Curriculum for

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

Session: 2018-19

Department of Biotechnology and Genetic Engineering
Islamic University, Bangladesh

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

2. Vision: Providing state-of-art knowledge and skills in the field of Biotechnology and Genetic Engineering for sustainable development of society and environment.

3. Mission:

- *To provide quality education for producing competent graduates in Biotechnology and Genetic Engineering to contribute in different sectors including agriculture, healthcare, industry and environment.*
- *To facilitate the development of scientists, entrepreneurs and policymakers towards nation building program.*
- *To disseminate knowledge and skills for the betterment of the society and promote meaningful collaboration with academia, industry and research organization across the globe*.

4. Program objectives:

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

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

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 Biotechnology and Genetic Engineering. 2. Analyse, synthesize and integrate knowledge and information within the context of multidisciplinary as well as interdisciplinary areas in Biotechnology and Genetic Engineering	***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 Biotechnology and Genetic Engineering education and research.	***Affective Level***
1. Operate and maintain the basic biotechnology equipment's adhering to good laboratory practices and bio-safety & security issues. 2. Develop practical skills for addressing the problems in biosciences.	***Psychomotor Level***

6. Course structure:

Program duration: 04 Years
Number of Semester: 08
Semester duration: according to ordinance
Total number of credit available: 160
Minimum credit to be earned for degree requirements: 160

6.1 Summary of the total credits

Year-wise distribution of credits

Year	Semester	Theory	Practical / Field work / Industrial visit / Research	Viva voce	Total
First	First	15	3	1	19
	Second	12	3	1	16
Second	First	15	3	1	19
	Second	15	3	1	19
Third	First	18	4	1	23
	Second	15	4	1	20
Fourth	First	18	5	1	24
	Second	12	7	1	20
Total					160

6.2 Course outline: Semester-wise course outline for the entire program

FIRST YEAR (2018-2019) FIRST SEMESTER

Course No	Course Title	Theoretical Marks	Tutorial / Assignment	Class Attendance	Presentation/Quiz	Total Marks	Credits*
BT-1101	Fundamentals of Biotechnology and Genetic Engineering	70	15	10	5	100	3.0
BT-1102	Basic Microbiology	70	15	10	5	100	3.0
BT-1103	Fundamentals of Biochemistry	70	15	10	5	100	3.0
BT-1104	Basic Plant Science	70	15	10	5	100	3.0
BT-1105	Organic Chemistry	70	15	10	5	100	3.0
BT-1106 (Lab)	Lab in Microbiology	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on Experiment =10	100	1.0
BT-1107 (Lab)	Lab in Biochemistry and Organic Chemistry	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on Experiment =10	100	1.0
BT-1108 (Lab)	Lab in Plant Science	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on Experiment =10	100	1.0
Non-Credit Course	Bangladesh Studies or Islamic Studies					100	00
BT-1109 (Viva-Voce)						50	1.0
Total Marks and Credits						**950**	**19**

* Exam duration of 3 credit theoretical course will be 4 hours

FIRST YEAR (2018-2019) SECOND SEMESTER

Course No	Course Title	Theoretical Marks	Tutorial / Assignment	Class Attendance	Presentation / Quiz	Total Marks	Credits*
BT-1201	Basic Genetics	70	15	10	5	100	3.0
BT-1202	Plant Physiology	70	15	10	5	100	3.0
BT-1203	Physical and Inorganic Chemistry	70	15	10	5	100	3.0
BT-1204	Basic Animal Science	70	15	10	5	100	3.0
BT-1205 (Lab)	Lab in Genetics	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on Experiment =10	100	1.0
BT-1206 (Lab)	Lab in Physical and Inorganic Chemistry	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on Experiment =10	100	1.0
BT-1207 (Lab)	Lab in Plant Physiology and Animal Science	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on Experiment =10	100	1.0
BT-1208 (Viva-Voce)						50	1.0
Total Marks and Credits						**750**	**16.00**

* Exam duration of 3 credit theoretical course will be 4 hours

SECOND YEAR (2018-2019) FIRST SEMESTER

Course No	Course Title	Theoretical/ Practical Marks	Tutorial/ Assignment	Class Attendance	Presentation / Quiz	Total Marks	Credits*
BT-2101	Molecular Biology-I	70	15	10	5	100	3.0
BT-2102	Metabolism	70	15	10	5	100	3.0
BT-2103	Plant Breeding	70	15	10	5	100	3.0
BT-2104	Medical Microbiology	70	15	10	5	100	3.0
BT-2105	Cytology and Cytogenetics	70	15	10	5	100	3.0
BT-2106 (Lab)	Lab in Molecular Biology and Metabolism	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-2107 (Lab)	Lab in Medical Microbiology	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-2108 (Lab)	Lab in Plant Breeding	70 (Examination)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-2109 (Viva-Voce)						50	1.0
Total Marks and Credits						**850**	**19**

* Exam duration of 3 credit theoretical course will be 4 hours

SECOND YEAR (2018-2019) SECOND SEMESTER

Course No	Course Title	Theoretical/ Practical Marks	Tutorial/ Assignment	Class Attendance	Presentation / Quiz	Total Marks	Credits*
BT-2201	Plant Tissue Culture	70	15	10	5	100	3.0
BT-2202	Immunology I	70	15	10	5	100	3.0
BT-2203	Enzymology	70	15	10	5	100	3.0
BT-2204	Biostatistics	70	15	10	5	100	3.0
BT-2205	Human Physiology	70	15	10	5	100	3.0
BT-2206 (Lab)	Lab in Immunology and Enzymology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-2207 (Lab)	Lab in Plant Tissue culture	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-2208 (Lab)	Lab in Biostatistics	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-2209 (Viva-Voce)						50	1.0
Total Marks and Credits						**850**	**19**

* Exam duration of 3 credit theoretical course will be 4 hours

THIRD YEAR (2018-2019) FIRST SEMESTER

Course No	Course Title	Theoretical Marks	Tutorial/ Assignment	Class Attendance	Presentation / Quiz	Total Marks	Credits*
BT-3101	Recombinant DNA Technology	70	15	10	5	100	3.0
BT-3102	Molecular Biology-II	70	15	10	5	100	3.0
BT-3103	Cell and Developmental Biology	70	15	10	5	100	3.0
BT-3104	Microbial Biotechnology	70	15	10	5	100	3.0
BT-3105	Endocrinology	70	15	10	5	100	3.0
BT-3106	Biodiversity	70	15	10	5	100	3.0
BT-3107 (Lab)	Lab in recombinant DNA technology and Molecular Biology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-3108 (Lab)	Lab in Biodiversity	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-3109 (Lab)	Lab in Cell and developmental Biology & Endocrinology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-3110 (Lab)	Lab in Microbial Biotechnology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-3111 (Viva-Voce)						50	1.0
Total Marks and Credit						**1050**	**23**

* Exam duration of 3 credit theoretical course will be 4 hours

THIRD YEAR (2018-2019) SECOND SEMESTER

Course No	Course Title	Theoretical Marks	Tutorial/ Assignment	Class Attendance	Presentation	Total Marks	Credits*
BT-3201	Immunology-II	70	15	10	5	100	3.0
BT-3202	Agricultural Biotechnology	70	15	10	5	100	3.0
BT-3203	Animal Biotechnology	70	15	10	5	100	3.0
BT-3204	Virology	70	15	10	5	100	3.0
BT-3205	Neurobiology	70	15	10	5	100	3.0
BT-3206 (Lab)	Lab in Virology & Immunology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-3207 (Lab)	Lab in Agricultural Biotechnology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-3208 (Lab)	Lab in Animal Biotechnology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-3209	Field work / Industrial visit / Research organization visit/Industrial Training/ Survey work		50 (Report)	30 (Overall performance)	Presentation (20)	100	1.0
BT-3210 (Viva-Voce)						50	1.0
Total Marks and Credit						**950**	**20**

* Exam duration of 3 credit theoretical course will be 4 hours

FOURTH YEAR (2018-2019) FIRST SEMESTER

Course No	Course Title	Theoretical Marks	Tutorial/ Assignment	Class Attendance	Presentation / Quiz	Total Marks	Credits*
BT-4101	Pharmaceutical Biotechnology	70	15	10	5	100	3.0
BT-4102	Techniques in Molecular Biology	70	15	10	5	100	3.0
BT-4103	Biosafety and Biosecurity	70	15	10	5	100	3.0
BT-4104	Research Methodology	70	15	10	5	100	3.0
BT-4105	Oncology	70	15	10	5	100	3.0
BT-4106	Food Biotechnology	70	15	10	5	100	3.0
BT-4107 (Lab)	Lab in Pharmaceutical and Food Biotechnology	70(Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-4108 (Lab)	Lab in Techniques in Molecular Biology and Oncology	70(Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-4109 (Lab)	Lab in Research Methodology and Biosafety	70(Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-4110	Field work / Industrial visit / Research organization visit/Industrial Training / Internship in Industry	50 (Report)	30 (Overall performance)	Presentation (20)		100	1.0
BT-4111	Research Project / Research idea generation and presentation					100	1.0
BT- 4112 (Viva-Voce)						50	1.0
Total Marks and Credits						**1150**	**24**

* Exam duration of 3 credit theoretical course will be 4 hours

FOURTH YEAR (2018-2019) SECOND SEMESTER

Course No	Course Title	Theoretical Marks	Tutorial/ Assignment	Class Attendance	Presentation / Quiz	Total Marks	Credits*
BT-4201	Bioinformatics and System Biology	70	15	10		100	3.0
BT-4202	Fermentation & Bioprocess Technology	70	15	10		100	3.0
BT-4203	Environmental Biotechnology	70	15	10		100	3.0
BT-4204	Cell Signalling	70	15	10		100	3.0
BT-4205 (Lab)	Lab. in Fermentation Technology	70(Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-4206 (Lab)	Lab in Bioinformatics	70(Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-4207 (Lab)	Lab in Environmental Biotechnology	70 (Exam)	05 (Lab Note Book)	10 +05 =15 (Attendance+ Performance)	Viva on experiment=10	100	1.0
BT-4208	Research project / Survey / Internship in Industry	30 (Dissertation)	20 (Overall performance)	50 (Presentation)		100	4.0
BT- 4209 (Viva-Voce)						50	1.0
Total Marks and Credits						**850**	**20**

* Exam duration of 3 credit theoretical course will be 4 hours

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: [According to the ordinance]

- Marks distribution for theory courses: [According to the ordinance]
- Marks distribution for sessional courses: [According to the ordinance]
- Bases for class attendance marks (both for theory and sessional): [According to the ordinance]
  Continuous Assessment: [According to the ordinance]
- **Thesis evaluation:** [According to the ordinance]
- **Grading system and grading scale:** [According to the ordinance]
  Assessment tools:
  Theory courses:
- Class participation (Example: attendance)
- Continuous assessment (examples: Quiz, spot test, open book exam, presentation, assignments, written exams etc.)
- Term final examination (written test)

Practical courses:

- Class participation (Example: attendance)
- Practical 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.)
- Dissertation
- Viva-voce (oral)

Course Title: Fundamentals of Biotechnology & Genetic Engineering	Course No: BT-1101	Credit: 3	Year:1st	Semester: 1st

Rationale: This course is designed to provide fundamental concepts of Biotechnology

Course Objectives:

- Conceptualize general knowledge of Biotechnology
- Acquire knowledge on different discipline of Biotechnology
- Acquaint with general techniques used in Biotechnology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Biotechnology. 2. Explain the scope and importance of Biotechnology. 3. Describe the current trends in Biotechnology
Course Content	**1 Introductory Biotechnology:** Definition; History; Multidisciplinary nature of biotechnology; Scope and opportunity of biotechnology; Applications of biotechnology; Biotechnology in Bangladeshi perspectives. **2 Recombinant DNA Technology:** Basic concept, Components and techniques in genetic engineering; Key tools of gene cloning; Application of microorganisms in genetic engineering. **3 Agricultural Biotechnology:** Agriculture related applications, Plant character amenable to change by biotechnology - seed quality, herbicide resistance; Biocontrol of plant pathogens, insects, pests and weeds; Single cell protein (SCP) – mushroom production. **4 Animal Biotechnology:** Scope and application of biotechnology in medicine and pharmaceuticals - hormones, vaccines ,gene therapy and disease diagnosis; Molecular farming - product from animal; cell culture and transgenic animals. **5 Environmental Biotechnology:** Biotechnology in service of environment related applications - pollution control, waste disposals and biogas production. **6 Current Trends:** Microbial application - large scale preparation of organic chemicals (i.e., ethanol, acetic acid etc.); Livestock improvement - dairy products, meat quality, animal disease control and food development. **7 Industrial Biotechnology:** Bioreactors; Fermentation process; Fermentation product, Biological regulation and process control; Product recovery in biotechnology.
Reference:	1. John E. Smith: Biotechnology, Cambridge University Press. 2. Glick, Pasternak and Patten: Molecular biotechnology - Principles and Application 3. R.C. Dubey: A Text Book of Biotechnology 4. S. Ignacimuthu: Plant Biotechnology 5. Virender L. Chopra: Biotechnology in Agriculture

<table>
<tr><td colspan="2">Course Title: Basic Microbiology</td><td>Course No: BT-1102</td><td>Credit: 3</td><td>Year:1st</td><td>Semester: 1st</td></tr>
<tr><td colspan="6">Rationale: This course is designed to provide general concepts of Microbiology</td></tr>
<tr><td colspan="6">Course Objectives:
• Conceptualize general knowledge of Microbiology
• Acquire general knowledge on different areas of Microbiology
• Acquaint with general techniques used in Microbiology</td></tr>
<tr><td>Intended Learning Outcomes (ILOs)</td><td colspan="5">At the end of the course the students will be able to-
1. Describe various aspects of Microbiology
2. Explain the history, scope and importance of Microbiology
3. Describe the current trends in microbiology to be used in Biotechnology</td></tr>
<tr><td>Course Content</td><td colspan="5">1. Introduction: Definition; A brief history of microbiology; Germ theories of diseases, Characteristics of prokaryotic & eukaryotic cells; Whittaker’s five kingdom concept; Scope of microbiology in human welfare; Sanitation & environmental pollution control; Applications of microbiology in medicine, agriculture, food & dairy industry.
2. Major Groups of Microorganisms: Bacteria - Typical bacterial cell, size, shape and arrangement, structures (external & internal), Composition of cell wall; Concept of spores and cysts, Classification and taxonomy, Nutritional requirement and nutritional types of bacteria; Physical conditions required for growth (temperature, gaseous requirements); Oxygen-toxicity; Growth and reproduction; Synchronous growth; Oxygenic & anoxygenic phototrophic bacteria; Fungi - Characteristics, morphology, classification, growth and reproduction; Importance in natural process. Others - Salient features of algae, protozoa, cyanobacteria and actinomycetes & Virus.

3. Microscopy and Microscopic Examination:
Microscopy- Basic principle, Components, Functions and types of microscopes, The path of light, Magnification & resolution, Calculation of total magnification, Micrometry (measurement of cell size); Applications; Advantages and limitations of light (bright-field, dark-field, fluorescence, phase-contrast and confocal) and electron (transmission and scanning) microscopy; Staining - Definition, Staining procedure, Different types of staining, Types of dyes used in staining, Mechanism of gram-staining.

4. Culture Techniques:
Definition of culture media; Types of media; Preparation of media; Composition of media; Pure culture and mixed culture; Methods of isolating pure cultures; Different methods for preservation of pure culture; Quantitative measurement of growth.

5. Control of Microbial Growth:
Principles and mechanism of microbial control (sterilization, pasteurization, disinfection, antisepsis, degermation, and sanitization); Physical methods of microbial control (heat, moist heat, autoclave, pasteurization, dry heat, filtration, low temperature, desiccation, osmotic pressure, and radiation); Chemical methods of microbial control (various disinfectants and antiseptics).</td></tr>
<tr><td>Reference:</td><td colspan="5">1. Madigan MT, Martinko JM, Stahl D, Clark DP. Brock Biology of Microorganisms. Benjamin Cummings (14th edition 2014 or a later edition).
2. Tortora GJ, Funke BR, Case CL. Microbiology: An Introduction. Addison Wesley Longman (12th edition 2015 or a later edition).
3. Micael J. Pelczer, Jr. ECS, Chan & Noel R. Krieg: Microbiology, 5th edition (1998).</td></tr>
</table>

Course Title: Fundamentals of Biochemistry	**Course No: BT-1103**	**Credit: 3**	**Year:1st**	**Semester: 1st**

Rationale: This course is designed to provide general concepts of Biochemistry

Course Objectives:

- Conceptualize general knowledge of Biochemistry
- Acquire general knowledge on different areas of Biochemistry
- Acquaint with general techniques used in Biochemistry

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Biochemistry
2. Explain the history, scope and importance of Biochemistry
3. Describe the current trends in microbiology to be used in Biochemistry

Course Content

1 Introduction:
Definition; Scope and achievement of biochemistry; Applications of biochemistry.

2 Carbohydrates:
Definition; Classification; Properties; Chemical reactions; Mutarotation; Ring structure; Invert sugar; Reducing sugar; Structure; Properties and functions of disaccharides and polysaccharides; Qualitative test for carbohydrate; Biological function of carbohydrates.

3 Lipids:
Lipid - Definition, classification and properties of lipids; Fatty acids - General formula, nomenclature and properties, essential and nonessential fatty acids; Properties of fats and oils; Phospholipids and their classification; Lipid bilayer; Biological function of lipid.

4 Amino Acids:
Definition, structure, classification and properties of amino acid; Titration curve of amino acids; General reaction and qualitative test of amino acids; Essential, nonessential and nonstandard amino acids.

5 Peptide and Proteins:
Definition of peptide and protein; Formation of peptide bond; Chemical synthesis of a peptide; Classification of proteins; Structure of proteins; Denaturation and renaturation of proteins; Biological functions of protein.

6 Vitamins:
Sources, structure, **active forms,** physiological functions, deficiency symptoms of fat soluble vitamins; Sources, RDA, structure, active forms, biochemical function and deficiency symptoms of water soluble vitamins (Vit. C and Vit. B complex); Absorption and storage of vitamins.

7 Minerals:
Classification; sources, biochemical and physiological function, deficiency symptoms of some important minerals (i.e., Ca, Fe, Mn, Mg, Co, Na, K, P, Cl, Zn, Ni); Absorption of minerals.

8 Food & Nutrition:
Food, nutrition, malnutrition and sub nutrition; Balanced diet; Diet chart, Humanisation of cow's milk; Calorie value; Energy expenditure; Nutritional disease.

Reference

1. Lehninger A, Nelson DL, Cox MM. *Lehninger Principles of Biochemistry (6th Ed.). New York,*W H Freeman (2012).
2. Berg JM, Tymoczko JL and Stryer L. *Biochemistry (8th Ed.).* W H Freeman & Company, New York (2015).
3. Lodish H, Berk E, Kaiser J et al. *Molecular Cell Biology* (8th Ed.), New York, WH Freeman (2016).
4. Alberts B, Johnson A, Lewis J et al. *Molecular Biology of the Cell* (6th Ed.), New York, WH Freeman (2014).
5. Petsko GA, Ringe D. *Protein Structure and Function,* New Science Press (2008).
6. Karp G. *Cell and Molecular Biology: Concepts and Experiments*. Wiley & Sons (7th edition 2013).
7. Mckee T, Mckee JR. *Biochemistry: The Molecular Basis of Life*. Oxford ((5th Edition 2013)
8. Voet D, Voet JG. *Biochemistry*. Wiley & Sons (4th edition 2010)

Course Title: Basic Plant Science	Course No: BT-1104	Credit: 3	Year:1st	Semester: 1st

Rationale: This course is designed to provide general concepts of basic plant science.

Course Objectives:

- Conceptualize general knowledge of basic plant science
- Acquire general knowledge on different areas of basic plant science
- Acquaint with general techniques used in basic plant science

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of basic plant science 2. Explain the history, scope and importance of basic plant science 3. Describe the current trends in Botany to be used in Biotechnology
Course Content	**1. Introduction:** Definition; Scope and branches of botany; Importance of studying botany, model plants. **2. Systemic Botany:** Taxonomy, definition, objectives and uses of taxonomy; Units, systems and basis of classification; Naming of plant; Classification of plant; Systemic study and economic importance of the following families of angiosperms- *Gramineae, Leguminosae, Orchidaceae and Verbenaceae*; Practical implications of systemic study of families in biotechnology. **3.Biodiversity:** Biological diversity-definition, terminology, diversities in plant kingdom, importance of biological diversity, benefits and services provided by ecosystems, causes for the losses of biodiversity, convention on biological diversity (CBD), Obligations under CBD, Biodiversity of Bangladesh, Biodiversity conservation. **4. Economic Botany:** Study of angiospermic plants as source of cereal, fibre, medicine, oil, beverage, rubber, sugars and narcotics. **5. Anatomy:** Tissue and tissue systems, compact and classification, characteristic, functions and distribution of different types of plant tissues; Importance of studying tissue and tissue system in biotechnology. **6. Embryology:** Reproduction; Alternation of generation; Gametogenesis (micro and megasporogenesis, micro and megagametogenesis); Types of embryo sac and their development; Pollination and fertilization; Parthenogenesis and apomixes.
Reference:	1. P. Maheshwari: An introduction to Embryology of Angiosperm 2. K. Esau: Anatomy of seed plants 3. A. Fahn: Plant Anatomy 4. Lawrence: Taxonomy of Vascular Plants 5. B. P. Pandey: Economic Botany 6. Leveque and Mounolou: Biodiversity

Course Title: Organic Chemistry	Course No: BT-1105	Credit: 3	Year:1st	Semester: 1st

Rationale: This course is designed to provide general concepts of Organic Chemistry

Course Objectives:

- Conceptualize general knowledge of Organic Chemistry
- Acquire general knowledge on different areas of Organic Chemistry
- Acquaint with general techniques used in Organic Chemistry

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Organic Chemistry
2. Explain the scope and importance of Organic Chemistry
3. Describe the current trends in Organic Chemistry to be used in Biotechnology

Course Content

1 Introduction:
IUPAC nomenclature of organic compounds; Characteristics and type of organic reactions - addition, elimination, substitution and rearrangement reactions.

2 Aliphatic Compounds:
Aliphatic alcohols; Aldehyde and ketone; Carboxylic acids and amides; Aliphatic amines- preparation and chemical reactions.

3 Aromatic Compounds:
Phenol and aromatic alcohol; Quinone, aromatic aldehydes and ketones - preparation and chemical reactions; Amine and diazonium salts - preparation and chemical reactions.

4 Mechanisms of Organic Reactions:
Generation of carbonium ions, carbanions, nucleophiles and electrophiles; Mechanism of some important reactions with examples i.e., Aldol condensation, Friedel-crafts alkylation & acylation, Diels–Alder reaction, Hofmann degradation, Wurtz fittig reaction, Reimer-Tiemann reaction and benzoin condensation.

5 Heterocyclic Compounds:
Definition, nomenclature, synthesis & chemical reactions of furan, pyrrole, thiophene and pyridine.

6 Aklaloids:
Definition, sources, classification, extraction, structure determination, synthesis and uses of some biologically important alkaloids (i.e., nicotine, quinine, atropine, morphine, heroine).

7 Polymers:
Definition; Classes of synthetic addition polymers, condensation polymers, fibres and fabrics; Natural and synthetic rubbers; Copolymers; Polymer structure and properties.

Reference

1. B.S.Bahl and Arun Bah: *Advanced organic chemistry;* S. Chand & Company Ltd. (2014).
2. Morrison and Boyd: *Organic chemistry*, 7th Ed
3. Paula Yurkanis Bruice: *Organic Chemistry*, 7th Ed. (2013).
4. Atkins Robert C. and Carey Francis A.: *Organic chemistry: A brief course*; 3rd Ed.
5. Carey Francis A. and Giuliano Robert M.: *Organic chemistry*, 9th Ed. (2013)
6. Solomon and Fryhle: *Organic chemistry*, 10th Ed. (2009).

Course No: BT-1106 (Lab) **Course Title: Lab in Microbiology**
Full Marks: 100 **Credit: 1.0**

Exp.-1: Observation of living bacterial cells, Yeasts & Moulds in Microscope
Exp.-2: Different staining (Gram staining, Acid fast staining, Capsule staining, Spore staining, Flagella staining).
Exp.-3: Media preparation & sterilization techniques.
Exp.-4: Techniques for isolation of pure cultures.
Exp.-5: Techniques for preservation and maintenance of pure cultures.
Exp.-6: Observation of cultural characteristics of bacteria on various media.
Exp.-7: Observation of cultural characteristics of yeasts on various media.
Exp.-8: Biochemical identification of microorganisms.
Exp.-9: Determinations of Microbial number by spread plate and pour plate method.

Course No: BT-1107 (Lab) **Course Title: Lab in Biochemistry & Organic Chemistry**
Full Marks: 100 **Credit: 1.0**

Exp.-1: General accuracy and precision of research laboratory.
Exp.-2: Preparation of standard solutions using solid and liquid solutes.
Exp.-3: Preparation of 0.1N solution of Na_2CO_3 and determination of the strength of HCl solution.
Exp.-4: Estimation of acetic acid content of vinegar.
Exp.-5: Estimation of iron content of Mohr's salt by the dichromate method.
Exp.-6: Estimation of copper by iodometry.

Course No: BT-1108 (Lab) **Course Title: Lab in Plant Science**
Full Marks: 100 **Credit: 1.0**

Exp.-1: Study of model plants
Exp.-2: Preparation of herbarium sheet for plant identification and preservation
Exp.-3: Study of angiospermic plants
Exp.-4: Study of different types of stomata
Exp.-5: Anatomical study of plants
Exp.-6: Study of Plants reproductive organ
Exp.-7: Identification/ display board preparation of economically important plants

Course No: BT-1109	**Course Title: Viva-Voce**
Full Marks: 100	**Credit: 1.0**

20-05-99 Bs Zvwi‡L AbywôZ GKv‡WwgK KvDwÝ‡ji 56 Zg mfvi 21 bs wm×všÍ Abyhvqx wmwÛ‡K‡Ui 146 Zg mfvq Aby‡gvw`Z

BmjvgxK ÷vwWR Gi wm‡jevm
cÖbqb KwgwU cÖ¯ÍvweZ cvV¨m~Px-99

c~b©gvbt-100

1| Bmjvg I Ab¨vb¨ cÖwm× a‡g©i mswÿß cwiwPwZ|

2| **(K)** ZvInx`, Cgvb I Bmjvg **(L)** wkiK Ges Bnvi cÖKvi †f` **(M)** we`AvZ I Bnvi cÖKvi †f`|

3| Bmjvgx kixq‡Zi Drmmgyn (Avj-KziAvb, Avj-nv`xm, BRgv I wKqvm)|

4| Bmjv‡g nvjvj I nviv†gi weeib Ges Aciva `g‡bi weavb|

5| **Bev`Zt- (K)** dih mvjvZ,hvKvZ, mIg I n¾ **(L)** IqvwRe mgyn, **(M)** mybœZ mgyn, **(N)** gy¯Ívnve mgyn|

06| **Bmjvgx AvPvi AvPibt- (K)** gyAvgvjvZ- Bmjv‡gi `„wó‡Z cvi¯úwiK †jb‡`b, kÖwgK I gvwjK m¤úK©, **(L)** Fb`vZv I MÖnxZv, †µZv we‡µZv, gvZv-wcZv, †QvU eo, QvÎ wkÿK Gi g‡a¨ Ges cÖwZ‡ekxi mwnZ m¤úK©, **(M)** Bmjv‡gi åvZ…Z¡ I RbKj¨vbgyjK KvR|

7| **Bmjvgx AvLjvKt-** ZvKIqv, mei, Av`j, Bnmvb, wm`K, j¾v, wmóvPvi, aygcvb, gv`K, c`©v, AvgvbZ I wLqvbZ|

8| **Abyev`t- (K)** myiv Avj gywgbyb Gi 1g iæKz **(L)** myiv wdj †_‡K bvm **(M)** wekwU nv`xm (Bwe KZ…©K 1995-96 mv‡ji cÖKvwkZ wm‡jevm D‡jøL †gvZv‡eK (ms‡hvwhZ)|

9| **Bmjvgx wkÿv I ms¯‹…wZt-** ¯^iæc, ˆewkô¨, ¸iæZ¡ I cÖfve|

10| **A_©bxwZt-** `vwi`ª we‡gvP‡b cywRev`, mgvRev` I Bmjv‡gi fzwgKv|

11| **Bmjvgx ivóªt-** msÁv, ¯^iæc, ˆe‡`wkK bxwZ I AwaKvi|

12| **Bmjv‡gi wePvi e¨e¯’vt-** Bmjvgx AvB‡bi Drm mgyn, AvaywbK I Bmjvgx wePvi e¨e¯’v, wePvi‡Ki †hvM¨Zv I ¸bvejx, Bmjvgx wePvi c×wZ, mv‡g¨i I wfwË‡Z b¨vq wePvi cÖwZôv, gnvbex (mt) I LwjdvM‡bi wePvi e¨e¯’v|

13| **Bmjv‡g mvgwiK e¨e¯’vt-** wRnv‡`i msÁv, cÖKvi‡f` I ¸iæZ¡, Bmjv‡gi mgibxwZ, AvaywbK mf¨Zvi hy×|

14| **Bmjvg cÖPvit-** Bmjv‡g Zvejx‡Mi cÖ‡qvRbxqZv I ¸iæZ¡, Bmjvg cÖPvi Gi c×wZ I cÖPv‡ii ¸bvejx, evsjv‡`‡k Bmjvg cÖPvi, evsjv‡`‡k Gb.wR.I Ges L„xôvb wgkbvixi ZrciZv , Bmjvg cÖPv‡ii gva¨g mgy‡ni fzwgKv|

15| **gvbevwaKvit-** Bmjvg I cvðv‡Z¨|

(W. †gvnv¤§` Avkivd Avjx)
AvnevqK
BmjvgxK ÷vwWR KwgwU
Bmjvgx wek¦we`¨vjq
Kzwóqv|

Course Title: Basic Genetics	Course No: BT-1201	Credit: 3	Year:1st	Semester: 2nd

Rationale: This course is designed to provide general concepts of Basic Genetics

Course Objectives:

- Conceptualize general knowledge of Basic Genetics
- Acquire general knowledge on different areas of Basic Genetics
- Acquaint with general techniques used in Basic Genetics

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Basic Genetics 2. Explain the scope and importance of Basic Genetics 3. Describe the current trends in Basic Genetics and Cytogenetics to be used in Biotechnology
Course Content	**1. Introduction:** Nucleotide, nucleoside, purine and pyrimidine bases, bases occur in DNA and RNA, structure of DNA and RNA, chargof rules, gene, genome, genetics, genotype, phenotype, test cross, backcross, reciprocal cross, dominant gene, recessive gene, lethal gene, mutation and mutant gene, allele and pseudoallele-definition, characteristics, examples and importance. **2. Mendelism:** Mendelian principles, experiments and achievements, monohybrid and dihybrid inheritance, Mendelian genetics in humans, pleiotropism and phenocopy, deviation of Mendel's law-dominant (12:3:1) and recessive (9:3:4) epistasis, duplicate dominant (9:7) and duplicate recessive (15:1) genes, dominant and recessive interaction (13:3), duplicate gene with cumulative effect (9:6:1). 4. **Linkage and recombination:** Types of linkage, discovery of linkage- autosomal and sex, detection of linkage, genetic linkage and gene mapping, detection and estimation of genetic linkage in human, genetic mapping of human chromosome,genetic interference and coincidence. 5. **Sex determination:** Mechanism of sex determination in man, grasshopper, Drosophila and fowl, Balance theory of sex determination, sex-linked inheritance, sex influence and sex limited characters. 7. **Cytoplasmic inheritance:** Variegation in leaves of higher plants, inheritance of extranuclear genes, maternal inheritance 8. **Human Genetics:** Pedigree analysis, aminocentesis, twins, human traits, disorders due to mutant genes.
Reference:	1. Monooe W.Strickberger: Genetics 2. Adrian M.SRB : General Genetics 3. Enmund W. Sinnott: Principles of Genetics 4. Gupta: Genetics

Course Title: Plant Physiology	Course No: BT-1202	Credit: 3	Year:1st	Semester: 2nd

Rationale: This course is designed to provide general concepts of Plant Physiology

Course Objectives:

- Conceptualize general knowledge of Basic Plant Physiology
- Acquire general knowledge on different areas of plant physiology
- Acquaint with general techniques used in plant physiology to be used in Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Plant Physiology
2. Explain the scope and importance of study of plant physiology
3. Describe the current trends in plant physiology to be used in Biotechnology

Course Content

1. **Photosynthesis:**
   Definition, most important and accessory pigments in prokaryotic and eukaryotic system, different kinds of photosystems, mechanism of photosynthesis, C_3, C_4 and CAM pathways, photorespiration, photophosphorylation, cyclic and non cyclic photophosphorylation, bacteriorhodopsin, the importance of photosynthesis for the existence of the biological world.
2. **Respiration:**
   Definition, mechanism of aerobic and anaerobic respiration, conversion of pyruvate into acetyl-CoA, fermentation, factors affecting the rate of respiration, conversion of seed lipids into glucose- glyoxylate cycle, secondary metabolism of glucose- pentose phosphate pathway, production of L-ascorbic acid (VitaminC) and D-glucuronate.
3. **Nitrogen Metabolism:**
   Mechanism of nitrogen fixation by nitrogenase complex, steps of nitrogen cycles with involved microorganisms and/or enzymes, symbionts, nonsymbionts and function of leghemoglobin, practical importance of nitrogen fixation.
4. **Plant Hormones:**
   Definition, classification, sources, structure, physiological functions, deficiency symptoms and practical applications plant hormones and related compounds- auxins, cytokinins, gibbreilins, absicic acid, ethelene, beassin, steriods.
5. **Mineral Nutrition of Plants:**
   Sources, physiological functions and deficiency symptoms of micro- and macro nutrients, mechanism of absorption of water & mineral salts by plants.
6. **Reproductive growth:**
   Physiology and flowering,seed germination factors, germination test, evaluation of germinated seedling, normal and abnormal seedling and dormancy, photoperiodism and vernalization, mechanism of flowering, florigen and its role in flowering, types, causes, artificial breaking of dormancy.

Reference:

1. Lehninger: Principles of Biochemistry
2. A. C. Deb: Fundamentals of Biochemistry
3. Jain: Plant physiology
4. Devlin: Plant physiology
5. S.N. Verma : Plant Physiology

<table>
<tr><td colspan="2">Course Title: Physical and Inorganic Chemistry</td><td>Course No: BT-1203</td><td>Credit: 3</td><td>Year:1st</td><td>Semester: 2nd</td></tr>
<tr><td colspan="6">Rationale: This course is designed to provide general concepts of Physical & Inorganic Chemistry</td></tr>
<tr><td colspan="6">Course Objectives:
• Conceptualize general knowledge of Physical & Inorganic Chemistry
• Acquire general knowledge on different areas of Physical & Inorganic Chemistry
• Acquaint with general techniques used in Physical & Inorganic Chemistry</td></tr>
<tr><td>Intended Learning Outcomes (ILOs)</td><td colspan="5">At the end of the course the students will be able to-
1. Describe various aspects of Physical & Inorganic Chemistry
2. Explain the scope and importance of study of Physical & Inorganic Chemistry
3. Describe the current trends in Physical & Inorganic Chemistry to be used in Biotechnology</td></tr>
<tr><td>Course Content</td><td colspan="5">1. Acids, Bases and Buffers:
Various concepts of acids and bases, pH measurement and pH scale, ionization of acids and bases, acid –base titration reactions and indicators, common ion effect, acidic and basic properties of biological important molecules, acid base balance and its maintenance, buffer solution, mechanism of buffer action, buffer capacity, some important biological buffers, Henderson-Hasselbatch equation.

2. Thermodynamics:
Systems and surroundings, reversible and irreversible process, molar heat capacities, isothermal and adiabatic expansion with work equation; state and path function, first and second law of thermodynamics, enthalpy, entropy, free energy, free energy changes and spontaneous bio-reactions, relationship between free energy change and equilibrium constant, third law of thermodynamics, applications of thermodynamics to biochemistry.

3. Colligative properties of solution:
Dilute solutions, Raoult’s law and its derivation, lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmosis and osmotic pressure.
4. Colloids and adsorption:
Definition, classification and general properties of colloid, Brownian movement, coagulation, gell and emulsion, definition, causes and classification of adsorption, classical and langmuir adsorption isotherm, phase rule, phase diagram of water.

5. Inorganic Chemistry:
Atomic structure, Bohr and Rutherford atom models, electronic configuration, ionization potential, electron affinity, electro negativity, ionic bonds, types of ions, covalent bond, coordinate covalent bond, valence bond approach, sigma (σ) and pi (π) bonds, bond length, bond order, hydrogen bond, Van der wall’s forces, metallic bond, role of inorganic elements in some vital complexes of biological importance e.g. hemoglobin, cytochromes, ferredoxin, chlorophylls.</td></tr>
<tr><td>Reference</td><td colspan="5">1. Bhal & Tuli: Essential of Physical Chemistry. S Chand & Co Ltd. (2010).
2. Sharma K K and Sharma L: Textbook of Physical Chemistry, Vikash publishing, (2012).
3. D. Freifelder: Prniciples of Physical Chemistry. 2nd or later Ed. (1984).
4. Morris, J. G. A.: A Biologist’s Physical Chemistry. 2nd or later Ed. (1974).
5. Berg JM, Tymoczko JL and Stryer L. Biochemistry (8th Ed.). W H Freeman & Company, New York (2015).
6. Atkins P. W. & Beran J. A.: General Chemistry, 2nd or later edition (1992).</td></tr>
</table>

Course Title: Basic Animal Science	Course No: BT-1204	Credit: 3	Year:1st	Semester: 2nd

Rationale: This course is designed to provide general concepts of basic animal science

Course Objectives:

- Conceptualize general knowledge of basic animal science
- Acquire general knowledge on different areas of basic animal science
- Acquaint with general techniques used in Basic Zoology to be used in Biotechnology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of basic animal science 2. Explain the scope and importance of study of basic animal science 3. Describe the current trends in basic animal science to be used in Biotechnology
Course Content	**1. Introduction:** Scope and branches of Animal Science **2. Invertebrates:** Definition, diversity of invertebrates, major and minor phyla, lower and higher invertebrates, contrast between lower and higher invertebrates, invertebrates versus vertebrates, phylogeny of invertebrates, major characteristics of invertebrates, outline classification of animals. **3. Chordata:** Definition, diversity of chordates, three fundamental chordate characters, origin and ancestry of chordate, major subdivisions of chordate, general characters of chordate, brief classification of chordata with characters. **4. Wildlife Biology:** Definition, introduction to the wildlife and broad classification of wildlife in Bangladesh, wildlife preservation and its importance in Bangladesh, wildlife order of 1973 **5. Fundamental of Animal Life:** Origin of living system, Lamarckism and Darwinism, neo-Darwinism, modern synthetic theory. **6. Palaeontology:** Geological time scale, process of fossilization. **7. Vertebrate Embryology:** Introduction, fertilization, parthenogenesis, egg types, cleavage, blastulation, gastulation, gametogenesis, development of chick, placentation in mammals.
Reference:	1. Kotpal: Modern textbook of Zoology (Vertebrates) 2. E. L. Jordan and P. S. Verma: Invertebrate zoology 3. Ganguly and Shinha: Biology of animals (Vol. 1, 2 & 3). 4. Parker and Haswall: Textbook of zoology (Vol. 1& 2) 5. K.Z.Hossian : Wild life of Bangladesh

Course No: BT-1205 (Lab)	Course Title: Lab in Genetics
Full Marks: 100	Credit: 1.0

Exp.-1: Study of Mendelian ratio and non-Medelian ratio by Chi- square test.
Exp.-2: Study of Pedigree analysis
Exp.-3: Study of Sex determination
Exp.-4: Construction of Genetic map
Exp.-5. Study of Cytoplasmic Inheritance
Exp.-6: Analysis of Criss cross inheritance

Course No: BT-1206 (Lab)	Course Title: Lab in Physical and Inorganic Chemistry
Full Marks: 100	Credit: 1.0

Exp.-1: Preparation of buffer and determination of pK of acetic acid.
Exp.-2: Determination of pH, preparation of buffer and demonstration of buffer action.
Exp.-3: Determination of pKa of ethanoic
Exp.-4: Liver glycogen extraction and estimation.
Exp.-5: Determination of protein content by the Lowry method.
Exp.-6: Determination of glucose content of serum by the nelson-Somogyi method.

Course No: BT-1207 (Lab)	Course Title: Lab in Plant Physiology & Animal Science
Full Marks: 100	Credit: 1.0

Exp.-1: Identification of microbial flora of frozen food and fish
Exp.-2: Identification of different fish pathogens
Exp.-3: Detection of pathogenic microbes in potable water
Exp.-4: Blood group testing
Exp.5: Antimicrobial sensitivity test of microorganisms (Qualitative)
Exp.6: Action of antiseptics, disinfectants, UV light & photo reactivation & antimetabolites
Exp.-7: Collection of serum and plasma from human peripheral blood.
Exp.-8: Determination of effect of auxin by Avena Section test
Exp.-9: Study on effect of sunlight on chlorophyll content
Exp.-10: Studies on the Zooplankton of a tropical fish pond

Course No: BT-1208	Course Title: Viva-Voce
Full Marks: 100	Credit: 1.0

Course Title: Molecular Biology-I	Course No: BT-2101	Credit: 3	Year:2nd	Semester: 1st

Rationale: This course is designed to provide general concepts of Molecular Biology

Course Objectives:

- Conceptualize general knowledge of Molecular Biology
- Acquire general knowledge on different areas of Molecular Biology
- Acquaint with general techniques used in Molecular Biology to be used in Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Molecular Biology
2. Explain the scope and importance of study of Molecular Biology
3. Describe the current trends in Molecular Biology to be used in Biotechnology

Course Content

1. **Introduction:**
   Chemical nature of hereditary materials, experiment with bacteria and bacteriophage indicating DNA to be the material of heredity, central dogma of molecular biology, gene-phenotype relationship.

2. **Structure and function of DNA & RNA:**
   Different physico-chemical properties of DNA (i.e. Tm value, Cot value; hybridization kinetics), homoduplex and heteroduplex, tandem sequence; palindrome sequence; structure (primary, secondary and tertiary) of RNA, types of RNA; role of different RNAs.

3. **Replication:**
   DNA replication, experiment in favor of semi-conservative replication, DNA polymerases, mechanism of replication, control of DNA synthesis in prokaryotic and eukaryotic system, reverse transcription, mechanism of telomere replication.

4. **Transcription:**
   Structural organization of a gene, components of a gene, cis-acting element, trans-acting element, response element, promoters, enhancers, silencers, terminators and transcriptional factors; prokaryotic and eukaryotic RNA polymerases; Mechanism of transcription-initiation, elongation and termination of RNA synthesis in both prokaryotic and eukaryotic systems, regulation of transcription.

5. **Translation:**
   Organization of prokaryotic and eukaryotic ribosomes, the genetic code and their characteristics, clover leaf structure of tRNA, wobble hypothesis; mechanism of translation-initiation, elongation and termination; control of translation both in prokaryotes and eukaryotes; post-translational modifications.

Reference:

1. Benjamin Lewin : *Genes XI*, 11th edition (2013).
2. J. Watson: *Molecular Biology of the Gene*, 7th edition (2013).
3. Lehninger A, Nelson DL, Cox MM. *Lehninger Principles of Biochemistry (6th Ed.). New York*,W H Freeman (2012).
4. Berg JM, Tymoczko JL and Stryer L. *Biochemistry (8th Ed.)*. W H Freeman & Company, New York (2015).
5. Lodish H, Berk E, Kaiser J et al. *Molecular Cell Biology* (8th Ed.), New York, WH Freeman (2016).
6. Alberts B, Johnson A, Lewis J et al. *Molecular Biology of the Cell* (6th Ed.), New York, WH Freeman (2014).
7. Karp G. *Cell and Molecular Biology: Concepts and Experiments*. Wiley & Sons (7th edition 2013).

Course Title: Metabolism	Course No: BT-2102	Credit: 3	Year:2nd	Semester: 1st

Rationale: This course is designed to provide general concepts of Metabolism

Course Objectives:

- Conceptualize general knowledge of Metabolism
- Acquire general knowledge on different areas of Metabolism
- Acquaint with general techniques used in Metabolism to be used in Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Metabolism
2. Explain the scope and importance of study of Metabolism
3. Describe the current trends in Metabolism to be used in Biotechnology

Course Content

1. **Metabolism of carbohydrates:**
   Catabolism, anabolism, intermediary metabolism, major pathways of glucose utilization, glycolysis, regulation, fate of pyruvate, fermentation, respiration, glycogenolysis and glycogenesis, control of glycogen metabolism, gluconeogenesis and its regulation; biosynthesis of di, oligo and polysaccharides, regulation of carbohydrate metabolism, disorders of carbohydrate metabolism.

2. **Tricarboxylic Acid Cycle:**
   TCA cycle and its reaction, amphibolic nature of the TCA cycle, anaplerotic reactions, regulation of the TCA cycle.

3. **Electron Transport and Oxidative Phosphorylation:**
   Mitochondrial structure and the compartmentation of respiratory metabolism, electron transport through mitochondrial electron carriers; organization of complexes in ETC,

   oxidative phosphorylation, substrate level phosphorylation, chemiosmotic model, shuttle systems, generation of free radicals, Q cycle.

4. **Lipid Metabolism:**
   Transport of fatty acid from cytosol to mitochondria, β-oxidation of even and odd number fatty acid, ω-oxidation, fatty acid biosynthesis, regulation of fatty acid

   metabolism, biosynthesis of prostaglandins, ketone body formation and

   utilization, disorders of lipid metabolism.

5. **Protein Metabolism:**
   Biosynthesis of amino acids, transamination, oxidative deamination and decarboxylation

   of amino acids, toxicity of ammonia, urea cycle, disorders of protein metabolism.

6. **Nucleic acid metabolism:**
   Importance of nucleotides; biosynthesis and regulation of purine and pyrimidine

   nucleotides, degradation of nucleotides, disorders of nucleic acid metabolism.

7. **Bioenergetics:**
   Biological energy transformation, laws of thermodynamics, free energy, free energy changes, cAMP biosynthesis and degradation, biochemical and physiological function, cAMP as second messenger, cytochromes and cytochrome P450, NADH, NADPH and $FADH_2$ as electron carriers.

Reference:

1. R.K.Murray : Harper's Biochemistry
2. L.Stryer: Biochemistry
3. Lehninger : Principles of Biochemistry
4. Benjamin Lewin: Genes IX
5. U. Satyanarayana : Biochemistry
6. Bruce Alberts et al: Molecular Biology of the cell
7. T.M.Devlin: Text Book of Biochemistry with clinical correlation

Course Title: Plant Breeding	Course No: BT-2103	Credit: 3	Year:2nd	Semester: 1st
Rationale: This course is designed to provide general concepts of Plant Breeding				
Course Objectives: • Conceptualize general knowledge of Plant Breeding • Acquire general knowledge on different areas of Plant Breeding • Acquaint with general techniques used in Plant Breeding to be used in Biotechnology				
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Plant Breeding 2. Explain the scope and importance of study of Plant Breeding 3. Describe the current trends in Plant Breeding to be used in Biotechnology			
Course Content	**1. Introduction:** Introduction, history nature of plant breeding, origin and evolution of cultivated crop-wheat and rice, sources of variation, different breeding system, quantitative and qualitative character, heritability, genetic structure of population, gene frequency, biometrical technique in plant breeding, ideotype concept, national and international institute for crop improvement, quality traits of selected crops including rice, wheat and potato. **2. Mode of reproduction and pollination:** Mode of reproduction and pollination control, male sterility and incompatbility in breeding, introduction and self acclimatization, polyploid in breeding, **3. Breeding methods of self and cross pollinated crops:** General concept of selection, self pollinated and cross pollinated crops, pure line selection, pedigree selection, mass selection, bulk method, back cross method, population improvement, hybrid and synthetic variety, single seed descent method, recurrent selection, etc. **4. Heterosis and inbreeding depression:** Introduction, inbreeding depression- history, effect and degress of inbreeding depression, heterosis and hybrid vigar, genetic basis of heterosis and inbreeding depression. **5. Breeding for abiotic stress resistance:** Abiotic stress- drought, salt-tolerant, flood tolerant. **6. Breeding for diseases and insect resistance:** Some common diseases, host- pathogen relationship, resistance and related term, source of diseases and insect resistance, genetics of diseases and insect resistance, breeding methods of diseases and insect resistance. **7. Hybridization:** Introduction, history of hybridization, objectives of hybridization, types of hybridization, procedure of hybridization. **8. Improved Seeds:** Improve seed- its production, maintenance and handling, release of new variety in developing countries.			
Reference:	1. Shukla, R.S : Cytogenetics, Evolution and Plant Breeding 2. Singh, R.K & Singh, R.K : Genetics and Plant Breeding 3. Singh, B.D : Plant Breeding 4. Pirchner : Population Genetics in Animal Breeding			

Course Title: Medical Microbiology	Course No: BT-2104	Credit: 3	Year:2nd	Semester: 1st

Rationale: This course is designed to provide general concepts of Medical Microbiology

Course Objectives:

- Conceptualize general knowledge of Medical Microbiology
- Acquire general knowledge on different areas of Medical Microbiology
- Acquaint with general techniques used in Medical Microbiology to be used in Biotechnology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Medical Microbiology 2. Explain the scope and importance of study of Medical Microbiology 3. Describe the current trends in Medical Microbiology to be used in Biotechnology
Course Content	**1. Public health Microbiology:** Introduction of indicator organism. Coliform, Faecal coliform, Total coliform and Faecal coliform detection method. Airborne and waterborne pathogen. **2. Introduction of some important microorganisms:** Characteristics of some enteric pathogens (*Escherichia, Salmonella, Shigella*), gram-negative rods (*Pseudomonas, Neisseria*), gram-negative cocci (*Mycoplasmas*), gram-positive rods (*Bacillus, Clostridium*) and gram-positive cocci (*Staphylococcus, Streptococcus*). **3. Identification of Microorganism:** Microscopic, cultural and biochemical tests, serological tests, phage typing. **4. Antibiotics and Drugs:**Definition of antibiotics, sources of antibiotics, classification of antibiotics, synthetic & semi-synthetic antibiotics, narrow and broad-spectrum antibiotics, bactericidal & bacteriostatic actions of antimicrobial drugs; structure & mechanism of action of antibiotics (penicillin, tetracycline, streptomycin, erythromycin, cephalosporin, chloramphenicol), definition of sulphadrugs, structure and mode of action of sulfamides, drug-resistance. **5. Microbes and diseases:** Origin of normal flora, distribution, occurrence & importance of microbiota, factors influencing the normal flora, concept of infectious diseases, natural resistance, pathogenicity and virulence, reservoirs of infections, transmission of diseases, mechanism of infection, infection of blood and lymphatic system, microbial virulence factors, microbial toxins, classification of exotoxins, mechanism of action of exotoxins. **6. Common and Emerging infectious diseases:** Causative agents, symptoms, prevention and treatment of common cold, flu, dengue, malaria, rabies, pertussis, tuberculosis, diarrhea, cholera, tetanus, small pox, chicken pox, pneumonia, pertussis, bird flu and Nipah virus.
Reference:	1. E. Jawetz, J.L. Melnick & E.A. Adelberg; *Review of Medical Microbiology*, 27th Ed. (2015). 2. E.M. Cooke & G. L. Gibson. *Essential Clinical Microbiology : An introductory Test* –Willy Medical publication (1983) 3. James H. Jorgensen & Michael A. Pfaller; *Manual of Clinical Microbiology*, 11th Ed. (2015) 4. A. A. Salyers & D.D. Whitt.; *Bacterial Pathogenesis : A Molecular Approach*, 2nd Ed. (2002). 5. M.R. Chowdhury: *Modern Medical Microbiology*, 5th Ed. (1999) or later Ed. 6. Mims C, Playfair John H. L. & Roitt Ivan: *Medical Microbiology*, 2nd Ed. (1998). 7. Perry JW, Morton D, Perry JB. *Laboratory Manual for General Biology*, Brooks Cole (5th edition 2006 or a later edition). 8. Cappuccino L, Sherman N. *Microbiology: A Laboratory Manual*, 11th edition (2016). 9. John Harley, *Laboratory exercise in Microbiology*, 9th edition (2013).

<table>
<tr><td colspan="2">Course Title: Cytology and Cytogenetics</td><td>Course No: BT-2105</td><td>Credit: 3</td><td>Year:2nd</td><td>Semester: 1st</td></tr>
<tr><td colspan="6">Rationale: This course is designed to provide general concepts of Cytology and Cytogenetics</td></tr>
<tr><td colspan="6">Course Objectives:
• Conceptualize general knowledge of Cytology and Cytogenetics
• Acquire general knowledge on different areas of Cytology and Cytogenetics
• Acquaint with general techniques used in Cytology and Cytogenetics to be used in Biotechnology</td></tr>
<tr><td>Intended Learning Outcomes (ILOs)</td><td colspan="5">At the end of the course the students will be able to-
1. Describe various aspects of Cytology and Cytogenetics
2. Explain the scope and importance of study of Cytology and Cytogenetics
3. Describe the current trends in Cytology and Cytogenetics to be used in Biotechnology</td></tr>
<tr><td>Course Content</td><td colspan="5">1. Introduction
Cytology and cytogenetics, Chromosome morphology and karyotype, Chromosome banding
2. Structural changes of chromosomes
Deletion, duplication, inversion, translocation: Defination, types, origin, meiotic behavior, role in evolution and uses in cytological study.
3. Numerical changes of chromosomes: Euploidy
Autopolyploidy: Origin and occurance, phenotypic effects. Meiotic behavior and meiotic configuration of autotriploids and autotetraploids. Breeding bhaviour, Genetics of autopolyploids.
Allopolyploidy: Criteria for distinction of autopolyploids and allopolyploids, Allopolyploidization of autopolyploids. Genome analysis in allopolyploids and synthesis of new species using allopolyploidy.
4. Numerical changes of chromosomes: Aneuploidy
Source of primary, secondary and tertiary trisomics, source of monosomic and nullisomic locating genes through monosomic analysis. Meiotic and breeding behavior of trisomic, monosomic and nullisomic.Characterization and identification of trisomics.
5. Chromosomal abnormalities and syndromes in human:
Structural and numerical chromosomal abnormalities in human, Cri-du-chat syndrome, Down syndrome, Turner syndrome, Klinefelter syndrome, XY females and XX males. Autosomal disorders, X-linked disorders. Sex-limited and sex-influenced phenotypes, Genomic imprinting, trinucleotide repeats
6. Substitution lines:
Cytogenetics of substitution lines. Production of different substitution lines and their genetic analysis.</td></tr>
<tr><td>Reference:</td><td colspan="5">1. Gupta PK. Cytogenetics
2. Khus GS. Cytogenetics of Aneuploidy
3. Sharma A. Chromosomes
4. Pawan kumar Dhar. Human genetics</td></tr>
</table>

Course: BT-2106 **Lab in Molecular Biology and Metabolism**

Full Marks: 100 **Credit: 1.0**

Exp.-1: Chemical synthesis of oil of wintergreen.
Exp.-2: Chemical synthesis of aspirin.
Exp.-3: Estimation of ascorbic acid content of biological samples.
Exp.-4: Determination of saponification number of fat or oil.
Exp.-5: Determination of iodine number of fat or oil.
Exp.-6: Determination of lactose content in milk.
Exp.-7: Varification of Beer-Lambert law and determination of unknown concentration of supplied sample by photometric method.
Exp.-8: Determination of λ_{max}.
Exp.-9: Effect of pH on protein solubility (precipitation of serum albumin and globulin at their respective pI).
Exp.-10: Isolation of casein by precipitation at its isoelectric point.

Course: BT-2107 **Lab in Medical Microbiology**

Full Marks: 100 **Credit: 1.0**

Exp.-1: Effect of temperature and pH on growth
Exp.-2: Effect of heat on vegetative cells and spores of bacteria and spores of yeast and mold
Exp.-3: Effect of osmotic pressure of growth, MIU, KIA & IMVIC test
Exp.-4: Nitrate reduction, oxidase, catalase & litmus milk reaction test
Exp.-5: Identification of unknown bacterial culture with the held of Bergey's manual of systematic bacteriology
Exp.-6: Microscopic study of the pathogenic microorganisms present in air, water & soil (Gram reaction, morphology, mobility, etc)
Exp.-7: Microbial flora of throat & skin
Exp.-8: Identification of human staphylococcal pathogens
Exp.-9: Identification of human streptococcal pathogens
Exp.-10: Detecting *Salmonella spp*. on poultry

Exp.11: Quantitative examination of bacteria in raw and pasteurized milk; Methylene blue reduction test
Exp.12: Microbiological analysis of fermented foods and nonfermented foods

Course: BT-2107 **Lab in Plant Breeding**

Full Marks: 100 **Credit: 1.0**

Exp.-1: Study of Seed quality (Purity test, germination test, moisture content test, etc)
Exp.-2: Seed certification procedure
Exp.-3: Hybridization technique (Self-pollination and cross-pollination crops)
Exp.-4: Breeding methods for Self-pollination and cross-pollination crops
Exp.-5: Pedigree record analysis

Course: BT-2109	**Viva-voce**
Full Marks: 50	**Credit: 1.0**

Course Title: Plant Tissue culture	Course No: BT-2201	Credit: 3	Year:2nd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Plant Tissue Culture

Course Objectives:

- Conceptualize general knowledge of Plant Tissue Culture
- Acquire general knowledge on different areas of Plant Tissue Culture
- Acquaint with general techniques used in Plant Tissue Culture to be used in Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Plant Tissue Culture
2. Explain the scope and importance of study of Plant Tissue Culture
3. Describe the current trends in Plant Tissue Culture to be used in Biotechnology

Course Content

1. **Introduction:**
   History of tissue culture, cellular totipotency, laboratory organization, media preparation and techniques in tissue culture, phytohormons, organ culture-root culture, shoot tip or meristem culture, flowerbud or complete flower culture, culture of isolated ovary, embryo culture and rescue in agricultural and horticultural crop, *in vitro* pollination and fertilization, prospects of PTC in Bangladesh and other countries, Micropropogation, Preparation of virus free plants.
2. **Callus culture:**
   Establishment and maintenance, cytology of callus, organogenesis from callus culture and its importance.
3. **Somatic embryogenesis and production of artificial seed:**
   Different stages of somatic embryogenesis and artificial seed, Importance of somatic embryogenesis, encapsulation.
4. **Single cell culture:**
   Factor affecting single cell culture and its importance, growth pattern of cell in suspension culture.
5. **Anther and pollen culture:**
   Anther and pollen culture for haploid production, application of haploid, diploidisation procedure.
6. **Protoplast Culture:**
   Isolation, culture, somatic hybridization and cybridization, importance of somatic hybridization.
7. **Somaclonal Variation:**
   Origin and causes of somaclonal variation, improved varieties through somaclonal variation genetic and epigenetic basis, establishment of cell lines and evaluations.
8. **Cryopreservation:**
   Definition, different steps, merits – demerits of germplasm and *in vitro* conservation, *in vitro* pollination and fertilization.

Reference:

1. Bajaj, Y. P. S. : Biochemistry in Agriculture and Forestry.
2. Islam, S. A. : Plant Tissue Culture.
3. Pierik R.L.M. : In vitro culture of higher plants. Kluwer Academic Publishers
4. Razdan : Plant Tissue Culture

Course Title: Immunology I	Course No: BT-2202	Credit: 3	Year:2nd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Immunology

Course Objectives:

- Conceptualize general knowledge of Immunology
- Acquire general knowledge on different areas of Immunology
- Acquaint with general techniques used in Immunology to be used in Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Immunology
2. Explain the scope and importance of study of Immunology
3. Describe the current trends in Immunology to be used in Biotechnology

Course Content

1. **Introduction:**
   Components of immune system; Types of immunity - innate and adaptive immunity; humoral and cell-mediated immunity, features of immune response: memory, specificity and recognition of self and non-self; clonal selection.

2. **Cells involved in immune response:**
   Cell surface markers, T cells, B cells, natural killer cells, antigen presenting cells; polymorphonuclear granulocytes- neutrophils, eosinophils, basophils; platelets; mast cells and its triggering, primary and secondary lymphoid organs and tissues.

3. **Structure and function of antibody:**
   Immunoglobulin classes and subclasses, structural features and biological properties of immunoglobulin, antigen- antibody interaction, affinity and avidity.

4. **Immunogens and antigens:**
   Requirements for immunogenicity, epitope, primary and secondary responses, major sources of antigens, characteristics and determinant.
5. **T-cell receptors and major histocompatibility complex:**
   T-cell receptors, major histocompatibility complex (MHC) antigens, antigen processing and presentation to T cells, T cell-B cell interaction, lymphocyte activation, cytokine action on B cells and T cells, cell- mediated cytotoxicity.

6. **Complement system:**
   Complement proteins, classical, alternative and lectin activation pathways, regulation of complement pathways, biological effects.

7. **Regulation of the Immune Response and Immunological Tolerance:**
   Regulation by antigen, antibody, lymphocytes; idiotypic and neuroendocrine modulation of immune responses, genetic control of immnue responses; experimental induction of tolerance; Central thymic, peripheral or post-thymic and B cell tolerance to self antigens; potential therapeutic application of tolerance.

Reference:

1. Ivan M. Roit etal: *Essential Immunology*, 12th edition (2011).
2. Male, Brostoff, Roth &Roitt: *Immunology*, Elsevier, 8th edition (2012).
3. Abul K. Abbas, Andrew H. Lichtman: *Cellular and Molecular Immunology*, 7th edition (2011).
4. Abul K. Abbas, Andrew H. Lichtman: *Basic Immunology: functions and disorders of immune system*, 4th edition (2012).

Course Title: Enzymology	Course No: BT-2203	Credit: 3	Year:2nd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Enzymology

Course Objectives:

- Conceptualize general knowledge of Enzymology
- Acquire general knowledge on different areas of Enzymology
- Acquaint with general techniques used in Enzymology to be used in Biotechnology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Enzymology 2. Explain the scope and importance of study of Immunology 3. Describe the current trends in Enzymology to be used in Biotechnology
Course Content	**1. Introduction to enzymes:** Definition, classification, nomenclature, apoenzyme, holoenzyme, co-enzyme, prosthetic group; cofactors, specificity of enzymes; specific activity; active site, common features of active site; evidences in support of enzyme- substrate complex formation, factors influencing the rate of enzyme-catalyzed reactions such as substrate concentration, enzyme concentration, pH, temperature, coenzyme and cofactors; factors contributing to the catalytic efficiency of enzyme such as proximity, orientation, strain. **2. Enzyme kinetics:** Mono-substrate reactions; Michaelis-Menten equation and its derivation, definition, determination and significance of Km and Vmax. **3. Inhibition of enzyme:** Reversible and irreversible inhibition; competitive, non-competitive and uncompetitive inhibition with specific examples from metabolism. **4. Regulatory and catalysis strategies:** Regulation by proximity and orientation, covalent modification, feed-back inhibition, allosteric inhibition; acid-base catalysis, regulation by proteolysis, characteristics and biological importance of isoenzymes, basic catalytic principles, mechanism of enzyme action- proteases, chymotrypsin, lysozyme, ribonuclease A, carboxypeptidase, carbonic anhydrases. **5. E**z**yme technology:** Therapeutic, analytical, manipulative and industrial uses of enzyme, Microbial screening for the production of enzyme, technology of enzyme production, genetic engineering and protein engineering of enzymes**.** **6. Immobilization of enzymes:** Definition, supporting materials, properties of supporting materials, techniques of immobilization with their advantages and disadvantages.
Reference:	1. Boyer: The enzymes 2. Dixon : Enzymes 3. Lehninger, A.L : Text Book of Biochemistry 4. Voet & Voet : Biochemistry: 5. F.C.Engle: Enzyme kinetics 6. Stryer: Biochemistry 7. Fersht: Enzymatic reaction mechanism 8. Guyton. H : Text book of medical physiology

Course Title: Biostatistics	Course No: BT-2204	Credit: 3	Year:2nd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Biostatistics

Course Objectives:

- Conceptualize general knowledge of Biostatistics
- Acquire general knowledge on different areas of Biostatistics
- Acquaint with general techniques used in Biostatistics to be used in Biotechnology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Biostatistics 2. Explain the scope and importance of study of Biostatistics 3. Describe the current methods of Biostatistics to be used in Biotechnology
Course Content	**1. Elementary biometry:** Definition, Scope of biostatistics**,** problems in measurements; Populations and parameters: Samples and statistics; data and information, presentation of data, distribution of data. **2. Variables:** Discrete and continuous variables. **3. Central tendency:** Calculation of the mean, variance and standard deviation. Machine method of calculating the variance and standard deviation, Estimation of standard deviation from the range, Standard deviation of the mean, Confidence limit of the mean. **4. Test of Hypothesis:** **t-test:** The t test in paired experiments, the t test in non-paired experiments, selection of appropriate method of calculating t, confidence limits of a difference between means. **chi-square (x2) test:** The 1 x n table, the 2 x n table, the use of x2 with occurence-nonoccurence data, x2 analysis of a 2 x 2 or four fold table, alternate methods of calculating x2, tests of significance when cell frequencies are small, general remarks. **5. Correlation analysis:** Correlation analysis- Karl pearson's methods, Spearman rank method, concurrent deviation method, least square method, partial and multiple correlation. **6. Regression analysis:** Regression analysis-simple linear regression, curve fitting standard error estimation, multiple regressions. **7. Analysis of variance:** Analysis of variance components, use and utility of analysis of variance, one, two and three way classification. Ducan's multiple range test: Least significance difference test The relationship between t and F test, General remarks. **8. Experimental design:** Introduction, complete block design, Randomized complete block design, Latin square design, Fixed and random effect and interaction, Population base experimental design, Epidemiological experimental design. **9. Factorial analysis:** Factorial design and orthogonal comparison among treatment total.
Reference:	1. Daniel, W.W.: Biostatistics: A Foundation for Analysis in the Health Sciences (Wiley Series in Probability and Statistics) 10th edition (2014). 2. Thomas Hill & Paul Lewicki: Statistics: Methods and Applications, 1st edition (2005) 3. Snedecor, G.W. and Cochran, W.G.: Staistical Methods, 8th edition (1989).

Course Title: Human Physiology	Course No: BT-2205	Credit: 3	Year:2nd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Human Physiology

Course Objectives:

- Conceptualize general knowledge of Human Physiology
- Acquire general knowledge on different areas of Human Physiology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Human Physiology 2. Explain the scope and importance of study of Human Physiology 3. Describe the current research on Human Physiology to be used in Biotechnology
Course Content	**1. Muscular system:** Structure of a skeletal muscle, skeletal muscle fibers, neuromuscular junction, motor units, skeletal muscle contraction, oxygen supply and cellular respiration, oxyge debt, muscle fatigue, smooth muscles, cardiac muscles. **2. Circulatory System:** Body fluid, volume, types, compartmentalization of fluid (ICF, ECF), composition of blood, blood plasma, blood serum, plasma protein, origin of blood cells, development of blood cells (R.B.C, W.B.C & Platelets), properties and function of RBC & PMN, structure and function of hemoglobin, myoglobin, thalasemia, sickle cell anemia, blood coagulating factors & coagulation process, blood group and Rh factor, blood transfusion. **3. Cardiovascular System:** Anatomy and physiology of heart, conduction and regulation of heart beat, cardiac cycle, heart block, heart sound, blood pressure, regulation of blood pressure. **4. Liver:** Anatomy and structure of liver, physiological function, hepatic, vascular and lymph systems, liver disorders. **5. Respiratory System:** Physiology of lungs, mechanism and control of breathing, transport of O_2 and CO_2, oxygen dissociation curve of hemoglobin and myoglobin, Bohr effect, chloride shift, human respiratory disorders. **6. Nervous System:** General functions of the nervous system, structure of neuron, classification of neurons and neuroglia, membrane potential, action potential, refractory period, impulse conduction, synapse, neurotransmitters, neuropeptides, structure and functions of spinal cord, structure and functions of cerebellum, structure of peripheral nerves, general characteristics of autonomic nervous system, autonomic neurotransmitters. **7. Urinary and Reproductive system:** Structure and function of kidney, physiology of urine formation, role of the kidney in the regulation of water, salt and acid-base balance, renal disorders. Male and female reproductive system, spermatogenesis and action of male hormones, ovulation, menstrual cycle, hormonal regulation of menstrual cycle, contraceptives, pregnancy, human development, lactation, menopause.
Reference:	1. Guyton: Medical physiology 2. C.C.Chatterjee: Human Physiology

Course No: BT-2206 (Lab)	Course Title: Lab in Immunology and Enzymology
Full Marks: 100	**Credit:1.0**

Exp.-1: Determination of creatinine of a urine sample.
Exp.-2: Isolation and determination of cholesterol from chicken egg.
Exp.-3: Determination of serum glucose by the glucose oxidase method.
Exp.-4: Determination of serum alanine aminotransferase by the enzymatic method.
Exp.-5: Determination of serum total bilirubin by colorimetry.
Exp.-6: Determination of serum creatinine by colorimetry.
Exp.-7: Determination of serum GOT and GPT activity
Exp.-8: Study on the activity of salivary amylase.
Exp.-9: Determination of Km and Vmax of bovine kidney alkaline phosphatase.

Course No: BT-2207 (Lab)	Course Title: Lab in Plant Tissue Culture
Full Marks: 100	**Credit: 1.0**

Exp.-1: Media Preparation and sterilization, Inoculation and Incubation
Exp:-2: Germplasm conservation (Cryopreservation)
Exp:-3: Isolation of single cell from plant organ, Single cell culture, culture and somatic hybridization
Exp:-4: Artificial seed production
Exp:-5: Characterization of callus tissues

Course No: BT-2208 (Lab)	Course Title: Lab in Biostatistics
Full Marks: 100	**Credit: 1.0**

Exp.-1: Study of relationship between Sample and Population
Exp:-2: Study of T-test
Exp:-3: Study of Correlation and Regression analysis
Exp:-4: Study of Analysis of Variance
Exp:-5: Study of experimental design
Exp.-6: Practical application of various software (ORIGIN, SPSS etc)

Course No: BT-2209	Course Title: Viva-Voce
Full Marks: 100	**Credit: 1.0**

Course Title: Recombinant DNA Technology	**Course No: BT-3101**	**Credit: 3**	**Year:3rd**	**Semester: 1st**

Rationale: This course is designed to provide general concepts of Recombinant DNA Technology

Course Objectives:

- Conceptualize general knowledge of Recombinant DNA Technology
- Acquire general knowledge on different areas of Recombinant DNA Technology
- Acquaint with general techniques used in Recombinant DNA Technology to be used in Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Recombinant DNA Technology
2. Explain the scope and importance of study of Recombinant DNA Technology
3. Describe the current methods of Recombinant DNA Technology to be used in Biotechnology

Course Content

1. **Introduction:**
   Gene-cloning concept and basic steps, definition of genetic engineering, tools of genetic engineering, multiple applications of genetic engineering.
2. **Amplification of target gene:**
   Restriction site tagged primers, DNA sequence and restriction map, process and mechanism of PCR, isolation of PCR product.
3. **Gene cloning Vector:**
   Molecular biology of *E.coli* and bacteriophages in the context of their use in genetic engineering, definition & properties of plasmid, types, size, copy number, replication, regulation of replication, incompatibility groups; host controlled restriction and modification; isolation of plasmid DNA, other gene cloning vectors-bacteriophage λ and other phage vectors; cosmids, phagemids, virus vectors for animals-YAC, BAC.
4. **Gene cloning:**
   Principles of cutting DNA molecules, host controlled restriction and modification, restriction endonucleases- definion, types, nomenclature, recognition sequences and cutting site, sticky end and blunt ends, isoschizomers, DNA ligase, linkers, adaptors, transformation methods of recombinant DNA-physical and biological methods, selection and screening; other enzymes used in genetic engineering-exonucleases, ribonucleases, DNA polymerases, ligases, kinases, phosphatases, reverse transcriptase, DNAases, proteinases, S1 nuclease.
5. **Gene Library:**
   Construction of genomic library and cDNA library; screening of gene libraries by DNA Hybridization, immunological assay and protein activity.
6. **Mammalian Cell Expression Vectors:**
   Selectable and screenable markers; Two-vector expression system; two-gene expression Vector, Gene targeting and site-specific recombination.
7. **Gene Expression in Prokaryotes:**
   Tissue specific promoter, wound inducible promoters; strong and regulatable promoters; increasing protein production; fusion proteins; translation expression vectors, DNA Integration into bacterial genome, increasing secretion, metabolic load.
8. **Gene Editing Technology:**

Reference:

1. J. Sambrook, and T. Maniatis: Molecular cloning. A laboratory Manual (Vol I,II,III).
2. R. W. Old: Principles of Gene Manipulation, An Introduction to Genetic Engineering.
3. J. A. Smith, K. Struhl: Current protocols in Molecular Biology.
4. Alberts, Johnson: Molecular biology of the cell
5. Lodish, Berk, Matsudaira: Molecular cell Biology

Course Title: Molecular Biology-II	Course No: BT-3102	Credit: 3	Year: 3rd	Semester: 1st

Rationale: This course is designed to provide general concepts of Molecular Biology

Course Objectives:

- Conceptualize general knowledge of Molecular Biology
- Acquire general knowledge on different areas of Molecular Biology
- Acquaint with general techniques used in Molecular Biology to be used in Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Molecular Biology
2. Explain the scope and importance of study of Molecular Biology
3. Describe the current methods of Molecular Biology to be used in Biotechnology

Course Content

1. **Molecular Organization of Chromosome:**
   Molecular concept of gene & chromosomes, centromere, telomere, nucleosome and its organization in eukaryotic chromosome, histone and nonhistone proteins, super coiling of DNA; chromatin structure and gene activity, structural gene sequence, protein coding genes, tandemly repeated and simple sequence DNA, Mobile DNA, Retroposon.
2. **Recombination and repair:**
   Detail mechanism of recombination; holliday model, bacterial recombination, specialized recombination, site specific recombination, phase strategy, conjugation, transformation, bacterial and eukaryotic transposons, repair systems (i.e. excision repair, mismatch repair, retrieval systems), triggering of the SOS system. DNA repair defects.
3. **Post transcriptional events:**
   Splice junctions, mechanism of nuclear splicing, self-splicing of group I and group II introns, alternative splicing; capping and polyadenylation, other events, Cis and trans splicing, RNA processing, catalytic activities of ribozymes.

   Post transcriptional regulation:

   RNAi, si RNA, microRNA, nonsense mediated mRNA decay, RNA editing.
4. **Epigenetics:** Introduction, Propagation of heterochromatin and its interaction with histone protein, chromosome condensation, DNA methylation, inheritance of epigenetic effect, factors for influencing the epigenetic modification.
5. **Mutation:**
   Classification, molecular basis of mutation, *in vitro* mutagenesis, site-directed mutagenesis, correlation between mutagenicity and carcinogenocity, Mutation rate and its measurement. practical applications of mutation; Ames test, Xeroderma pigmentosum, Fanconi's anemia, Retinoblastoma etc. and their relationship with cancer.
6. **Regulation of Gene Expression:**
   Autogenous control, positive and negative control; the operon: *lac* operon, *ara* operon, *trp* operon; DNA binding domains of regulatory proteins, interaction of regulatory proteins with other proteins, repressors, genes with multiple promoters, gene silencing, heat shock genes. Quorum sensing regulated gene expression.

Reference:

1. Benjamin Lewin : *Genes XI*, 11th edition (2013).
2. J. Watson: *Molecular Biology of the Gene*, 7th edition (2013).
3. Lehninger A, Nelson DL, Cox MM. *Lehninger Principles of Biochemistry (6th Ed.). New York*,W H Freeman (2012).
4. Berg JM, Tymoczko JL and Stryer L. *Biochemistry (8th Ed.)*. W H Freeman & Company, New York (2015).
5. Lodish H, Berk E, Kaiser J et al. *Molecular Cell Biology* (8th Ed.), New York, WH Freeman (2016).
6. Alberts B, Johnson A, Lewis J et al. *Molecular Biology of the Cell* (6th Ed.), New York, WH Freeman (2014).
7. Karp G. *Cell and Molecular Biology: Concepts and Experiments*. Wiley & Sons (7th edition 2013).

<table>
<tr><td colspan="2">Course Title: Cell and Developmental Biology</td><td>Course No: BT-3103</td><td>Credit: 3</td><td>Year: 3rd</td><td>Semester: 1st</td></tr>
<tr><td colspan="6">Rationale: This course is designed to provide general concepts of Cell and Developmental Biology</td></tr>
<tr><td colspan="6">Course Objectives:
• Conceptualize general knowledge of Cell and Developmental Biology
• Acquire general knowledge on different areas of Cell and Developmental Biology
• Acquaint with general techniques used in Cell and Developmental Biology to be used in Biotechnology</td></tr>
<tr><td>Intended Learning Outcomes (ILOs)</td><td colspan="5">At the end of the course the students will be able to-
1. Describe various aspects of Cell and Developmental Biology
2. Explain the scope and importance of study of Cell and Developmental Biology
3. Describe the current methods of Cell and Developmental Biology to be used in Biotechnology</td></tr>
<tr><td>Course Content</td><td colspan="5">Cell Biology:
Definition; History; Origin of Cells and multicellularity; Cell theory; Units of measurement of cell; Ultra structure and functions of cell organelles (cell wall, plasma membrane, mitochondria, lysosome, nucleus, chloroplast, ribosome, microbodies); Chemical organization of cell; Cell cycle and cell division.
Developmental Biology:
1. Introduction
History, Anatomical tradition, Principles of development-life cycles, Developmental patterns and evolution of differentiation, Experimental embryology, Role of genes in development, Amniocentesis.
2. Early Embryonic Development
Gametogenesis- Spermatogenesis and oogenesis, Types of eggs, Fertilization- changes in gametes, mono- and polyspermy; The early development of C. elegans; The early development of Xenopous-cleavage, Gastrulation, Embryonic induction and organizers; The early development of chick-cleavage, Gastrulation.
3. Later Embryonic Development
Differentiation of germ layers-Formation of neural tube (development of CNS and eye), skin, notochord, somites, coelom and digestive tube (upto rudiments), Extraembryonic membranes in birds and human, Implantation of embryo, Placentation – structure, types and physiology of placenta.
4. Post-Embryonic Development
Metamorphosis- changes and hormonal regulation of metamorphosis in insects and amphibians, Regenerationmodes of regeneration-epimorphosis, Morphallaxis and compensatory regeneration (with one example), Ageingconcepts and model (C. elegans)
5. Implications of Developmental Biology
Medical implications: Infertility –Diagnosing Infertility, IVF, Teratogenesis – teratogenic agents and effect of teratogens on embryonic development</td></tr>
<tr><td>Reference:</td><td colspan="5">1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.</td></tr>
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<tr><td colspan="2">Course Title: Microbial Biotechnology</td><td>Course No: BT-3104</td><td>Credit: 3</td><td>Year: 3rd</td><td>Semester: 1st</td></tr>
<tr><td colspan="6">Rationale: This course is designed to provide general concepts of Microbial Biotechnology</td></tr>
<tr><td colspan="6">Course Objectives:
• Conceptualize general knowledge of Microbial Biotechnology
• Acquire general knowledge on different areas of Microbial Biotechnology
• Acquaint with general techniques used in Microbial Biotechnology to be used in Biotechnology</td></tr>
<tr><td>Intended Learning Outcomes (ILOs)</td><td colspan="5">At the end of the course the students will be able to-
1. Describe various aspects of Microbial Biotechnology
2. Explain the scope and importance of study of Microbial Biotechnology
3. Describe the current trends of Microbial Biotechnology</td></tr>
<tr><td>Course Content</td><td colspan="5">1. Introduction:
History, scope and application of modern microbial biotechnology, fermentation concept, fermentor / bioreactor, stages of fermentation, solid substrate and submerged fermentation process, downstream processing.
2. Primary metabolites:
Alcohols, microbes used in alcohol production, fermentable substrates, medium, methods of ethanol fermentation by yeasts and bacteria, alcoholic beverages, wines, beer,cider and distilled beverages, uses of alcohols.
3. Secondary metabolites:
Synthesis of antibiotics, chemical nature of some important antibiotics, narrow and broad spectrum antibiotics, semi-synthetic antibiotics, general mode of antibiotic action, strain improvement for penicillin, fermentation medium and process of penicillin production. Production of Toxin.
4. Vaccines:
Definition, types, recombinant vaccines-hepatitis virus, subunit vaccines-herpes simplex virus, foot and mouth diseases, tuberculosis, peptide vaccines, genetic immunization, attenuated vaccine, vector vaccines, live attenuated vaccine, DNA vaccine, tumor vaccine.
5. Single cell protein:
Definition, importance, sources of single cell protein (SCP), prospects of SCP in Bangladesh, substrates for SCP, production of single cell protein from carbohydrates, n-alkanes, methane and methanol, food and feed grade SCP, drawback of SCP, some available SCP products.
6. Microbial production of therapeutic agents:
Isolation of interferon cDNA, engineering human interferon and human growth hormone, enzymes-DNaseI and alginate lyase against cystic fibrosis, monoclonal antibody as therapeutic agents, production of antibodies in E. coli., HIV therapeutic agents.
7. Microbial Production of Enzyme and Organic acid:
Microbial production of enzyme (Amylase, Protease, Xylanase, Lipase, Peneicillin acylase, glucose isomerase, lactase). Microbial production of citric acid, Acetic acid, lactic acid. synthesis and importance of small biomolecules – L-ascorbic acid, indigo, amino acids, adhesive protein, melanin.</td></tr>
<tr><td>Reference:</td><td colspan="5">1. Michael J. W., Neil L. M. , John S. R., Gary H.: Industrial Microbiology: An Introduction, 1st Edition (2001).
2. Miller BM & Litsky W: Industrial Microbiology, McGraw-Hill Inc.,US (1976).
3. G. Reed: Prescott and Dunn`s Industrial Microbiology, CBS Publishers (2004).
4. Smith J. E.: Biotechnology, 5th edition (2009).
5. Glick B. R., Pasternak J. J. & Patten CL: Molecular biotechnology: Principles and Application of Recombinant DNA, 4th edition (2009).
6. Davis P.: Single Cell Protein, Academic Press Inc (1975)
7. Fogarty W.M.: Microbial enzymes and biotechnology, Elsevier Science Ltd (1983)
8. Primrose S.B.: Modern biotechnology, Blackwell Science Inc (1987)
9. Alexander N. Glazer, Hiroshi Nikaido: Microbial Biotechnology, Fundamentals of Applied Microbiology, 2nd edition (2007).</td></tr>
</table>

Course Title: Endocrinology	Course No: BT-3105	Credit: 3	Year: 3rd	Semester: 1st

Rationale: This course is designed to provide general concepts of Endocrinology

Course Objectives:

- Conceptualize general knowledge of Cell and Endocrinology
- Acquire general knowledge on different areas of Endocrinology
- Acquaint with general techniques used in Endocrinology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Endocrinology 2. Explain the scope and importance of study of Endocrinology 3. Describe the current methods used in Endocrinology
Course Content	1. **Characteristics of hormone system**: Introduction, general functions of hormones, major endocrine glands, paracrine, and and autocrine, actions of hormone, hormone receptors and its abnormalities, factors affecting hormonal secretion. 2. **Hormone action:** Synthesis and mode of action of cyclic AMP and functions of cyclic AMP, adrenergic receptor, mechanism of action of peptide hormone amine hormones, and steroid hormones. 3. **Pituitary and hypothalamic hormones**: Introduction, structure and synthesis, physiological and biochemical action of pituitary and hypothalamic hormones. Abnormalities of growth hormone secretion. 4. **Thyroid and parathyroid hormones**: Introduction, structure, synthesis, transportation, mechanism of action and pathophysiology. 5. Hormones of adrenal cortex: Introduction, chemistry, biosynthesis, its regulation, transport, mechanism of action and pathophysiology. Physiological functions of cortisol and aldosterone. 6. **Hormones of adrenal medulla**: Introduction, structure, biosynthesis and mechanism of action. **7. Hormones of gonads:** Structure, biosynthesis, mechanism of action. 8. **Pancreatic hormones (Insulin, glucagons):** Structure, synthesis, secretion, distribution and degradation and mode of action. 9. Gastro intestinal hormones.
Reference:	1. Text Book of Medical Physiology by Guyton 2. Text Book of Biochemistry with Clinical Correlation by Thomas M. Delvin 3. Human Physiology by Chakrabarti, Gosh & Sahana 4. Lecture Notes on Endocrinology: Willium Jeffcoate.

Course Title: Biodiversity	Course No: BT-3106	Credit: 3	Year: 3rd	Semester: 1st

Rationale: This course is designed to provide general concepts of Biodiversity

Course Objectives:

- Conceptualize general knowledge of Biodiversity
- Acquire general knowledge on different areas of Biodiversity
- Acquaint with general techniques used in Biodiversity

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Biodiversity 2. Explain the scope and importance of study of Biodiversity 3. Describe the current trends used in Biodiversity
Course Content	**1. Biodiversity:** Definition, types of diversity, nature, origin, measurement and necessity of genetic diversity and species diversity, a general account on ecosystem diversity. **2. Uses and values of Biodiversity:** Uses of bioresources, plant-food, timber, medicinal, ornamental and other uses, animal- food animals (terrestrial and aquatic), non food uses of animals, domestic livestock, uses of microbes, valuing biodiversity-instrumental (goods, services, information and psychospiritual values) and inherent or intrinsic values, ethical and aesthetic values-an outline account on methods of valuing biodiversity. **3. Loss of Biodiversity:** Species extinction - fundamentals causes, deterministic and stochastic processes, current and future extinction rates, methods of estimating loss of biodiversity, threatened species, IUCN threat categories (extinct, endangered, vulnerable,rare, intermediate and insufficiently known), threat factors (habitat loss, over-exploitation for uses, introduction of exotics, diseases, habitat fragmentation etc.), common threat plant and animal taxa of Bangladesh, red data books. **4. Conservation and sustainable management of biodiversity and bioresources:** National polices and instruments relating the protection of the domesticated or wild flora and fauna as well as habitats- international policies and instruments- a general account on multilateral treaties- the role of CBD, IUCN, GEF, IBPGR, NBPGR, WWF, FAO, UNESCO and CITES, bioresources, biotechnology and intellectual property rights- an elementary account on WTO, GATT and TRIPS, bioprospecting and IKS, biopyracy. **5. Conservation of Biodiversity:** Importance of conservation and conservation biology, current practices in conservation, habitat or ecosystem approaches, species-based approaches, social approaches, chipko movement, *in situ* (afforestation, social forestry, agroforestry, botanical gardens, zoos, biosphere reserves, national parks, sanctuaries, sacred groves and sthalavrikshas) and ex situ (cryopreservation, gene banks, seed banks, pollen banks, sperms banks, DNA banks, tissue culture and biotechnological strategies), ecorestoration, environmental and biodiversity laws, environmental education, role of biotechnology in biodiversity, biodiversity assessment and conservation through biotechnology.
Reference:	1. Groombridge, B: Global biodiversity and status of the Earthís living resources. 2. UNEP: Global biodiversity assessment 3. Gary K.Meffe & .Ronald Carroll,C: Principles of Conservation biology

Course No: BT-3107 (Lab)	Course Title: Lab in Recombinant DNA Technology and Molecular Biology
Full Marks: 100	Credit: 1.0

Exp.-1: Extraction of *Escherichia coli* Plasmid and Chromosomal DNA
Exp.-2: Determination of DNA Concentration and Purity by Ultraviolet Spectrophotometry
Exp.-3: Analysis of Plasmid DNA by Restriction Digestion and Agarose Gel Electrophoresis or DNA check run by Agarose Electrophoresis.
Exp.-4: Effect of Agarose Concentration on Migration of DNA Fragments
Exp.-5: Insertion of a Gene for Antibiotic Resistance from *Bacillus subtilis* into an *Escherichia coli* Plasmid
Exp.-6: Target DNA amplification by using PCR Methods.
Exp.-7: Ligation of Target DNA with Plasmid vectors.
Exp.-8: Transformation of ligated Plasmid construct with insert into Competent cell.

Course No: BT-3108 (Lab)	Course Title: Lab in Biodiversity
Full Marks: 100	Credit: 1.0

Exp.-1: Study of plant's anatomical biodiversity
Exp.-2: Biodiversity study of a given area by using Simpson's index (plants/insects)
Exp.-3: Study of insect-diversity in a crop filed
Exp.-4: Study of microbial diversity in soil/water/air
Exp.-5: Study of morphological diversity of bacteria and fungi

Course No: BT-3109 (Lab)	Course Title: Lab in Cell and Developmental Biology and Endocrinolgy
Full Marks: 100	Credit: 1.0

Exp.-1: Investigation of the viability of cells
Exp.-2: Meiosis in Grasshopper Testis (Poecilocerus Pictus)
Exp.-3: Mitosis in Onion Root Tip (Allium Cepa)
Exp.-4: Meiosis in Flower Buds of Allium Cepa-Acetocarmine Stain
Exp.-5: Differential Staining of Blood
Exp.-6: Estimation of Number of Erythrocytes [RBC] in Human Blood
Exp.-6: Estimation of Number of Leucocytes (WBC) in Human Blood
Exp.-7: Determination of serum glucose by the glucose oxidase method.
Exp.-8: Determination of glucose content of serum by the nelson-Somogyi method.
Exp.-9: Determining the Effect of Temperature on the Activity of Human Salivary a-Amylase
Exp.-10: Determining the Effect of pH on the Activity of Human Salivary a-Amylase

Course No: BT-3110 (Lab)	Course Title: Lab in Microbial Biotechnology
Full Marks: 100	Credit: 1.0

Exp.-1: Determination of bacterial growth by spectrophotometric method.
Exp.-2: Measurement of fungal growth by colony diameter
Exp.-3: Measurement of fungal growth by dry weight of mycelium
Exp.-4: Estimation of biomass, i) Dry cell weight estimation ii) Packed cell volume determination
Exp.-5: Effect of temperature and pH on microbial growth
Exp.-6: Determination of antibiotic sensitivity by disc method
Exp.-7: Screening of protease producing bacteria from natural sources.
Exp.-8: Study of solid substrate fermentation process.
Exp.-9: Screening of potential antimicrobial agent from natural sources
Exp.-10 Microbiological assay of pharmaceutical raw materials. .

Course No: BT-3111	Course Title: Viva-Voce
Full Marks: 100	Credit: 1.0

Course Title: Immunology-II	Course No: BT-3201	Credit: 3	Year: 3rd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Immunology

Course Objectives:

- Conceptualize general knowledge of Immunology
- Acquire general knowledge on different areas of Immunology
- Acquaint with general techniques used in Immunology to be used in Biotechnology

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Immunology 2. Explain the scope and importance of study of Immunology 3. Describe the current trends in Immunology to be used in Biotechnology
Course Content	**1. Immunoglobulin (Ig) Genetics:** Generation of antibody diversity, Antibody diversity & VDJ recombination, Immunity to infection- bacterial, viral & parasitic infection, evasive strategies by the pathogens. **2. Hypersensitivity:** Classification of hypersensitivity reaction, Disease associated with hypersensitivity reactions, Mechanisms of damage in hypersensitivity reaction, Methods for diagnosing conditions due to hypersensitivity, Modes of treating disease due to hypersensitivity & their rationale. **3. Transplantation and rejection:**: Barriers of transplantation, laws of transplantation, role of T-cell in rejection, genetic predisposition to graft rejection and prevention of rejection. **4. Autoimmune diseases:** Autoimmunity, association of autoimmunity with disease, genetic factors, pathogenesis, etiology, diagnosis and treatment. **5. Immunodeficiency** Primary and Secondary immunodeficiency. Immunodeficiency in AIDS & other conditions. Major primary immunodeficiency and their features. Relationship between site of lesion and resulting immunodeficiency. Diagnostic test for different immunodeficiency. **6. Tumor immunology:** Evidence for immune reactivity to tumor. Changes in cellular characteristics due to malignancy. Host components which affect tumor progression. Tumor cell components which protect it from the immune system. Rationale for tumor immunotherapy & know the approaches.
Reference:	1. Ivan M. Roit etal: *Essential Immunology*, 12th edition (2011). 2. Male, Brostoff, Roth &Roitt: *Immunology*, Elsevier, 8th edition (2012). 3. Abul K. Abbas, Andrew H. Lichtman: *Cellular and Molecular Immunology*, 7th edition (2011) 4. Abul K. Abbas, Andrew H. Lichtman: *Basic Immunology: functions and disorders of immune system*, 4th edition (2012).

Course Title: Agricultural Biotechnology	Course No: BT-3202	Credit: 3	Year: 3rd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Agricultural Biotechnology

Course Objectives:

- Conceptualize general knowledge of Agricultural Biotechnology
- Acquire general knowledge on different areas of Agricultural Biotechnology
- Acquaint with general techniques used in Agricultural Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Agricultural Biotechnology
2. Explain the scope and importance of study of Agricultural Biotechnology
3. Describe the current trends in Agricultural Biotechnology

Course Content

1. **Plant genome:**
   Nuclear genome, chloroplast genome, mitochondrial genome, structure of plant gene, inter relationship of different genome.

2. **Gene transfer system for plant:**
   Ti plasmid, Ri plasmid, T-DNA, *Agrobacteriam*- mediated gene transfer, direct methods of gene transfer, use of reporter and marker gene in transformed plant cell, transposable genetic eliments, production of marker free transgenic plants.

3. **Marker aided selection in plant breeding:**
   Morphological, biochemical and molecular marker, advantages and disadvantages, procedure and application of RFLP, RAPD and AFLP marker.

4. **Application of biotechnology in agriculture:**
   Development of diseases, insect and herbicide resistant plant, development of stress (salt and submergence) tolerance in plant, antisence RNA technology and fruit ripening, genetic manipulation of flower pigmentation, improvement of protein quality of seed by genetic engineering, modification of food plant taste, appearance and yield, plants as bioreactor-antibodies, polymers and foreign protein products.

5. **Plant-microbe interaction:**
   Basis of plant-microbe interaction(symbiosis), role of plant-microbe interaction in promoting plant growth and health, mechanism of plant defense, microorganisms and biocontrol / biological benefits of plant-microbe interaction, rhizoremediation, molecular mechanism of plant immunity, disease resistance gene-form and function.

6. **Biofertilizers:**
   Definition, types of biofertilizers, benefits of different types of biofertilizers.

7. **Biopesticides:**
   Definition, integrated pest management (IPM), application, advantages and disadvantages of biopesticides.

Reference

1. R. C. Dubey : A Text book of Biotechnology.
2. M. K. Razdan : An Introduction to Plant Tissue Culture.
3. Sickeviz : Plant Biotechnology.
4. Purohit : Agricultural biotechnology
5. Glick and Pasternak : Molecular Biotechnology
6. Primrose : An introduction to gene manipulation

Course Title: Animal Biotechnology	Course No: BT-3203	Credit: 3	Year: 3rd	Semester: 2nd

Rationale: This course is designed to provide general concepts of Animal Biotechnology				
Course Objectives: • Conceptualize general knowledge of Animal Biotechnology • Acquire general knowledge on different areas of Animal Biotechnology • Acquaint with general techniques used in Animal Biotechnology				
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Animal Biotechnology 2. Explain the scope and importance of study of Animal Biotechnology 3. Describe the current trends in Animal Biotechnology			
Course Content	**1. Introduction:** Definitions, major techniques of animal biotechnology, biosensors, biochips, biofilms and biosurfactents, bioinformatics, application of animal biotechnology, aquaculture improvement through biotechnology, animal diseases, livestock production, ruminal bacteria, improvement in nutritive value of low quality feeds. **2. Principles of animal cell and tissue Culture:** Origin, types of cells, primary culture, cell lines (Hela cell, CHO,COS, $HepG_{2,}$ HEK) and cloning, somatic cell fusion, flask culture, organ culture and whole embryo culture, techniques of cell and tissue culture, application of animal tissue culture. **3. Animal tissue culture media:** Blood plasma, blood serum, serum free media, tissue extracts, complex natural media, chemically defined media, and other tissue culture media. **4. Culture of specific cell types:** Epithelial cells, mesenchymal cells, hemopoietic cells, culture of tumor tissue. **5. Transgenic Animal Technology:** Transgenic mice, transgenic swine, transgenic cattle, methods for the introduction of recombinant DNA into chicken and mammalian embryos, problems after developing transgenic animals. **6. Human and Animal Health:** Hybridomas technology and production of monoclonal antibodies and its role in treatment and diagnosis of diseases, neoplasia, HIV and AIDS, gene therapy, development of erythropoietin and rituximab. **7. Embryo transfer technology & IVF:** Definition, collection of embryo, culture and transfer of embryos, Potential use of IVF, mechanism involved in IVF. **8. Cloning:** Definition, history of animal cloning, cloning of sheep, cattle, monkeys and human cloning.			
Reference:	1. Bulock J. and Kristiansen B: Basic Biotechnology. 2. Wisenan A : Principles of biotechnology. 3. Smith John E : Biotechnology. 4. Dubey, R. C : A Text book of Biotechnology			

Course Title: Virology	**Course No: BT-3204**	**Credit: 3**	**Year: 3rd**	**Semester: 2nd**
Rationale: This course is designed to provide general concepts of Virology				
Course Objectives: • Conceptualize general knowledge of Virology				

• Acquire general knowledge on different areas of Virology • Acquaint with general techniques used in Virology	
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Virology 2. Explain the scope and importance of study of Virology 3. Describe the current trends in Virology
Course Content	**1. Cultivation, detection and assay of virus:** Serological and molecular detection, plaques assay (PFU), infectious center assay, one-hit kinetic and two-hit kinetics of virus cultivation. **2. Host virus interaction:** Attachment, entry and uncoating, replication, assembly and maturation, exit of virus from host cells. **3. Bacterial virus, phage:** Multiplication of T-even bacteriophages (lytic & lysogeny cycle), bacteriophages λ, gene expression and assembly of bacteriophages. **4. Animal virus:** Classification based on gene expression, studies on virion structure, infectivity, mode of gene expression and virus assembly of representative member of each class – herpes virus, papovavirus, hepatitis virus (HBV and HCV), picornavirus, vesicular stomatitis virus (VSV), rabies virus, reovirus, retrovirus (HIV). **5. Effect of animal viruses on host cells:** Cytolytic effects, morphological and biochemical observations, inhibitions of proteins, RNA and DNA synthesis, pattern of viral infection- acute, chronic, persistent and latent viral infection. **6. Plant virus:** Structure, genomic organization and molecular aspects of tobacco mosaic virus (TMV), cotton leaf curl geminivirus (CLCuV) and potato virus X, Y, Papaya ring spot virus (PRSV). **7. Prevention and control of viral infection:** General prevention strategies, Immunization with vaccines and antiviral drugs, mechanism of action and limitations of use of these drugs.
Reference:	1. Nigel J. Dimmock, Andrew J. Easton, Keith N. Leppard: *Introduction to Modern Virology*, 7th edition (2016). 2. Nicholas H. Acheson: *Fundamentals of Molecular Virology*, 2nd edition (2011). 3. Arie J. Zuckerman, Jangu E. Banatvala, Paul Griffiths, Barry Schoub, Philip Mortimer: *Principles and Practice of Clinical Virology*, 6th edition (2009). 4. B.N. Fields, D. M. Knipe: *Fundamental virology*, 5th edition, (2007). 5. Madigan MT, Martinko JM, Stahl D, Clark DP. *Brock Biology of Microorganisms*. Benjamin Cummings (14th edition 2014 or a later edition). 6. Tortora GJ, Funke BR, Case CL. *Microbiology: An Introduction*. Addison Wesley Longman (12th edition 2015 or a later edition). 7. Micael J. Pelczer, Jr. ECS, Chan & Noel R. Krieg: *Microbiology*, 5th edition (1998).

Course Title: Neurobiology	**Course No: BT-3205**	**Credit: 3**	**Year: 3rd**	**Semester: 2nd**
Rationale: This course is designed to provide general concepts of Neurobiology				
Course Objectives: • Conceptualize general knowledge of Neurobiology • Acquire general knowledge on different areas of Neurobiology • Acquaint with general techniques used in Neurobiology				
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Neurobiology 2. Explain the scope and importance of study of Neurobiology 3. Describe the current trends in Neurobiology			

Course Content	**1.**	**Neural Development**	**:**	Structures of the nervous system, Organization of the nervous system, Origins of the nervous system, formation of the neural tube, formation of axon and dendrites in culture, migration of immature neurons, guidance of commissural axons.
	2.	**Nerve Cell Growth and Survival**	**:**	Neurotrophic factors, Map of the body surface in the human brain, synapse modification and its electrical activity.
	3.	**Signal Transmission at Synapses**	**:**	Electrical and chemical synapses, neurotransmitters, neural circuits, regeneration and repair of nerve tissue
	4.	**Spinal Cord and Spinal nerves**	**:**	Protective structures and gross anatomical features of the spinal cord, Sensory and motor tracts of the spinal cord, Reflexes and reflex arcs, components and connective tissue coverings of spinal nerves, distribution of spinal nerves.
	5.	**Brain and Cranial nerves**	**:**	Major parts of brain, Protective coverings of brain, names and functions of cranial nerves.
	6.	**Brain Diseases**	**:**	Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, Multiple Sclerosis, Amyotrophic Lateral Sclerosis, Epilepsy, Dementia, Hydrocephalus
Reference	1. Molecular Biology of the Cell : Bruce Alberts, Alexander Johnson, Lewis, etal 2. Principles of Anatomy & Physiology: Tortora, Grabowski 3. Human Anatomy & Physiology: Elaine N. Marieb			

Course No: BT-3206 (Lab)	**Course Title: Lab in Virology and Immunology**
Full Marks: 100	**Credit: 1.0**

Exp.-1:
Exp.-2:
Exp.-3: Collection of serum and plasma from human peripheral blood.
Exp.-4: Isolation and determination of cholesterol from chicken egg.
Exp.-5: Determination of serum total bilirubin by colorimetry.
Exp.-6: Determination of serum creatinine by colorimetry.
Exp.-7: Determination of serum SGOT and SGPT activity
Exp.-8: Determination of creatinine of a urine sample.

Course No: BT-3207 (Lab)	Course Title: Lab in Agricultural Biotechnology
Full Marks: 100	Credit: 1.0

Exp.-1: Isolation of plant genomic DNA by modified CTAB method
Exp.-2: Determination of DNA Concentration and Purity by Spectrophotometry.
Exp.-3: Isolation of chloroplast DNA.
Exp.-4: DNA check run by Agarose Electrophoresis
Exp.-5: Mobilization of recombinant Ti plasmid from common laboratory host (E. coli) to an Agrobacterium tumefaciens strain
Exp.-6: Transformation of plant cells using *Agrobacterium tumifaciens*
Exp.-7: Molecular analysis of putative transformed plants by Polymerase Chain Reaction

Course No: BT-3208 (Lab)	Course Title: Lab in Animal Biotechnology
Full Marks: 100	Credit: 1.0

Exp.-1: Preparation of animal cell lysis buffer
Exp.-2: Protein extraction from animal sources (spleen, liver kidney etc.)
Exp.-3: Preparation of buffer for SDS-PAGE.
Exp.-4: Preparation of SDS-Polyacrylamide Gels
Exp.-5: Protein quantification by Spectrophotometry.
Exp.-6: Separation of Protein Standards: SDS-PAGE
Exp.-7: Commassie Blue Staining and Destining analysis of SDS-PAGE.
Exp-8: Primary cell culture, cell counting and viability check.

Course No: BT-3209	Course Title: Field work / Industry or Research organization visit / Industrial training
Full Marks: 100	Credit: 1.0

Course No: BT-3210	Course Title: Viva-Voce
Full Marks: 100	Credit: 1.0

Course Title: Pharmaceutical Biotechnology	Course No: BT-4101	Credit: 3	Year: 4th	Semester: 1st
Rationale: This course is designed to provide general concepts of Pharmaceutical Biotechnology				
Course Objectives: • Conceptualize general knowledge of Pharmaceutical Biotechnology • Acquire general knowledge on different areas of Pharmaceutical Biotechnology • Acquaint with general techniques used in Pharmaceutical Biotechnology				
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Pharmaceutical Biotechnology 2. Explain the scope and importance of study of Pharmaceutical Biotechnology 3. Describe the current trends in Pharmaceutical Biotechnology			

Course Content	**1. Introduction:** Unit process, design and unit operation in pharmaceutical industry, sterile products, pilot - plant scale up techniques, packaging and managements of products. **2. Drug manufacturing process:** Pharmacopoeia, manufacturing facilities, sources of biopharmaceuticals, production of final products and analysis of final products, BP, USP, INN and accreditation.. **3. Quality assurance and organization model:** Definition of QA, system of QA appropriate to the manufacture of pharmaceutical products; organization of QA department. **4. Quality control:** Definition, good QC practices; quality control practices; responsibility of the head of QC department, QA/OC activities (GMP, GLP, GDP, HACCP), quality audit and self-inspection, environmental monitoring and control; cleaning validation; self-inspection; in-process inspection, quality management-GMP vs ISO 9000, 14000, 18000, ISO/IEC17025, WHO/PICs. **5. Documentation system:** All documents used in QA including SOP, FDA regulation; product registration, process and criteria; specifications for raw materials, packaging materials, finished products, DGDA, Drug licencing. **6. Calibration and validation:** Instrumental calibration, instrumental validation; validation of analytical methods, handling of complaint and product recalls. **7. Application of biotechnology to medicine:** Biosynthesis of some important medical and pharmaceutical products such as chemotherapeutic agents, enzymes, steroids and vitamins etc. **8. Human gene therapy:** *Ex vivo* and *in vivo* gene therapy, practice of gene therapy, viral gene delivery systems, pro-drug activation therapy; nucleic acid therapeutic agents. **9. Ethical dilemmas in clinical genetics:** Major ethical issues in developed and developing nations, needs of medical geneticists in the study of ethics, resources for ethical guidance, special position of women and children, responsibilities of health professionals with family genetic information. **10. Production of the pharmaceutically useful biopharmaceuticals by rDNA technology**
Reference:	1. Burger : Medical chemistry. 2. Remington's Pharmaceutical Science. 3. Rosenburg : Chemistry and physiology of vitamins. 4. Robert F. Muller, Ivan D. Young : Emery's Elements of Medical Genetics. 5. Leon Lachman : The theory and Practice Industrial Pharmacy. 6. Williams : Recombinant DNA. 7. B. K. Sharma, N., and P. K. Sigal. : Adaptation Biology and Medicine. 8. Gray Walls : Biopharmaceuticals

Course Title: Techniques in Molecular Biology	**Course No: BT-4102**	**Credit: 3**	**Year: 4th**	**Semester: 1st**
Rationale: This course is designed to provide general concepts of Techniques used in Molecular Biology				
Course Objectives: • Conceptualize general knowledge of Techniques used in Molecular Biology • Acquire general knowledge on different areas of Techniques used in Molecular Biology • Acquaint with general techniques used in Molecular Biology				
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of techniques used in Molecular Biology 2. Explain the scope and importance of study of techniques used in Molecular Biology 3. Describe the current trends in techniques used in Molecular Biology			

Course Content	**1. Techniques for isolation:** DNA isolation from bacteria and different biological systems (blood, soft tissue, semen, swabs, bones etc.), RNA isolation, protein isolation from liver, rat tail and bacteria. **2. Electrophoresis**: Agarose, SDS-PAGE; pulse field gel electrophoresis, Western blot. **3. Principles and methods of some techniques**: Gel filtration; ion-exchange and affinity chromatography; HPLC; colony hybridization, southern and northern hybridization, western blotting, *in situ* hybridization, combinatorial chemistry. **4. Labelling of Nucleic Acid and Probes:** Radioactive and non-radioactive labeling techniques- nick translation, end labeling, primer extension, methods based on RNA polymerases; choice of label. **5. Analytical methods in biotechnology:** DNA microarrays / DNA chips; variable number of tandem repeats (VNTRs), short tandem repeats (STRs), DNA fingerprinting, hybridization and PCR based DNA fingerprinting, applications of fingerprinting in various fields (i.e., criminal detection, immigration, paternity testing, identification of missing / dead person, varietal identification of plants), reverse transcriptase PCR (RT-PCR), real time PCR, western blot. **6. Molecular diagnosis of diseases:** Molecular diagnosis of some diseases caused by viral and bacterial species (TB, STD, HIV, Hepatitis, diarrhoea causing microbes etc). β-thalassemia mutation using ARMS-PCR; bone marrow engraftment- DNA analysis using HLA typing.
Reference:	1. Williams and Fleming : Spectroscopic Methods in Organic Chemistry. 2. Walker : Techniques in Molecular Biology. 3. Hamilton and Swell : Introduction to HLPC. 4. Ausubel : Short protocols in Molecular Biology. 5. J. Sambrook and T. Maniatis : Molecular Cloning, A laboratory Manual. 6. R.W. Old: Principles of Gene Manipulation: An Introduction to Genetic Engineering

Course Title: Biosafety and Biosecurity	**Course No: BT-4103**	**Credit: 3**	**Year: 4th**	**Semester: 1st**
Rationale: This course is designed to provide general concepts of Biosafety and Biosecurity				
Course Objectives: • Conceptualize general knowledge of Biosafety and Biosecurity • Acquire general knowledge on different areas of Biosafety and Biosecurity • Acquaint with general techniques used in Biosafety and Biosecurity				
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of techniques used in Biosafety and Biosecurity 2. Explain the scope and importance of study of techniques used in Biosafety and Biosecurity 3. Describe the current trends in Biosafety and Biosecurity			

Course Content	**Introduction** Biosafety and biosecurity, Biosafety Principles, Classification of Microorganisms by Risk Group, Microbiological Risk Assessment in the Laboratory **Laboratory Safeguards and Procedures** Daily Safety Performance, PPE, Aerosol Hazards and its minimizing in the Laboratory, Handling and Storage of Hazardous Chemicals, Safety for Support Staff, Emergency Response and Security in the Laboratory, Spill clean-up procedure, Laboratory Safety Programme, Post-work Safeguards and Procedures, **Biological Safety Cabinets** HEPA Filters, Class I, II and III Biological Safety Cabinet, Certification Tests **Laboratory Design and Facilities** Biosafety Levels 1-4, Laboratory Commissioning and Certification **Biosafety and Recombinant DNA in Laboratories** Risk Assessment of rDNA technique, Biosafety regulation relating to recombinant DNA technology, Biosafety Issues for Transgenics **Decontamination and Waste Disposal** Heat Treatments, chemical treatment, Category of waste and their appropriate segregation, Storage, Labeling, and Packaging for Transport, Recycle, Incineration, Land Disposal **Transportation of Infectious and Biological Substances** Categories of Infectious Substances, Packaging instruction, International transport regulations **Biosafety guidelines of Bangladesh**
Reference:	**1.** Laboratory biosafety manual (Third edition, 2004) By World Health Organization.

Course Title: Research Methodology	**Course No: BT-4104**	**Credit: 3**	**Year: 4th**	**Semester: 1st**
Rationale: This course is designed to provide general concepts of Research Methodology				
Course Objectives: This course aims to guide students towards achieving competence and proficiency in the theory of and practice to research. This fundamental objective can be realized through helping the students to develop the subject of their research, skill in the application of research methods, and develop skills required in writing research proposals, research article, research reports, and dissertation.				
Intended Learning Outcomes (ILOs)	*Knowledge and understanding* - familiarity with research methodology in general - familiarity with the methods of the specific field of research in particular *Competence and skills*			

	- the capacity for scholarly analysis and synthesis - the capacity to review and assess new and complex phenomena, issues and situations autonomously and critically - the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively - the ability to plan and use appropriate methods to undertake research and other qualified tasks within predetermined time frames
Course Content	1. Foundations of Research: Meaning, Objectives, Motivation in Research, General Characteristics of Research, Criteria of Good Research, Types of Research 2. Problem Identification & Formulation: Scientific Thinking, What is a Research Problem, Selecting the Problem, Sources of the Problem, Defining a Problem, Statement of a Problem, Delimiting a Problem, Evaluation of a Problem. 3. The Review of Literature: Meaning of Review of Literature, Need of Review of Literature, Objectives of Review of Literature, Sources of Literature, The Functions of Literature, How to Conduct the Review of Literature, Some Hints for the Review of Literature, Precautions in Library Use, Reporting the Review of Literature. 4: The Research Hypotheses: Meaning of Hypothesis, Definitions of Hypothesis, Nature of Hypothesis, Functions of Hypothesis, Importance of Hypothesis, Kinds of Hypothesis, Characteristics of a Good Hypothesis, Variables in a Hypothesis, Formulating a Hypothesis, Testing the Hypothesis. 5. Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design: concept types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. 6. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. 7. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample, Practical considerations in sampling and sample size. 8. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. 9. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Biotechnology, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Need of Publications, Types of Publications (Research Reports, Research Articles, Books, Book Chapter, Thesis, Oral Presentations, News Letters, Letter to Editor etc.), Importance of Publications, Where to Publish, Indexing, Databases--- Scopus and Thomson Reuters, National and International Ranking Frameworks. Citation and Bibliography, Importance of Citations, Citation Styles, Organizing References, Fabrication and Falsification in Research, Plagiarism and its Consequences, Content and Idea Plagiarism, Paraphrasing and Citation, Anti---Plagiarism Tools---Turnitin 10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism. se of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Biotechnology Discipline. 11. Development of Research Proposal: Research Proposal and its elements, Formulation of research problem, criteria of sources and definition, Derivation and operationalization of variables, Developing assumptions and applications
Reference:	1. Research Methodology – C.R.Kothari

Course Title: Oncology	**Course No: BT-4105**	**Credit: 3**	**Year: 4th**	**Semester: 1st**
Rationale: This course is designed to provide general concepts of Oncology				
Course Objectives: • Conceptualize general knowledge of Oncology • Acquire general knowledge on different areas of Oncology • Acquaint with general techniques used in Oncology				

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Oncology 2. Explain the scope and importance of study of Oncology 3. Describe the current trends in Oncology
Course Content	**1. Introduction:** Definition, terminologies of benign and malignant tumors, tumor cell growth, clonality and kinetics of tumor cell growth, host factors affecting tumor cell growth, *in vitro* tumor cell growth, karyotypic changes in tumors. **2. Metastasis:** Pathways and mechanisms of metastasis of some cancer cells. **3. Carcinogenic agents and their cellular interactions:** Chemical carcinogenesis-carcinogenic chemicals, mechanism of chemical carcinogenesis. Radiation carcinogenesis - UV rays, ionizing radiation, mechanism of radiation carcinogenesis, viral carcinogenesis. Oncogenesis - DNA and RNA oncogenic viruses, mechanism of viral oncogenesis. **4. Oncogenes and cancer:** Proto-oncogenes and their functions, oncogenes, activation of proto-oncogenes, tumor Suppressor genes, control of cell cycle check points. **5. Host tumor interactions:** Effect of tumor on host, host defense against tumors. **6. Cancer diagnosis and treatment:** Biochemical tests and laboratory diagnosis of cancer, treatment of cancer, chemotherapy, radiotherapy, surgery, bio-chemotherapy, immunotherapy.
Reference:	

Course Title: Food Biotechnology	**Course No: BT-4106**	**Credit: 3**	**Year: 4th**	**Semester: 1st**
Rationale: This course is designed to provide general concepts of Food Biotechnology				
Course Objectives: • Conceptualize general knowledge of Food Biotechnology • Acquire general knowledge on different areas of Food Biotechnology Acquaint with general techniques used in Food Biotechnology				

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Food Biotechnology 2. Explain the scope and importance of study of Food Biotechnology 3. Describe the current trends in Food Biotechnology
Course Content	**1. Introduction:** Biotechnology: Its role and future in food industry, Importance of microorganism in food Biotechnology. **2. Impact of Biotechnology on major food ingredients:** Physical/chemical changes and improvement of sweeteners, fats, carbohydrates, proteins, bulking agents. Mushroom production and its importance. **3. Biotechnology of milk and Dairy products:** Composition of food value of milk, Pasteurization of milk and methods of pasteurization, Starter culture, yogurt cultured, fermented foods. **4. Food spoilage and Food preservation**: **5. Transgenesis**: Concept of transgene and transgenics, production of transgenic mice, transgenic and transgenic cattle, application of transgenics. Problems after developing transgenic animals. Transgenic animals in agriculture and nutritional science, Transgenic mice for biomedical research. Animal cell culture: Concept, history, Cell culture, limitation and condition. **6. GM food risk for health, agriculture and environment:** Allergies, Antibiotic resistance. Alteration of nutritional value, Loss of biodiversity. Environmental and health impacts of GM crops.
Reference:	**1.** Modern Food Biotechnology, Human Health & Development: An Evidence Based Study. Food Safety Department, World Health Organization. 2005 **2.** King R D, Food technology, John will and Sons, USA. **3.** Kosikowskim F, Cheese and fermented milk product, Comel University, Ithaka, NY. **4.** M.M. Ranga. Animal Biotechnology, 2003 Agrobios (India) **5.** James Jay, Food Microbiology.

Course No: BT-4107 (Lab)	Course Title: Lab in Pharmaceutical and Food Biotechnology
Full Marks: 100	Credit: 1.0

Exp.-1: Screening of antibiotic resistance bacteria from hospital effluent
Exp.-2: Thin layer chromatography of Biological sample
Exp.-3: Study of Colum chromatography
Exp.-4: Natural product extraction and purification
Exp.-5: Preparatory thin layer chromatography
Exp.-6: Evaluation of microbial load from fast food
Exp.-7: Culture of yogurt producing bacteria
Exp.-8: Production of yogurt by specific bacteria.
Exp.-9: Screening of microbes from dairy product
Exp.-10: Screening of gut microbes for probiotic production

Course No: BT-4108 (Lab)	Course Title: Lab in Techniques in Molecular Biology and Oncology
Full Marks: 100	Credit: 1.0

1. Amplification of DNA by PCR
2. Agarose gel electrophoresis
3. Purification of DNA of PCR product from Agarose gel
4. Total protein extraction from natural sources
5. Study of colony hybridization
6. Study of tumor inducing microbes
7. Investigation on carcinogenic material in daily food ingredients.
8. Primer design for identification of oncogene
9. Investigation of cancer causing gene
10. Screening of tumor suppressing bacteria.

Course No: BT-4109 (Lab)	Course Title: Lab in Research Methodology and Biodiversity
Full Marks: 100	Credit: 1.0

1. Preparation of PPT slide on research data
2. Preparation of a research proposal
3. Preparation of a poster for presenting research work
4. Study on data analysis for presenting in research paper
5. Preparation of presentation from research article and review paper
6. Development of research hypothesis
7. Write down review of literature from several articles.
8. Differentiate between research article and dissertation.
9. Study on ecosystem of Local River.

Course No: BT-4110	Course Title: Field work / Industry or research organization visit / Internship in industry
Full Marks: 100	Credit: 1.0

Course No: BT-4111	Course Title: Research Project / Research Idea generation and Presentation
Full Marks: 100	Credit: 1.0

Course No: BT-4112	Course Title: Viva-Voce
Full Marks: 50	Credit: 1.0

Course Title: Bioinformatics and System Biology	**Course No: BT-4201**	**Credit: 3**	**Year: 4th**	**Semester: 2nd**

Rationale: This course is designed to provide general concepts of Bioinformatics & System Biology

Course Objectives:

This course will introduce the student to Bioinformatics & contemporary Systems Biology focused on cells, their constituents and their functions. Biology is moving from molecular to modular. As our knowledge of our genome and gene expression deepens and we develop lists of molecules (proteins, lipids, ions) involved in cellular processes, we need to understand how these molecules interact with each other to form modules that act as discrete functional systems.

Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Bioinformatics & System Biology 2. Explain the scope and importance of Bioinformatics & System Biology 3. Describe the current trends in Bioinformatics & System Biology
Course Content	1. **Introduction of Bioinformatics & Database**: Definition of bioinformatics, development of bioinformatics, tools of bioinformatics, Database, database management system, Types of database, gene bank sequence database, structure databases, Information retrieval from biological databases, NCBI data model, BLAST, MSA, Phylogenetic tree construction, application of omics. 2. **Genomics**: Introduction, genetics to genomics, whole genomes sequencing, genome sequence acquisition and analysis, evolution and genomes, Variation in the human genome, known examples of SNPs that cause diseases, pharmacogenomics, ethical consequences of genomic variations. 3. **Expression Data Analysis**: DNA/RNA microarrays, oligo microarray/chip technology, affymetrix protocol and data generation, spotted microarray technology, cDNA and oligo spotted arrays 4. **Proteomics**: Introduction, protein 3D structures, protein sequencing, protein identifications (2-hybrid system, 2-D gel electrophoresis, mass spectrometry/MALDI-TOF, other arrays), protein interaction networks, measuring protein interactions, large-scale databases of information for protein sequences, structures, functions and interactions; mining of protein databases. 5. **Systems Biology:** Macromolecular interactions: Protein – Protein, Protein – Nucleic acids, Protein – carbohydrates etc. Gene and protein networks. Top down and bottom up approaches in systems biology. Computational methods, tools, and databases in systems biology, their description, analysis and applications to the biological community. Sequence and structure based methods of predicting protein-protein interactions, drug design.
Reference:	1. Campbell & Heyer: *Discovering Genomics, Proteomics, & Bioinformatics.* Pearson Education,(2003). 2. Baxevanis & Ouellette: *Bioinformatics, Methods of Biochemical Analysis Series*, Vol. 43, (2001). 3. Pevzner, P.A.: *Computational Molecular Biology*, MIT Press, (2000). 4. Andreas D. Baxevanis & B. F. Francis Ouellette: Bioinformatics: *A Practical Guide to the Analysis of Genes and Proteins*, 3rd Edition (2004). 5. Systems Biology: Properties Of Reconstructed Networks by Bernhard O. Palsson Cambridge University Press (January 16, 2006) 6. Bioinformatics: A practical approach by Shui Qing Ye. 2008 CRC Press

Course Title: Fermentation and Bioprocess Technology	**Course No: BT-4202**	**Credit: 3**	**Year: 4th**	**Semester: 2nd**

Rationale: This course is designed to provide general concept of Fermentation & Bioprocess Technology

Course Objectives:

- Conceptualize general knowledge of Fermentation & Bioprocess Technology
- Acquire general knowledge on different areas of Fermentation & Bioprocess Technology
- Acquaint with general techniques used in Fermentation & Bioprocess Technology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Fermentation & Bioprocess Technology
2. Explain the scope and importance of study of Fermentation & Bioprocess Technology
3. Describe the current trends in Fermentation & Bioprocess Technology

Course Content

1. **Introduction:**
   Definition of industrial biotechnology, white, red and green biotechnology, importance of industrial biotechnology. Isolation and screening of industrially useful microorganisms, characteristics of an ideal industrial microorganism, techniques for isolation of microorganisms.

2. **Bioreactors:**
   Basic concept of bioreactors, Instrumentation of a typical bioreactor, batch, ideal continuous flow stirred tank reactors (CSTR), packed bed, fluidised bed bioreactors, relationship between batch and continuous biological reactors, tubular and tower reactors, scale up of bioreactors, reactors sterilization process.

3. **Bioprocessing and bioprospecting:**
   Media design for fermentation process, strategies for seed culture maintenance and build up for inoculation of large scale processes, process engineering and instrumentation, Definition of bioprospecting, general approach in bioprospecting.

4. **Product Kinetics and Recovery Operation:**
   Product formation kinetics, effect of inhibitors and activators in batch and chemostat culture of growth linked and non-growth linked product formation. Mechanical separation of cells from fermentation broth, distribution of cells, extraction and other methods of product recovery.

5. **Uses of Immobilized biocatalysts:**

   Applications of immobilized cells and enzymes to industrially important chemicals, food, pharmaceuticals, etc.

6. **Uses of Biomass:**

   Definition and chemical composition of biomass, utilization of biomass for food, fuel and chemicals i.e., commercial production of fructose, silage fermentation, utilization of cellulose.

7. **Recombinant Protein Production in Bacteria and Yeast:**

   Escherichia coli, *Bacillus subtilis*, *S. cerevisiae* expression systems.

Reference:

1. P.F. Stanbury & A. Whitaker: *Principle of Fermentation Technology*, 3rd edition (2016)
2. Brian McNeil, Linda M. Harvey: *Practical Fermentation Technology*, 1st edition (2008)
3. Mansi El-Mansi: *Fermentation Microbiology and Biotechnology*, 2nd edition, (2006).
4. H A Modi: *Fermentation Technology* (Vol: I and II Set), 1st edition (2009).

Course Title: Environmental Biotechnology	**Course No: BT-4203**	**Credit: 3**	**Year: 4th**	**Semester: 2nd**

Rationale: This course is designed to provide general concepts of Environmental Biotechnology

Course Objectives:

- Conceptualize general knowledge of Environmental Biotechnology
- Acquire general knowledge on different areas of Environmental Biotechnology
- Acquaint with general techniques used in Environmental Biotechnology

Intended Learning Outcomes (ILOs)

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

1. Describe various aspects of Environmental Biotechnology
2. Explain the scope and importance of study of Environmental Biotechnology
3. Describe the current trends in Environmental Biotechnology

Course Content

1. Introduction:

Definition of environmental biotechnology, history of environmental biotechnology, environmental factors, principles of microbial ecology, terrestrial environments, aquatic environments, energy sources for ecosystem, productivity, adaptation, interaction between plants, animals and microorganisms.

2. Biodiversity:

Biological diversity-definition, terminology, diversities in plant kingdom, importance of

Biological diversity, benefits and services provided by ecosystems, causes for the losses

of biodiversity, convention on biological diversity (CBD), obligations under CBD,

Biodiversity of Bangladesh, biodiversity conservation.

3. Environmental Pollution:

Origin of pollution, pollutants, air, soil and water pollution, pesticides and herbicides pollution, heavy metal pollution and, oil pollution, crude oil biodegradation.

4. Microbial community:

Structure, diversity and stability of microbial communities, measurement of microbial metabolisms, microbial interactions with some inorganic pollutants, microbial recovery of petroleum and fuel production.

5. Water and Waste treatment:

Liquid and solid waste treatment, waste water and sewage treatment, water treatment and testing, landfills technologies, composting, microbes and geological environment, environmental sustainability, ETP.

6. Bioremediation:

Bioremediation of materials: basic concepts; factors involved in bioremediation; Bioremediation of leather, wool and plastics; biodegradation of recalcitrant industrial wastes and its treatment, structure-recalcitrant relationship, factors affecting the microorganisms to degrade xenobiotics polutant, biodegradation and metabolism of pesticide and aromatic compounds.

7. Microbial Control:

Microbial control of insect, pest, animal pastes, weeds and cyanobacterial blooms, genetic engineering in biological control.

8. Environmental laws and standards:

Reference:

1. *Smith J. E.:* Biotechnology, *5th edition (2009).*
2. *Glick B. R., Pasternak J. J. & Patten CL:* Molecular biotechnology: Principles and Application of Recombinant DNA, *4th edition (2009).*
3. *Fogarty W.M.:* Microbial enzymes and biotechnology, *Elsevier Science Ltd (1983)*
4. *Primrose S.B.:* Modern biotechnology, *Blackwell Science Inc (1987)*
5. *Alexander N. Glazer, Hiroshi Nikaido:* Microbial Biotechnology, Fundamentals of Applied Microbiology, *2nd edition (2007).*

	6. *Alan Scragg:* Environmental Biotechnology, *2nd edition (2005).* 7. *Dara, S.:* Text Book of Environmental Chemistry and Pollution Control, *7th edition (2004).*

Course Title: Cell Signalling	**Course No: BT-4204**	**Credit: 3**	**Year: 4th**	**Semester: 1st**
Rationale: This course is designed to provide general concepts of Cell Signalling				
Course Objectives: • Conceptualize general knowledge of Cell Signalling • Acquire general knowledge on different areas of Cell Signalling • Acquaint with general techniques used in Cell Signalling				
Intended Learning Outcomes (ILOs)	At the end of the course the students will be able to- 1. Describe various aspects of Cell Signalling 2. Explain the scope and importance of study of Cell Signalling 3. Describe the current trends in Cell Signalling			
Course Content	**1. Introduction:** General principles of cell signaling; extracellular signal molecules and their receptors, cellular response to specific combinations of extracellular signal molecules, different response by different cells to same extracellular signal molecules, NO signaling by binding to an enzyme inside target cell, nuclear receptor, G-protein-linked and enzyme-linked receptors. 2. **Signaling through G-protein-linked cell surface receptors:** cAMP and G-protein signaling, role of cAMP-dependent protein kinase (PKA) in mediating effects of cAMP, inositol phospholipids signaling pathway, role of Ca+/calmodulin – dependent kinases in mediating actions of Ca+. 3. **Signaling through enzyme –linked cell surface receptors:** Receptor tyrosine kinases, docking sites 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, PI3-kinase/ protein kinase B signaling pathway, insulin receptor acts through PI3-kinase pathway, cytokine receptors and the JAK-STAT pathway, two components signaling pathway of bacterial chemotaxis. 4. **Signaling pathways that depends on regulated proteolysis:** Activation of notch receptor by cleavage, binding of wnt proteins to frizzled receptors, stressful and proinflammatory stimuli act through NF_kB-dependent signaling pathway. 5. **TGFα signaling receptors:** Activated type ITGα receptors phosphorylate Smad transcription factors, Smad signaling via negative feedback loop, TGFα signaling and abnormal cell proliferation.			
Reference:	1. Glick, B.R. and Pasternak, J.J: Molecular biotechnology 2. J. Sambrook, E. F. Fritsch and T. Maniatis: Molecular cloning- A laboratory manual (Vol I, II, III). 3. Williams: Recombinant DNA. 4. Watson: Molecular biology of gene. 5. R. W. Old and S.B. Primrose, Principles of gene manipulation 6. Robert F. Muller, Ian D Young: Emery's elements of medical genetics. 7. Istavari Rasko and C. Stephen Downes: Genes in medicine. 8. Strachan, T. A. and Read A. P.: Human molecular genetics. 9. Alberts, Johnson: Molecular biology of the cell 10. Lodish, Berk, Matsudaira: Molecular cell biology			

Course No: BT-4205 (Lab)	Course Title: Lab in Fermentation Technology
Full Marks: 100	**Credit: 1.0**

1. Production of Alcohol from rice / molasses / fruits
2. Screening of fermentable substrate
3. Isolation of lactose fermenting bacteria
4. Production of vinegar in laboratory
5. Study on different types of fermenter

Course No: BT-4206 (Lab)	Course Title: Lab in Bioinformatics and system biology
Full Marks: 100	**Credit: 1.0**

Exp.-1: Study of DNA sequence analysis by Bioinformatics tools
Exp.-2: Protein sequence analysis from DNA sequence
Exp.-3: DNA sequence analysis from Protein sequence
Exp.-4: Construction of Multiple sequence alignment
Exp.-5: Construction of Phylogenetic tree
Exp.-6: Study of Primer design
Exp.-7: Study of Protein structure (Primary, Secondary and tertiary- 3D structure)

Course No: BT-4207	Course Title: Lab in Environmental Biotechnology
Full Marks: 100	**Credit: 1.0**

1. Water analysis for total microbial load by standard techniques
2. Determination of BOD of H_2O
3. Determination of COD of H_2O
4. Study on bad effect of pollutants on ecosystem
5. Laboratory diagnosis of fungal infection
6. Study of antagonistic effect of microbes for biocontrol.

Course No: BT-4208	Course Title: Research Project / Survey / Internship in Industry
Full Marks: 100	**Credit: 4.0**

Course No: BT-4209	Course Title: Viva-Voce
Full Marks: 50	**Credit: 1.0**