechanism of A*grobacterium* mediated gene transformation, Ti -plasmid, organisation of Ti- plasmid, Promoters and terminators etc.

Gene Transfer Techniques: Gene transfer methods- *Agrobacterium* mediated transformation of Ti-plasmid, vector less and vector mediated gene transfer, Co-integrative

and binary vectors for plant transformation. Direct gene transfer methods: Particle bombardment, PEG mediated transformation, Electroporation, Silicon carbide fibres- "WHISKERS" etc. Transfer of T-DNA in to host genome, advantage and disadvantages of, binary vectors, co-integrative vector., *in-planta* transformation, chloroplast transformation, clean gene technology etc.
Cloning of Plant Gene: Enzymes used for cloning techniques, Cells for cloning, construction of rDNA for plant transformation.
Molecular Approaches to Evaluate Gene Expression in Plant: Gel electrophoresis, blotting techniques – southern, western, northern etc. DNA labelling, PCR and RT -PCR techniques for the evaluation of transgene expression.
Plant Gene Isolation, Identification and Synthesis: Isolation of plant genomic DNA from transgenic plants, plasmid DNA isolation, transgenic plant adaptation and different morphological evaluation.

Recommended References:

1. S.M. Kingsman A.J Kingsman, Genetic Engineering.
2. P. Joshi, Genetic Engineering with its application.
3. Bernard R. Glick. Molecular Biotechnology.
4. Purohit, Agricultural Biotechnology.
5. IndraK Vasil and Trevor A. Thrope
6. Adrian Slater, Niger Scott and Mark Fowler, Plant Biotechnology

Course Title: Plant Biotechnology Lab

Course No.: GEB 424 Credit: 01 Contact Hours: 02 Hours/week

Course: GEB-424: Plant Biotechnology Lab	**Credit Hour: 01**	**Year: 4th**	**Semester: I**
Rationale: Applications of biotechnological techniques in the laboratory will provide students with the basic understanding of the molecular mechanisms that underline cellular processes in plants, with reference examples utilized in advanced Agricultural / Horticultural and Pharmaceutical Industry.			
Course Objectives: To provide fundamental knowledge in Plant Molecular Biotechnology and its application in laboratory. The laboratory teaching of this course will provide students an opportunity to get hands on training with some of the most basic, yet widely utilized techniques in plant molecular diagnostics, DNA structure and Gene/Genome organization.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be expert to- • DNA extraction methods, gene isolation and nucleotide sequence analysis, • Acquaint with principles, technical requirement, scientific and commercial applications in Plant Biotechnology, • Support methodologies to plant improvement, as well as DNA handling with PCR-based detection diagnostic tools,			
Teaching Strategy: Lecture, , Animation, Experiment in the lab, Visit etc			
Assessment Strategy: Quiz Test, MCQ, Assignment, Short Answer, Short Question etc.			
Course Contents			
Isolation of genomic DNA from transgenic plants and control plants: Objectives, principle, requirements and procedure, results			
DNA quantification, estimation, detection by Gel electrophoresis: Objectives, principle, requirements and procedure, results, CTAB methods			

Plasmid Isolation and different vector construction: Objectives, principle, requirements and procedure, results
Application of transgenic techniques for different crops: Transformation techniques, A*grobacterium* mediated gene transfer, Micro-injection, Particle bombardment method.
Molecular analysis of transgenic plants: PCR, RT-PCR, Southern blot, Western blot, Northern blot etc.

Recommended References:

1. Joshi, Genetic Engineering with its application.
2. Adrian Slater, Niger Scott and Mark Fowler, Plant Biotechnology

Course Title: Fisheries Biotechnology

Course No.: GEB 425 Credits: 02 Contact Hours: 24 Total Marks: 100

Course: GEB-425: Fisheries Biotechnology	**Credit Hour: 02**	**Year: 4th**	**Semester: I**
Rationale: This course is most important for the development of fisheries sector for produce valuable products from fisheries resources as well as for conservation strategies.			
Course Objectives: The objectives of this course are to know different biotechnological approaches and apply them in fisheries sector of Bangladesh, to know about value added products and to produce different value added products and bi-products, to know different diseases of fish and shell fish and health management in hatchery and grow out, etc.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Understand the principle behind reproduction in fish • Determine the sex of some species of fish. • Identify genetic materials and protein synthesis code in fish. • Know the ploidy production in fish. • Explain the principle of hybridization in fish. • Classify and explain the reproductive circles in fish. • Understand crossing over and genetic mapping of chromosome in fish • Identify the target gene for transgenesis			
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc			
Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.			
Course Contents			
Introduction: Fish, fisheries and fish biotechnology; application of biotechnology in aquaculture, technological progress, status of fish biotechnology in Bangladesh.			
Manipulation of Reproduction in Fish and Shellfish: Chromosomal engineering: Genome manipulation, polyploidy, gynogenesis, androgenesis, method of chromosomal manipulation, genetic hybridization, embryo manipulation, induction of ploidy and evaluation. Endocrine induction: Hormonal manipulation of genetic sex, genetic sex selection, strategy of sex reversal, monosex stock, management of hormone treatment, biological effects of sex reversal, integrated approach.			
Fish Genomics: Organization of fish and shellfish genome, genetic improvement, selective breeding, domestication and strain evaluation; Advanced techniques related to fish and shell fish breeding; Candidate gene fish and shellfish for transgenesis, characterization of transgenic fish, potential hazards and benefits transgenic fish, future of transgenic induction for aquaculture; Molecular markers and their role in aquaculture biotechnology.			
Value Added Products from Fish: Definition of value added products, seafood, seafood marketing, list of value added products, development of value-added products, medical and			

nonmedical innovative products, fish by products.
Biotechnology in Health Management for Aquaculture: General understanding of pathology in aquaculture; infectious risk assessment in a hatcheries; hygiene in hatchery and farm; immune protection of fish in aquaculture, factors influancing the immune response; disease management tools – immunostimulants, prebiotics, probiotics, bioremediators, enzymes and nutritional supplements, vaccines, advanced drug delivery mechanisms, use of specific pathogen free (SPF) and specific pathogen resistant broodstock (SPR); diagnsostics and their application in aquaculture health management; policies and Regulatory issues with regard to use of antibiotics and drugs for treatment of fish and shellfish diseases; role of HACCP and GMP in fish and shellfish disease management; quarantine and health certification issues.
Advances in Shrimp Biotechnology: Different approaches of biotechnology applied in shrimp production.
Gene Bank and Conservation: *In-situ* conservation of fish gene; *ex-situ* genome bank of fish and shellfish; application of cryopreservation methods in fish and shellfish management; cryopreservation in aquatic biodiversity.
Growth Enhancement of fish and shellfish: Endocrine and molecular control of genetics – enzymology of steroid production in fishes; cell types involved in sex steroid production; receptor mediated action of sex steroids; hormonal control of vitellogenesis; hormonal control of sexual maturation; neuroendocrine control of gonadal development.
Fish cell culture: Culture of fish, molluscs and crustacean cells and development of cell lines with their applications in aquaculture; development of germ cells and germ cell transplantation in fish; use of fish cell lines in geno-ecotoxicology assessment; application of fish stem cell technology to aquaculture and marine products.

Books Recommended:

1. Ranga,M.M. and Q.J.Shammi (2005). Fish Biotechnology. Agrobios, India.
2. Bishop, M. D. *et. al* (1994). Genetics. 136.
3. Crawford, A.M. *et. al.* (1995). Gnetics. 140.
4. Itami, T, *et. al*. (1998). Advanced in shrimp biotechnology. National Centre for Genetic Engineering and Biotechnology. Bangkok.
5. Gjedren, T. (1990). Genetics in Aquaculture III Ed., Elsevier.

Course No.: GEB 402

Course Title: Field Work and Study Tour (Compulsory)

Credit: 01

1. Visit to different research station and laboratory.
2. Field visit to apply biotechnology in different agricultural field.
3. Assignment submission after field tour.

Course Title: Forensic and Molecular Diagnostics

Course No.: GEB 431 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-431: Forensic and Molecular Diagnostics	**Credit Hour: 03**	**Year: 4th**	**Semester: II**
Rationale: The course provides theoretical knowledge to the graduate in the area of molecular diagnosis for acquired, inherited, and infectious diseases and forensic science.			
Course Objectives:			

- To learn the basic principles of molecular biology and their relevance to the identification of disease-causing genes/mutations and the diagnosis of genetic disorders.
- understand modern tools employed to study DNA structure, identify variations in structure among individuals and the molecular basis of human diseases
- Describe the structure and organization of genes, chromosomes and the human genome mutations and genetic abnormalities which can result in genetic diseases.
- To learn modern DNA technology to the application of disease gene identification and analysis and current molecular techniques in diagnostic pathology testing.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Demonstrate knowledge and understanding of a range of concepts and issues in Forensic science.
- Show proficiency in assessing, evaluating, analyzing, and synthesizing scientific information and data interpretation from a variety of sample sources.
- Demonstrate knowledge and techniques fundamental to the practice of forensic science.
- Demonstrate an understanding of ethical standards in the forensic science profession.
- Work cooperatively with others, while demonstrating an increasing understanding of how to be an independent learner.
- Define the various mutations and genetic abnormalities which can result in genetic diseases.
- Relate modern DNA technology to the application of disease gene identification and analysis.
- Explain the effects of human genome variation and its effect on disease.
- Perform a range a molecular genetics techniques and analyze the experimental results.
- Evaluate the role of current molecular techniques in diagnostic pathology testing.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc

Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Introduction: Basic concept, genetic principles, variable number of tandem repeats (VNTRs)/ Minisattelite sequences, short tandem repeats (STRs)/ Microsattelite sequences.

DNA Isolation: Isolation of genomic DNA from whole blood cell, soft tissue, semen, microorganism, bones, plant material, seeds

DNA Fingerprinting: Hybridization based DNA fingerprinting (RFLP) - radioactive, fluorescent and chemiluminescent methods; PCR-based DNA fingerprinting- single locus and multi locus DNA fingerprinting, RAPD, and AFLP.

Polymorphism: Polymorphism of some genetic locus in relation to diseases.

Application of DNA Fingerprinting: Identification of genotype/ varieties, breeds, strains; criminal investigation, immigration, paternity dispute; identification of missing person etc.

PCR based Detection: Detection of bacterial and viral diseases of aquatic animals.

Multiplex PCR: Diagnosis of cystic fibriosis, abnormal mucus clearance from the respiratory tract with frequent infections, pancreatic insufficiency, abnormal salt transport, infertility in males.

ARMS-PCR: Detection of –Thalassemia mutation.

FMR-1 Gene Trinucleotide Repeat analysis: Detection of Fragile X syndrome. Mental retardation, long faces large ear, prominent jaw, post-pubertal macroorchidism.

Genomic Southern Hybridization: Detection of pheladelphia chromosome; acute leukemia

and Chronic myeloid leukaemia.
Sequencing: Identification of bacterial species on the basis of 16S rDNA sequences.

Recommended References:

1. Freefelder, D. 1985. Essentials of Molecular Biology. Narosa Publishing House. New Dilhi.
2. Fowler, E. A. 1993. Techniques for Engineering Genes. Butterworth-Heinemann Ltd., UK.
3. Gupta, P. K. 1997. Cell and molecular Biology. Rastogi Pub., India.
4. Henry, R. J. 1984. Lab. applications of Plant Molecular Biology. Chapman and Hall Pub., London.
5. Micklos, D. A. and G. A. Freyer. 1990. DNA Science, Cold Spring Harbor Lab Press, New York.
6. Stansfield, W. D. 1996. Theory and Problems of Molecular and Cell Biology. McGraw Hill Co. New York.
7. Weising, K. H., H. Nybom, K. Woff and W. Meyer. 1995. DNA Fingerprinting in Plants and Fungi. CRC Press, USA.

Course Title: Forensic and Molecular Diagnostics Lab

Course No.: 432 Credit: 01 Contact Hours: 02 Hours/week

Course: GEB-432: Forensic and Molecular Diagnostics Lab	**Credit Hour: 01**	**Year: 4th**	**Semester: II**

Rationale: This course provides a comprehensive overview of the fundamental principles of forensic and clinical molecular diagnostics and explores the use of molecular techniques in the diagnosis of disease.

Course Objectives:

- Apply knowledge of cellular structure and function, especially DNA and RNA, to molecular diagnostic procedures.
- Gain a thorough working knowledge of nucleic acid extraction, resolution and detection.
- Gain a solid foundation in the most commonly utilized molecular diagnostic testing protocols. Apply the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory such as: nucleic acid extraction, resolution and detection, analysis and characterization of nucleic acids and proteins, nucleic acid amplification and DNA

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Demonstrate knowledge and understanding of some of the links between forensic science and the legal system
- Draw together information from different sources and make logical deductions as a result
- Demonstrate an understanding of how forensic scientists operate and use scientific evidence in a legal context
- Relate modern DNA technology to the application of disease gene identification and analysis.
- Explain the effects of human genome variation and its effect on disease.
- Evaluate the role of current molecular techniques in diagnostic pathology testing.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab,

Assessment Strategy: Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Laboratory works based on GEB 431

Course Title: Protein and Enzyme Technology

Course No.: GEB 433 Credits: 3 Contact Hours: 36 Total Marks: 100

Course: GEB-433: Protein and Enzyme Technology	Credit Hour: 03	Year: 4th	Semester: II

Rationale: Proteins and enzymes have great role in different industrial and health sectors. This course will provide sufficient knowledge in those fields.

Course Objectives: The students will be able to understand the characteristics of proteins and enzymes, large scale production and application of different enzymes used in health and industrial sectors. They will also be able to know the three dimensional structure and catalytic sites of proteins, protein degradation, protein stability and recombinant protein technology.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Describe protein structure in organizational levels,
- Describe the conventional sources and production of significant proteins and enzymes in industrial scale.
- Explain the key structural and energetic factors which give rise to increased enzyme stability important for industrial application,
- Understand the therapeutic applications of proteins and enzymes and their mechanisms of actions.
- Know the various technology of protein and enzyme modification and engineering for enhance activity and stability.
- Summarize current processes involved in industrial enzyme production, from protein production to purification and formulation,
- Describe methods for selection and optimization of industrial enzymes using genetic and biochemical techniques,
- Describe the principles and methods of metabolic engineering of (micro) organisms to produce industrial chemicals.
- Research on contemporary use and application of protein and enzyme technology in diversified field.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc

Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Protein Technology: The scope of protein biotechnology; the range of industrially significant proteins; proteins employed in health-care industry; protein sources; microorganisms as a source of proteins; plants as a source of industrially important proteins; animal tissue as a protein source; conformational stability of proteins; recombinant protein technology; protein engineering.

Enzyme Technology: Industrial approach to enzyme production; development of new enzyme preparations; biochemical applications of enzymes; medical uses of enzyme; the use of enzymes as biocatalyst in organic chemistry; restriction endonuclease; biochemical processing; industrial and technical uses of enzymes; application of enzymes in food industry; use of enzymes in the extraction of natural products; detoxifying enzymes; enzyme based detergents; use of enzymes as cleansing agents; enzymes in the leather industry; enzymes in the textile industry; enzymes in the paper manufacture; enzymes in the antibiotics; miscellaneous uses of biocatalysts.

Recommended References:

1. Walsh G. and Headon D. Protein Biotechnology.
2. Frank F. Protein Biotechnology: Isolation, Characterization and Stabilization.

3. Cleland JF and Craik CS. Protein engineering: Principles and Practice.
4. Wiseman A. Handbook of Enzyme Biotechnology.
5. Bohak Z and Sharon N. Biotechnological Applications of Proteins and Enzymes.

Course Title: Agricultural Biotechnology

Course No.: GEB 435 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-435: Agricultural Biotechnology	**Credit Hour: 03**	**Year: 4th**	**Semester: II**

Rationale: This course offers the improvements of crops, with classical and modern biotechnological approaches (R-DNA) as well as development of bio-pesticide.

Course Objectives: After attending the course, the students would be able to know how to improve crops, how to produce transgenic crops and environmental friendly bio-pesticides. They will be able to know biosafety and risk management related to genetically modified crops and biopesticides. Moreover, they will gather the knowledge to produce mutational crops and their breeding scheme.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Understand how biotechnology has been used to develop knowledge of complex processes that occur in the plant community
- Demonstrate an understanding of the implications of genetic change in crop improvement.
- Genetic improvement of crop and biosafety analysis
- Demonstrate an understanding of the application of both conventional and molecular breeding, and outline the social and regulatory issues relating to recombinant DNA technology in an agricultural context
- Use basic biotechnological techniques to explore molecular biology of crop
- Understand the processes involved in the planning, conduct and execution of plant biotechnology experiments
- Explain how biotechnology is used for crop improvement and discuss the ethical issues in adopting genetically modified crops.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc

Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Introduction: Definition, achievements, scope and importance of agricultural biotechnology in the present century.

The Improvement of Crop Yield and Quality: Transgenic crops: Scope and importance of transgenic crops, transgenic crops for improved crop productivity (herbicide resistant crop), improved nutritional quality (golden rice etc.), crop yield and seed production. Engineering plant protein composition for improved nutrition. Genetic manipulation of crop yield by enhancement of photosynthesis.

Molecular Markers for Agricultural Crop Improvement: Diversity analysis of different crops with different molecular markers.

Transgenics in Crop Improvement: Biotic stress resistant crop development: characteristics of biotic stresses and types, minimising losses due to biotic stresses. Biotechnological approaches for resistance to biotic stresses: Insect resistance, Virus resistance, Disease resistance mechanism etc. Development of Pathogen and herbicide resistant transgenic crops.

Biological control: Bio-pesticide, bio-insecticide and herbicide, application of biotechnology for pest, insect and weed control, integrated pest management (IPM).

Mutation crop improvement: Artificial mutations in plants, use of induced techniques in crop improvement, limitation of mutation breeding.
GMO and Bio-safety: Introduction, definitions, planned introduction of GMOs, organizations related to GMOs, objectives of bio-safety guidelines, Risk assessment, risk regulation, containment, bio-safety during industrial productions, and regulations.

Recommended References:

1 P. Joshi, Genetic Engineering with its application.
2 Bernard R. Glick. Molecular Biotechnology.
3 Purohit, Agricultural Biotechnology.
4 IndraK Vasil and Trevor A. Thrope
5 Natesh, S. 1993. Biotechnology in Agriculture. Oxford and IBM Pvt. Ltd. India.
6 Chect , I.(1993) .Biotechnology in Plant Disease Control . Wiley-Liss Pub. Singapore.
7 Perscly, G.J. (1997). Agricultural Biotechnology: Country Case Studies .AB International. UK.
8. S.M. Kingsman A.J Kingsman, Genetic Engineering.
9. Adrian Slater, Niger Scott and Mark Fowler, Plant Biotechnology.

Course Title: Animal Biotechnology

Course No.: GEB 437 Credits: 03 Contact Hours: 36 Total Marks: 100

Course: GEB-437: Animal Biotechnology	Credit Hour: 03	Year: 4th	Semester: II

Rationale: The course focuses on the vast array of applications in animal biotechnology and genetic engineering. Lectures will cover embryo transfer in domestic animals, *In vitro* fertilization in ruminants, genetic manipulation, micromanipulation of farm animal embryos, cloning and techniques for genetic engineering. The importance of animal biotechnology in these areas will be explored through examples such as gene transfer and animal transgenesis.

Course Objectives: This course will make the student to apply their knowledge to

- Develop an understanding of current techniques used in biotechnology and their applications to animal agriculture and the biomedical field.
- Develop an understanding to the gene transfer methods
- Develop an understanding to the embryo transfer, and *IVF* techniques
- Develop an understanding to the transgenic animal
- Develop an understanding to the cloning of animal
- Understand and discuss how genetic engineering has benefited the producer and consumer.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

- Learn how to how to collect and transfer embryos in domesticated animals.
- Understand the *IVF* techniques in ruminants, micromanipulation of farm animal embryos, cloning and techniques for genetic engineering.
- Acquaint with techniques to produce transgenic animals.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc

Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

Introduction: Application of Biotechnology for animal production.

Embryo Transfer Technology in Domestic Animals: Definition, history, advantages and applications of embryo transfer. Steps in embryo transfer technique: selection and management of donor and recipients; super ovulation; estrus synchronization; estrus detection; insemination of the donor; preparation of culture media; collection of embryos

using surgical and non-surgical methods. Handling of embryos: identification of embryos; evaluation of embryos; cryopreservation of embryos; transfer of embryos limitations of embryo transfer techniques (Superovulation, principles of superovulation, protocols for superovulation in farm livestock)
Biotechnological Utilization of Female Reproductive Potential: *In Vitro* fertilization (IVF) in ruminants; potential uses of IVF. Mechanisms involved in IVF: harvesting and maturation of oocytes; collection and capacitating of sperm; fertilization and development of embryos to a transferable stage.
Metablomics and Metabonomics in Animal Biotechnology: Definition, promising areas of applications of metabolomics in livestock production systems. Metabonomics and the impact of dietary components on gene expression and production of metabolites.
Transgenic Animal Production and Applications: Methods of transgenic animal production; advantages and limitations of methods; transgenic animal as human disease model; applications of transgenic models and transgenic livestock.
Cryobiology: Definition, Importance, principles of cryopreservation, methods of cryopreservation.
Sexing of Sperms and Embryos: Sperm sexing**,** Separation of X and Y chromosome; Cytogenetics of X and Y spersm; Techniques of sperm separation(albumin column, H-Y antigen, Flow sorting by DNA content, Sephadex column); Embryo sexing technique: separation on the basis of sexual dimorphism, fluorescent in situ hybridization, detection of the H-Y antigen, Use of Y specific DNA Probes.
Artificial Insemination (AI): Methods of sperm collection, Evaluation of sperm quality in farm animals, Techniques of insemination in livestock and poultry. Merits and demerits of different techniques of Artificial Insemination (AI).
Cloning: Definition; history of animal cloning; cloning of mammals.
Manipulation of Gametes and Embryos: Evaluation of chromosomes of ova; embryos and zonapellucida; manipulation of gametes. Anatomy and physiology of embryos in relation to micromanipulation; culture methods; dividing embryos. Combining embryonic cells; intracellular manipulation and conservation of manipulated embryos.
Peptides in Animal Health: Synthetic peptide production and applications in animal therapeutics; production and applications of monoclonal and polyclonal antibodies.
Animal Vaccine Production by Recombinant DNA Technology: Subunit vaccines, attenuated vaccines and vector vaccines for animal's viral and bacterial diseases.

Recommended References:

1. Ashis, S. Verma and AnchalShing (2014). Animal Biotechnology, Models in Discovery and Translation; 1st edition, Elsevier Publications.
2. Bernard R. Glick and Jack J. Pasternak (2007). Molecular Biotechnology, Third edition.
3. Benjamin, B.G. (1981). New Technologies in Animal Breeding, Academic Press, NY, London, Tokyo, Sydney.
4. Gordon, I. (1983). Controlled Breeding in Farm Animals. Pergamon Press, Oxford, NY, Toronto Sydney, Paris and Frankfurt.
5. Ferguson, L.R. (2006). Nutrigenomics: Integrating Genomic Approaches into Nutrition Research. Molecular Diagnostic Therionology.
6. Hafez, E.S.E. (1987). Reproduction in Farm Animals. LEA and Fibiger, Philadelphia.
7. Singh, B., S.K. Gautam, M.S. Chauhan and S.K. Singla (2015). Text Book of Animal Biotechnology. The Energy Resources Institute (TERI), New Delhi, India.
8. Twyman, R.M. (2005). Gene Transfer to Animal Cells. Garland Science/Bios Scientific Publishers, NY, USA.

Course Title: Animal Biotechnology Lab

Course No.: **GEB 438** **Credit: 01** **Contact Hours: 2 Hours/week**

Course: GEB-438: Animal Biotechnology Lab	**Credit Hour: 01**	**Year: 4th**	**Semester: II**

Rationale: The practical course will provide training on selection of donor and recipient animals; synchronization of estrus; detection of estrus; super ovulation and artificial insemination and different techniques of embryo collection and transfer in farm animals.

Course Objectives: This course will make the student to apply their knowledge for

- Demonstration on the basic laboratory techniques of embryo transfer technology in domestic animals
- Demonstration on mechanisms involved in *In Vitro* Fertilization (IVF).

Intended Learning Outcomes (ILOs):

At the end of the course the students will be able to learn

- Learn how to select donor and recipient animals; synchronization of estrus; super ovulation and artificial insemination; collection, evaluation and transfer of embryos of farm animals. Mechanisms involved in IVF in ruminants.

Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc

Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.

Course Contents

1. Selection of donor and recipient animals.
2. Synchronization and detection of estrus. .
3. Superovulation and artificial insemination.
4. Collection and evaluation of embryos
5. Transfer of embryos.
6. Demonstration on mechanisms involved in *In Vitro* Fertilization (IVF) in ruminants and animal transgenesis.

Course Title: Research Methodology

Course No.: **GEB 439** **Credits: 03** **Contact Hours: 36** **Total Marks: 100**

Course: GEB-439: Research Methodology	**Credit Hour: 03**	**Year: 4th**	**Semester: II**

Rationale: This course provides an overview of a range of information and issues related to research methodology. The course provides knowledge and practical skills to research design, data collection, statistical and interpretative analysis, and final report presentation.

Course Objectives: The main purpose of the Research Methodology course is to introduce students to quantitative and qualitative methods for conducting meaningful inquiry and research. They will gain an overview of research intent and design, methodology and technique, format and presentation, and data management and analysis methods of experimental designs by commonly used statistical methods.

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Understand research concepts and process;
- Draw on the literature in the field, analyze and interpret research evidence published on a topic to establish a suitable research problem/issue or opportunity to explore further;
- Having identified a suitable research problem/issue or opportunity, design the research study using a suitable paradigm, associated methodologies and methods of data collection and analysis;
- Write a research proposal (research blueprint) describing the topic, making a case for research, using theories to underpin the research (if relevant), develop

propositions/hypothesis, research framework/conceptual models if relevant, a fully justified research design, sampling and significance of the study. Resources required and a timetable for project completion.
Teaching Strategy: Class Lecture, Projector Display, Animation, Experiment in the lab, Visit etc
Assessment Strategy: Q/A, Quiz Test, MCQ, Assignment, Short Answer, Short Question, PS (Problem solving) etc.
Course Contents
Introduction: Definition, types and objectives of research process, criteria of good research, basic concept of experiment and research.
Logistic Support: Direct and indirect logistic support for effective research.
Research Planning and Methodology: Meaning and characteristics of a problem, selections of a problem, meaning and characteristics of a good hypothesis, formulating and ways of stating of problem, meaning and characteristics stating of hypothesis, research approach, research project planning, identification and periodization of research problems for appropriate technology development.
Research System in Bangladesh: In agriculture, industry, fish, livestock and different university.
Data Collection and Presentation: Research design, data analysis in multiyear and multiplication; yield trial of genetically engineered crop varieties and calculation of genetically values.
Research Project Preparation, Implementation and Evaluation, Review of Literature: Purpose and source of review, preparation of index card for reviewing and abstracting, review of scientific reports.
Method of Writing Annual Reports and Research Highlights and Interpretation: Concept, technique and significance and precautions of interpretation types, purpose, format, steps and significance of research reports, evaluation of research reports, salient feature of research high lights and executive summary.

Recommended References:

1. Kothari, C.R.: Methods and Techniques.
2. Sing, A.K.: Measurements and Research Methods In Behavioral Sciences.

GEB 440 PROJECT+ SEMINER

7 Hours/week, 03 Credits

GEB 400 GENERAL VIVA VOCE

1 Credit

Examiners Panels

All teachers of the relevant Departments in all public Universities in Bangladesh and all pertinent scientists in all Government and Autonomous Research Institutes in Bangladesh.

Course Title: Application of DNA Science in Anthropology

Course No.: GEB: 301 (For ANP) Credits: 2 Contact Hours: 24 Total Marks: 100

Course: GEB-301 (For ANP): DNA Forensics in Anthropology	**Credit Hour: 02**	**Year: 3rd**	**Semester: I**

Rationale: This course will look at how genetics has changed over the years and the effects that this has had to forensic investigation, we will also look at how future advances in genetics might affect future criminals and investigations.

Course Objectives:

- To introduce participants to genetics
- To show how genetics can be used by forensic students
- To introduce participants to different cases where genetics has been used to solve crimes, this will include crime where the suspect is guilty, but also some recent cases where genetics has been used to exonerate people who have been imprisoned for a crime they did not commit

Intended Learning Outcomes (ILOs):

After completion of the course, the students will be able to-

- Gain knowledge and understanding of the relationship between the forensic sciences and the law
- Understand the methods and principals of forensic investigations and how forensic science can be applied in criminal investigations.
- Explain at an introductory level the organisational structures and procedures within forensic sciences
- Use and understand the basic terminology for forensic science correctly and contextually
- Gain a basic understanding of the history of forensic sciences and how forensic

sciences in the real world differ from the forensic sciences in fictional depictions.
Teaching Strategy: Lecture, PPT Lecture, Discussion, Problem solving etc.
Assessment Strategy: Q/A, Short Question, Quize, MCQ, Assignment etc
Course Contents
Introduction: Short communication of Cell, Nucleus, Chromosome, Gametogenesis, Mendelian Inheritance, Linkage and Crossing over, Sex Determination, Nucleic Acid (DNA, gDNA, mtDNA, RNA, Gene, Allele), etc.
Molecular Techniques: DNA Markers (SSR, STR, VNTRs, RAPD, RFLP, AFLP etc.), DNA Extraction, Primers, PCR, GE, Southern Blotting, Northern Blotting and Sequencing.
Practical Application: Genetic Variation, DNA polymorphism, DNA Fingerprinting (Individual Identity, Criminal Investigation, Parental Testing, Child Testing, Victim Identification, Gender differentiation), Population Genetics, Ancient DNA and Human evolution.

Recommended references:

1. Fowler, E. A. 1993. Techniques for Engineering Genes. Butterworth-Heinemann Ltd., UK.
2. Gupta, P. K. 1997. Cell and molecular Biology. Rastogi Pub., India.
3. Henry, R. J. 1984. Lab. applications of Plant Molecular Biology. Chapman and Hall Pub., London.
4. Micklos, D. A. and G. A. Freyer. 1990. DNA Science, Cold Spring Harbor Lab Press, New York.
5. Stansfield, W. D. 1996. Theory and Problems of Molecular and Cell Biology. McGraw Hill Co. New York.

Course Title: Application of DNA Science in Anthropology Lab

Course No.: GEB-242 Credits: 01 Contact Hours: 2 Hours/week

Course: GEB-242 (For ANP): DNA Forensics in Anthropology Lab	**Credit Hour: 01**	**Year:**	**Semester:**
Rationale: The major focus of this unit is the forensic application of molecular biology, in particular the use of DNA profiling and related techniques, together with techniques that detect protein and immunological variation, to individualize biological samples			
Course Objectives: • To introduce the forensic applications of molecular biology, especially PCR, DNA profiling and DNA sequencing. • To provide basic knowledge employed in the isolation, purification, and analysis of nucleic acids.			
Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to- • Identify and evaluate the biological evidence in criminal matters using DNA technologies. • Isolate the DNA from cells and techniques applied to DNA quantitation, electrophoretic separation, and sequence determination, as well as data interpretation, analysis and reporting.			
Teaching Strategy: Lecture, Animation, Lab Experiment etc			
Assessment Strategy: Short question, MCQ, Assignment, Quize etc			
Course contents			
1. DNA Extraction methodology.			
2. Quality and quantity check of Extracted DNA			
3. Primers and PCR Amplification			
4. Gel Electrophoresis			
5. Image Analysis			

Recommended References:

6. Fowler, E. A. 1993. Techniques for Engineering Genes. Butterworth-Heinemann Ltd., UK.
7. Gupta, P. K. 1997. Cell and molecular Biology. Rastogi Pub., India.
8. Henry, R. J. 1984. Lab. applications of Plant Molecular Biology. Chapman and Hall Pub., London.
9. Micklos, D. A. and G. A. Freyer. 1990. DNA Science, Cold Spring Harbor Lab Press, New York.
10. Stansfield, W. D. 1996. Theory and Problems of Molecular and Cell Biology. McGraw Hill Co. New York.