Syllabus for 4-Year Bachelor of Science (BS) in Biochemistry and Molecular Biology University of Dhaka

Sessions: 2020-2021 and onwards

Syllabus for 4-Year Bachelor of Science (BS)
in
Biochemistry and Molecular Biology
University of Dhaka

Sessions: 2020-2021 and onwards

- Each 4-credit theory course will be of 100 marks, comprising 60 lecture-hours, 3-credit theory course of 75 marks comprising 45 lecture-hours and 2-credit theory course will be of 50 marks comprising 30 lecture-hours.

- Each 4-credit practical course will be of 100 marks comprising 180 hours of laboratory work with 40% marks for continuous assessment and 60% marks for final examination.

- Examination (assessment and final) rules, allotment of marks etc. are given in the Rules and Guidelines for the BS (Honors) degree program under the Grading System.

- As per university rules a student must earn 140 credits within 4-6 academic years after his/ her first admission in the graduation program. He/she must also have earned the minimum required CGPA (2.5 on a 4.00 scale).

1st Year BS (Honors)

Departmental courses:

BMB-101	Biophysical Chemistry	3 Credits
BMB-102	Bioorganic Chemistry	4 Credits
BMB-103	Cells and Biomolecules	2 Credits
BMB-104	Peptides and Proteins	2 Credits
BMB-105	Molecular Biology-I	2 Credits
BMB-106	Laboratory Work	4 Credits
BMB-107	Viva-voce	2 Credits

Extra-departmental courses:

BMB-151	Foundation Course in English	2 Credits
BMB-152	Basic Microbiology	2 Credits
BMB-153	Basic Biology and Biodiversity	2 Credits
BMB-154	Introduction to Applied Biology	3 Credits

Total Credits in 1st Year BS (Honors): 28 Credits

2nd Year BS (Honors)

Departmental courses:

BMB-201	Enzymes	4 Credits
BMB-202	Carbohydrate Metabolism	4 Credits
BMB-203	Biological Membrane and Lipid Metabolism	3 Credits
BMB-204	Endocrinology	3 Credits
BMB-205	Molecular Biology-II	4 Credits
BMB-206	Laboratory Work	4 Credits
BMB-207	Viva-voce	2 Credits

Extra-departmental courses:

BMB-251	Human Physiology	4 Credits
BMB-252	Computer Basics and Data Analysis	4 Credits

Total Credits in 2nd Year BS (Honors): 32 Credits

3rd Year BS (Honors)

Departmental courses:

BMB-301	Metabolism of Nitrogenous Compounds	4 Credits
BMB-302	Biochemistry of Natural Products	2 Credits
BMB-303	Human Nutrition	4 Credits
BMB-304	Molecular Biology-III	2 Credits
BMB-305	Molecular Genetics	4 Credits
BMB-306	Plant Biochemistry	2 Credits
BMB-307	Basic Immunology	2 Credits
BMB-308	Clinical Biochemistry	4 Credits
BMB-309	Laboratory Work	8 Credits
BMB-310	Viva-voce	2 Credits

Extra-departmental courses:

BMB-351	Applied Biostatistics	4 Credits
BMB-352	Microbiology	2 Credits

Total Credits in 3rd Year BS (Honors): 40 Credits

4th Year BS (Honors)

Departmental courses:

BMB-401	Cell Biology	4 Credits
BMB-402	Plant Biotechnology	2 Credits

BMB-403`	Pharmaceutical and Food Biotechnology	4 Credits
BMB-404	Molecular Biology-IV	2 Credits
BMB-405	Biochemistry of Cancer	2 Credits
BMB-406	Virology	2 Credits
BMB-407	Immunology	4 Credits
BMB-408	Biochemistry of Drugs	2 Credits
BMB-409	Neurobiochemistry	2 Credits
BMB-410	Applied Human Nutrition	2 Credits
BMB-411	Basic Bioinformatics	2 Credit
BMB-412	Research Methodology	2 Credits
BMB-413	Laboratory Work	8 Credits
BMB-414	Viva-voce	2 Credits

Total Credits in 4th Year BS (Honors): 40 Credits

Grand total for BS (Honors) program: 140 Credits

1st Year BS (Honors)
Dep0artmental courses:

BMB-101	Biophysical Chemistry	3 Credits
BMB-102	Bioorganic Chemistry	4 Credits
BMB-103	Cells and Biomolecules	2 Credits
BMB-104	Peptides and Proteins	2 Credits
BMB-105	Molecular Biology-I	2 Credits
BMB-106	Laboratory Work	4 Credits
BMB-107	Viva-voce	2 Credits

Extra-departmental courses:

BMB-151	Foundation Course in English	2 Credits
BMB-152	Basic Microbiology	2 Credits
BMB-153	Basic Biology and Biodiversity	2 Credits
BMB-154	Introduction to Applied Biology	3 Credits

Total Credits in 1st Year BS (Honors): 28 Credits

BMB-101: Biophysical Chemistry **3 Credits**

1. **Thermodynamics:**
   i) First law of thermodynamics: Introduction, system, boundary, surroundings, intensive and extensive properties, thermodynamic processes, nature of heat and work, PV work, maximum work, first law of thermodynamics - internal energy, enthalpy, molar heat capacities, isothermal and adiabatic expansion, mathematical problems.

   ii) Thermochemistry: Exothermic and endothermic reactions, standard enthalpy of formation, thermochemical equations, reaction enthalpy - dependence on temperature,

bond energy.

iii) Second law of thermodynamics: Thermodynamics-reversibility and irreversibility, spontaneous processes, entropy, thermodynamic efficiency and Carnot's theorem, statements of second law, entropy changes - phase transition, heating, irreversible processes. Third law of thermodynamics.
Free energy - variation with temperature and pressure, Gibbs-Helmholtz equation, applications of thermodynamics in biochemistry, biochemical relevance of classical thermodynamics, open systems.

2. **Chemical equilibrium:** Nature of chemical equilibrium, law of mass action, equilibrium constant, equilibrium constant for different reactions, calculating equilibrium constant of reactions, predicting the direction of a reaction, calculating equilibrium concentrations, relationship between ΔG and Keq, effect of temperature and pressure, Le Chatelier's principle, equilibrium reaction involving protons, coupling of reactions. Applications in living systems.

3. **Chemical kinetics:** Definition, reaction rate, rate laws, zero-, first- and second-order reactions, molecularity of a reaction, pseudo-first order reaction, half-life, determination of order and rate constant, effect of temperature on reaction rates. Theories of reaction rates – the collision theory, the activated complex theory. Catalysis - definition, types, characteristics of catalysts, activation energy and catalysis.

4. **Acids and bases:** Bronsted-Lowry concept, Lewis concept, strengths of acids, strong and weak acids and bases, pH, numerical problems based on pH, buffer solutions. Henderson-Hasselbalch equation, numerical problems based on buffers, buffering against pH changes in biological systems, maintaining the pH of blood, acid-base titration, indicators: types of indicators, choice of suitable indicators.

5. **Properties of liquids (brief treatment):** Introduction – kinetic molecular description, intermolecular forces in liquids, dipole-dipole forces, ion-dipole forces, dispersion forces, hydrogen bond, dielectric constant, surface tension, viscosity, diffusion and osmosis, osmotic pressure, isotonic solutions, reverse osmosis, phase rule, components, degrees of freedom, phase diagram of one component system, phase diagram of water, ionization of water, water as a reactant.

6. **Spectrophotometry:** Beer-Lambert law, standard curves, working principle of a spectrophotometer.

References:

1. Essential of Physical Chemistry by ArunBahal, BS Bahl and GD Tuli.
2. Chemistry by Raymond Chang.
3. Principles of Biochemistry by Nelson, D. L. and Cox, M.M. Lehninger,
4. Physical Chemistry for the Biosciences by Raymond Chang

BMB 102: Bioorganic Chemistry **4 credits**

1. **Physico-chemical parameters for biomolecules:** Inter- and intra-molecular interactions: covalent bond, ionic bond, dative (coordinate covalent) bond, hydrogen bonding, hydrophobic interactions, Van der Waals interaction (London forces) with special references to their presence in biomolecules, hybrid orbitals, polarity of bonds, electronegativity, dipole.

2. **Nature of bonding in organic molecules and in relation to biomolecules:** Delocalized chemical bonding-conjugation, resonance, tautomerism hyperconjugation, bonding in fullerenes.

3. **Aliphatic hydrocarbon:** Homologous series. Alkanes, alkenes, alkynes-their synthesis and properties (briefly). The S_N2, S_N1 reactions mechanisms with references to biological systems, single electron transfer (SET) reactions. Mechanisms of addition reactions, mechanisms of elimination reactions with special references to biological systems.

4. **Aromaticity and aromatic reaction mechanisms:** Structure of benzene, sources of aromatic hydrocarbons, industrially important aromatic compounds, nomenclature of benzene derivatives, electrophilic and nucleophilic aromatic substitution, chemistry of aromatic aliphaticcompounds**.** Mechanisms of aromatic electrophilic substitution reactions, mechanisms of aromatic nucleophilic substitution reactions: bimolecular displacement mechanism, elimination-addition mechanism (benzene).

5. **Dienes:** Structure and properties of 1, 3-butadiene, addition reactions, polymerization, different types with examples. Natural polymer-rubber (composition and mechanism of formation). Diels-Alder and other reactions of dienes.

6. **Stereochemistryand stereoisomerism:** Chirality, chiral centre, polarimeter, plane polarised light and optical activity, specific rotation, enantiomers, diastereoisomers, meso compounds, racemic mixtures, racemic modifications, chiral biological molecules, biological importance of chirality, the R-S (rectus-sinister) system.

7. **Alcohols, ethers, epoxides and diols:** Occurrence, nomenclature, structure, synthesis, physical and chemical properties and their uses.

8. **Aldehydes and ketones:** Nomenclature, important biochemical carbonyl compounds, synthesis, mechanisms of carbonyl compound reactions: nucleophilic addition, addition-elimination, enolization-ketonization. Oxidation and reduction of carbonyl compounds, haloform reaction, enolisation in biological system, α-halocarbonyl compounds, aldol condensation, benzoin condensation, Claisen condensation, crossed aldol condensation, Perkin condensation, Mannich condensation, Claisen-Schmidt condensation. Wittig reaction, Reformatsky reaction.

9. **Rearrangement reactions**: Wagner-Meerwein rearrangement, pinacol-pinacolone rearrangement, Hoffman rearrangement, Beckmann rearrangement. Biological rearrangements.

10. **Carboxylic acids and their derivatives:** Nomenclature, synthesis, classification, properties, reactions, uses, decarboxylation reactions, dicarboxylic acids, acid chlorides, esters, acid amides, imides and acid anhydrides, soaps and detergents, biodegradable detergents.

11. **Aromatic and aliphatic nitro-compounds and amines:** Occurrence,nomenclature, synthesis, classification, properties, reactions, uses, diazonium compounds. Mechanism of diazotization and Sandmeyer reactions.

12. **Phenols:** Occurrence, nomenclature, synthesis, properties and reactions, polyhydric phenols.

13. **Heterocyclic compounds:** Chemical nature, classification and synthesis, with special reference to pyrroles, pyridines, pyrimidines and purines by mentioning their roles in biochemistry and biological systems.

References:

1. A text book of organic chemistry by Arun Bahl, B.S Bahl.
2. Organic chemistry by Robert Thomton Morrison and Robert Neilson Boyd.
3. Advanced Organic Chemistry. Reactions, Mechanisms and Structure. Jerry March. *Johm Willey & Sons, Inc.*
4. Organic Chemistry. Stereochemistry and Chemistry of Natural Products. I.L. Finar. *English Language Book Society/ Longman.*
5. Organic Chemistry. TW Fraham Solomons and Craig B Fryhle. John Wiley & Sons.

BMB-103: Cells and Biomolecules **2 Credits**

1. **History, scope and future of biochemistry**: The molecular logic of life; understanding the science of biochemistry; role of biochemistry in medicine, health and agriculture; application of biochemistry based on recombinant DNA technology in immunology, industry, diagnostics.
2. **Cells and organelles and their composition:** Isolation, identification and functional characteristics of organelles; comparison of prokaryotic and eukaryotic cells, common structural features of bacterial cells.
3. **Amino acids:** Classification, structural features, physico-chemical properties involving titration, buffering capacity, acid-base properties, characteristic chemical reactions, optical behavior, essential amino acids, nonstandard amino acids, synthesis of important biomolecules.

4. **Carbohydrates:** Monosaccharides and their biological properties, color reactions of carbohydrates, important derivatives of monosaccharides, sugar acids, important reactions of carbohydrates. Disaccharides and oligosaccharides of biological importance - maltose, lactose, sucrose and other disaccharides. Polysaccharides –storage and structural polysaccharides; structures and function of starch, glycogen and cellulose; other polysaccharides of biological interests – chitin, peptidoglycan; biological degradation of storage polysaccharides; artificial sweeteners; dextrans. Glycosaminoglycans and proteoglycans - structures and functions.
5. **Lipids:** Chemical nature, biological functions, classification with representative examples, fatty acids - nomenclature, saturated and unsaturated fatty acids and fats, essential fatty acids; triacylglycerol, phospholipids, sphingolipids, cerebrosides, gangliosides, action of phospholipases on membrane phospholipids; saponification value, iodine number, acid number, rancidity etc. with their significance, steroids and their importance (in brief); very brief idea about prostaglandins, prostacyclines, thromboxanes and leukotrienes along with their physiological importance.

References:

1. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox
2. Textbook of Biochemistry by Edward Staunton West, Wilbert R Todd, Howard S Mason, John T Van Bruggen
3. Text Book of Biochemistry with Clinical Correlations, 4th Edn., by Thomas M. Devlin.
4. Molecular Biology of the Cell. Bruce. Alberts, Denneis Bray, Julian Lewis, Martin Raff, Keith, Roberts, James, D. Watson. *Garland Publishing Inc.*

BMB-104: Peptides and Proteins **2 Credits**

1. **Peptides:** Characteristic properties, peptides of biological importance.
2. **Protein:** General introduction, classification of proteins based on biological functions and nutritional values.
3. **Protein structure:**
   i) Primary structure of proteins: Sequencing of proteins, sequence homology.
   ii) Fibrous proteins: Secondary structure of proteins, protein conformation, planar peptide bonds, α-helix, helix forming and destablizing amino acids, α- and β-keratins – conformation and structure, structures of collagen and elastin, filamentous proteins – actin, myosin and microtubules.
   iii) Globular proteins: Tertiary and quaternary structures of proteins, distinctive tertiary structures of myoglobin and ribonuclease, renaturation of ribonuclease, factors maintaining the tertiary structure of globular proteins, oxygen-binding curves of hemoglobin and myoglobin, cooperative binding of oxygen by hemoglobin, factors contributing to oxygen saturation curve of hemoglobin, sickle-cell anemia and its relation to hemoglobin.

iv) Protein denaturation: denaturing agentsand their mode of action, measure of denaturation processes using Anfinsen experiment.

4. **Exploring proteins - protein isolation, purification and characterization:**

i) Salting-in and salting out, isoelectric precipitation, dialysis, gel filtration, chromatography - ion-exchange and affinity chromatography, HPLC, electrophoresis – SDS-polyacrylamide gel electrophoresis, isoelectric focusing.

ii) Molecular weight determination by ultracentrifugation, SDS-PAGE, 2-D gel electrophoresis.

References:

1. Lehninger Principles of Biochemistry by Nelson, D. L. and Cox, M.M.
2. Text Book of Biochemistry with Clinical Correlations, by Thomas M. Devlin.
3. Text of Biochemistry. ES West, WR Todd, HS Mason and JT Van Bruggen. Macmillian Company.
4. Biochemistry (Lippincott Illustrated Reviews) by Richard A. Harvey, Denise R. Ferrier.

BMB-105: Molecular Biology-I **2 Credits**

1. **Heredity:** Mendel's laws of inheritance, gene concept, conceptual relationship between gene and chromosomes, and gene and enzymes.
2. **DNA as genetic material:** Griffith's experiment to prove the presence of a transforming principle, Avery, MacLeod and McCarty's experiment to determine that DNA and not RNA or protein was the transforming principle, further validation by Hershey and Chase.
3. **Chemistry of nucleic acids:** Classification and composition of nucleic acids, bases, sugars, nucleosides, nucleotides and polynucleotides.
4. **DNA structure:** Watson and Crick model and its characteristics, isolation of DNA from natural sources, its physicochemical properties.
5. **Gene expression:**

i) Replication as continuity of transfer of genetic information.

ii) Transcription, types of RNAs, their characteristics and function.

iii) Translation leading to functional protein synthesis, colinearity of genes and proteins.

6. **Application of Molecular Biology:** Concept -

i) Recombinant DNA technology – isolation of genes, restriction endonuclease, vectors, cloning and expression of cloned genes.

ii) Agricultural and industrial applications with examples.

iii) Application in medical and related fields – forensic studies, detection of molar diseases, pharmaceutical production, gene therapy.

iv) Some molecular biology techniques – polymerase chain reaction, DNA fingerprinting, DNA mapping, use of genetic markers, DNA sequencing.

7. **Recombinant DNA technology:** Concept and controversies of genetically modified organisms (GMOs).

References:

1. Molecular Biology made simple and fun, by David P. Clark; Lonnie D. Russell.
2. Lehninger Principles of Biochemistry, by David L. Nelson and Michael M. Cox.
3. Genetics: A Conceptual Approach, by Benjamin A. Pierce.
4. Principles of Genetics, by D. Peter Snustad, Michael J. Simmons.
5. Molecular Biology of the Cell. Bruce. Alberts, Denneis Bray, Julian Lewis, Martin Raff, Keith, Roberts, James, D. Watson. *Garland Publishing Inc.*
6. Cell and Molecular Biology. E.D.P. DeRobertis and E.M.F. DeRobertis. *Wavertev.*

BMB-106: Laboratory Work **4 Credits**

1. Use of electronic balances and preparation of standard solutions.
2. Standardization of HCl by titrimetric method.
3. Estimation of acetic acid content of vinegar by titrimetric method.
4. Estimation of calcium from milk by titrimetric method.
5. Estimation of iron from Mohr's salt and commercial iron tablets by dichromate method.
6. Estimation of ascorbic acid content of biological samples and vitamin C tablets by Bessel's titrimetric method.
7. Identification of organic compounds (elements and functional groups including Nitrogen, Sulphur, Halogen, aldehydes, ketones, carboxylic acids, phenols, amines and amides); Molisch test.
8. Determination of saponification number of fat or oil.
9. Determination of iodine number of fat or oil.
10. Determination of lactose content of milk by Benedict's method.
11. Determination of λ-max and verification of Beer-Lambert law by using Spectrophotometer.
12. Determination of serum protein content by the biuret method.
13. Determination of glucose content of serum by Nelson - Somogyi method.
14. Estimation of copper content of a solution by iodometric method.

BMB-107: Viva-voce **2 Credits**

Extra-departmental courses:

BMB-151: Foundation Course in English **2 Credits**

1. **Speaking:** This segment is aimed at improving students' speaking ability so that they can communicate freely in a good range of situations. This course will also help students reduce their shyness, nervousness and inhibition in speaking. This segment will include, but will not be limited to, the following functions/items:

- Introducing yourself and others.
- Expressing likes and dislikes, personal experiences, past habits, requests and offers, apologies and excuses, inviting, comparison and contrast.
- Describing people/place/things, narrating action and events, saying numbers and time.

- Giving and following instructions, asking for and giving direction.
- Reporting, complaining, suggesting.
- Role-plays in various authentic situations.
- Participating in debates, making extempore speech.
- Seminar presentations and interviews.
- Phonetics (IPA symbols; using a dictionary for pronunciation; phonetic transcriptions; intonation and stress).

2. Reading: This segment is mainly designed to provide the students an opportunity for reading, and understanding variety of texts and improving their communication skills and analytical capability, especially through effective reading. Reading should also involve activities and discussions that finally lead to effective writing.

Strategies of reading - Predicting, skimming, scanning, inferencing, and analyzing selected texts:

- Variety of texts reflecting common interests.
- Special texts related to students' major courses.

3. Writing: Students will learn the principles of and practice effective writing of different lengths. They should be able to write well-organized paragraphs and essays along with other types. They are expected to gain an understanding of the underlying principles of effective writing styles, to gain an understanding of the importance of the organization techniques of writing adapting to a variety of audiences and occasions and to demonstrate an ability to prepare and deliver effective written response s.

Item/Activities:

- Teaching the writing process - brainstorming, outlining, drafting and editing/proofreading. Paragraph development - paragraph structure, transitional devices/connectives.
- Paragraph types - descriptive, narrative, process analysis, cause and effect, argumentative etc.
- Essay writing - essay structure, thesis statement, introduction and conclusion, and different essay types.
- Writing formal letters.
- Report writing - academic reports, newspaper reports, lab reports etc.
- Miscellaneous - combining sentences, summary/paraphrase writing.

4. Listening: This segment will introduce students to diverse speakers and types of English. Listening comprehensions focusing on varying elements of vocabulary and structures will be practiced. Students will be taught how to be an active listener to obtain information and understand the key ideas.

Class practice will include listening to tapes suitable for students' needs.

5. Grammar: Grammar teaching will involve remedial work. Much of the language will be contextualized and will encourage students to study meaning as well as form. The grammar exercises and editing works will help students overcome all sorts of grammatical problems.

References:

1. Intermediate English Grammar by Raymond Murphy.
2. From Paragraph to Essay by Imhoof M. & Herman H.

3. Practicing Faster Reading by Mosback G & Mosback V.
4. Writing a College Handbook by Hefferman AWJ.
5. Effective Reading by Simon G.& Swan M.
6. English Phonetics and Phonology by Peter Roach.
7. Ship Or Sheep? by Ann Baker.

BMB-152: Basic Microbiology **2 Credits**

Theory: 40 Marks

1. **Overview of History of Microbiology:** Definition and scope of microbiology, naming and classifying microorganisms (Bacteria, Fungus, Protozoa, Algae and Virus) – binomial nomenclature, five kindom concept and eight kindom concept, general characteristics and functions of microbes; history of microbiology; theories of spontaneous generation; contributions of scientists in microbiology - Robert Hooke, Antonie van Leeuwenhoek, Francisco Redi, Lazzaro Spallanzani, John Needham, Louis Pasteur, John Tyndall, Joseph Lister, Alexander Fleming, Edward Jenner; the germ theory of diseases - Koch's postulates, applications of microbiology and the future.

2. **Microscopes**: Microscopy and different types of microscope - light microscope, phase contrast microscope, fluorescence microscope, electron microscope.

3. **Stains and staining techniques:** Definition of different types of stain and classification of stains; Gram staining; acid fast staining; negative staining; staining capsule, flagella and endospore.

4. **Bacteria**: Bacterial cell structure, classification of bacteria, nutritional requirement of bacteria; classification based on requirements of nutrients, oxygen, temperature, pH; growth media types and composition; inoculation and bacterial growth in nutrient broth and agar media; bacterial growth curve; F^+, F' and Hfr; factors affecting bacterial growth; isolation of bacteria from natural sources, preparing pure culture; enumeration of bacteria and maintenance of pure culture.

5. **Viruses (basic concepts):** Importance of viruses; chemical and physical characteristics of viruses; classification of viruses; virus cultivation and enumeration through plaque assay; structure of viruses – capsid symmetry, enveloped and non-enveloped viruses; lytic and cycle and lysogeny; concepts of viroids; cytopathic effect and host cell transformation by viruses; importance of bacterial virus e.g., λ-phage, T-phages; plant viruses e.g., TMV and animal viruses e.g., HBV, HSV, HIV, polio virus.

6. **Parasitology (brief understanding)**: Characteristics of protozoa, structure, life cycle, epidemiology, pathogenesis, diagnosis and treatment involving *Plasmodium sp*, *Trypanosoma sp*, *Leishmania sp*.

Practical: 10 Marks

1. Learning safety rules and uses of equipments of a common microbiology laboratory.

2. Learning the techniques of sterilization.
3. Practical uses of microscope.
4. Preparation of bacterial culture media (agar/ broth).
5. Isolation of bacteria by: streak / spread/ pour plate methods from water, food and others natural samples.
6. Identification of bacteria through biochemical tests – (i) acid production (ii) starch hydrolysis (iii) indole production.
7. Gram staining of gram-positive and gram-negative bacteria
8. Test for phenol sensitivity

References:

1. Microbiology by Chan ECS, Pelczar MJ. Jr., Krieg NR.
2. Prescott's Microbiology by Joanne Willey, Linda Sherwood, Chris Woolverton.
3. Fundamentals of Microbiology. IE Aleamo. Addison-Wesley Publishing Company.

BMB-153: Basic Biology and Biodiversity **2 Credits**

Theory: 40 Marks

1. **Plants and animals**: Economic importance, ecological and future importance.

2. **Plant pathology**: Definition of diseases in plants, plant diseases, their causes, diagnosis and control. Major pests - concept, modes of damage. Control of insects and pests in prevention and control of diseases, integrated pest management (IPM), biochemical defenses in plants.

3. **Animal pathology**: Feed, diseases, maintenance and health.

4. **Evolution and biodiversity**: Evolution -tree of life (TOL), scientific basis of TOL, explanation of TOL, genetic basis of TOL, story of the first cell and the energy source, evolution of eukaryotic cells,RNA world hypothesis. Biodiversity - concept, types, values and conservation in plants and animals. Ecosystem and habitats in plants - ecological features of hydrophytes, xerophytes and halophytes (mangroves). Ecosystem and habitats in animals - adaptations in arctic, temperate and tropical zones.

Practical: 10 Marks

1. **Plant pathology**:Major world-wide fungal diseases and examination of prepared slides.
2. **Plant breeding technologies**:Stomatal size and density as a function of different plants - simple sections and microscopic observations
3. **Animal physiology**:Collection of animal blood; **s**imple dissections of mice and collection of

muscle tissues, brain, heart and liver; slide observations.

References:

1. Plant Pathology by Agrios GN.
2. Bangshagatibidhya by Akhtaruzzaman M.
3. Introduction to Plant Breeding by Chaudhary RC.
4. Vascular Plant Taxonomy by Dirk RW, David JK and Zack EM.
5. Plant Anatomy by Esau K.
6. Environment and Plant Ecology by Etherington.
7. BangshagatiBidyarMulkatha by Islam AS.
8. Parasitology by Chatterjee KD.
9. Biodiversity and Conservation by Jeffries MJ.
10. Modern Textbook of Zoology: Invertebrates by Kotpal RL.
11. Protozoology by Kudo.
12. A Textbook of Vertebrate Zoology by Prasad SN and Kashypap V.
13. Foundations of Parasitology by Schmidt GD and Roberts LS.
14. General Zoology by Storer TI, Usinger, RL, Stebbins RC and Nybakken JW

BMB-154: Introduction to Applied Biology **3 Credits**

Theory: 65 Marks

1. **Health and Diseases:** Human diseases, infectious and non-infectious**;** etiology of disease, strategies and technologies for pathogen detection. Understanding disease prevention: immunity, vaccination, nutrition and role of gut microbiomes. Molecular basis of disease (basic aspect): diabetes, cholera, Parkinson disease.

2. **Agriculture:** Impact of urbanization and natural calamities on agriculture**;** green revolution vs. sustainable agriculture; minimizing the impact on the natural environment. Sustainable agricultural practices such as conservation agriculture and ecological intensification. Soil health and Rhizosphere. Role of endophytes in plant resilience. Soil health: conservation agriculture, ecological intensification, fertilizer and PGPRs. Food chains, food web and pyramids of biomass and energy and their effect on human preferences. Biotechnology in animal improvement.

3. **Food Security:** Population growth and the food crisis; basic plant physiology; adaptation to the environment in plants; evolutionary principles in crop plants and their applications; seed banks, gene banks and databases; designing the crops for the future; marker-assisted plant breeding, genetically modified plants and gene-edited plants. Biosafety oversights and compliance.

4. **Energy for a sustainable world**: Renewable energy, biofuels, waste management, reduction green-house gases.

5. **Industrial Biotechnology and Therapeutics:** Application of microbes and enzymes in food, textile and tannery industries. Sources, uses of drugs**;** search for new drugs; lead compound,

major steps in drug development**,** development of new vaccines. Artificial blood development, re-engineering of artificial blood.

6. **Ecology and Environment:** Effect of anthropometry on geochemical cycles; environmental and industrial pollution - air, water, thermal, sound; biochemical and molecular approach to control environmental pollution, bioremediation. Genetic rearrangement of microbes to clean up environment.

Practical: 10 Marks

1. Assignment/Field Visit

References:

1. Applied Biochemistry and Bioengineering by Lemuel Wingard.
2. Biology by Peter Raven, George Johnson, Kenneth Mason, Jonathan Losos, Susan Singer.
3. Environmental Biology by Allan M. Jones.
4. Biotechnology for Green Energy: Biofuels (Pocket K No. 24).
5. Evolution in Health and Disease by Stephen C. Stearns.
6. Industrial Biotechnology by Varun Shastri.
7. Drugs-From Discovery to Approval 1st Edition by Rick Ng.
8. Adaptation to climate change in agriculture in Bangladesh: The role of formal institutions by Md Torikul Islam, Melissa Nursey-Bray.
9. Nothing left to waste: The prospects for faecal sludge-based organic fertiliser in Bangladesh by Digbijoy Dey, AT M Ridwanul Haque, Babar Kabir, Elisabeth Kvarnström, Peter McIntyre, Sharmin Farhat Ubaid.

2nd Year BS (Honors)

Departmental courses:

BMB-201	Enzymes	4 Credits
BMB-202	Carbohydrate Metabolism	4 Credits
BMB-203	Biological Membrane and Lipid Metabolism	3 Credits
BMB-204	Endocrinology	3 Credits
BMB-205	Molecular Biology-II	4 Credits
BMB-206	Laboratory Work	4 Credits
BMB-207	Viva-voce	2 Credits

Extra-departmental courses:

BMB-251	Human Physiology	4 Credits
BMB-252	Computer Basics and Data Analysis	4 Credits

Total Credits in 2nd Year BS (Honors): 32 Credits

2nd Year BS (Honors)

Departmental courses:

BMB-201	Enzymes	4 Credits
BMB-202	Carbohydrate Metabolism	4 Credits
BMB-203	Biological Membrane and Lipid Metabolism	3 Credits
BMB-204	Endocrinology	3 Credits
BMB-205	Molecular Biology-II	4 Credits
BMB-206	Laboratory Work	4 Credits
BMB-207	Viva-voce	2 Credits

Extra-departmental courses:

BMB-251	Human Physiology	4 Credits
BMB-252	Computer Basics and Data Analysis	4 Credits

Total Credits in 2nd Year BS (Honors): 32Credits

BMB-201: Enzymes 4 Credits

1. **Enzymes:** Basics concepts – characteristics, classification, catalytic properties, lowering of activation energy, prosthetic group, coenzyme, cofactor, concept of specificity of enzyme, identification of residues at active sites and effect of substrate concentration, temperature and pH on enzyme activity; activity unit, specific activity, turnover number. Different methods for enzyme assay.
2. **Enzyme kinetics:** Michaelis-Menten equation, K_m and V_{max} determination and their significance; enzyme inhibition – reversible and irreversible, determination of nature of enzyme inhibition, using Line weaver Burk curve and citing examples, use of specific enzyme inhibitors as drugs.
3. **Coenzymes*:*** Roles of coenzymes in enzyme catalyzed reactions with reference to the following coenzymes: NADH, FADH, CoA, TPP, pyridoxal phosphate, biotin and tetra hydrofolate.
4. **Enzyme regulation:** Specific examples be cited in each category of regulation, Importance of enzyme regulation, covalent modification for enzyme regulation; *de novo* synthesis and enzyme breakdown as regulatory means, allosteric regulation showing concept of cooperativity; Hill equation, models of cooperation, isoenzymes, their distribution, regulatory role in metabolic flux, if any; zymogen, and their significance in metabolism, substrate cycles.
5. **Enzyme catalytic mechanisms:** To understand that enzymes bind substrates at the active site, stabilize transition state and provide functional groups that make and break bonds required - specific examples: (i) Ribonuclease, (ii) Carbonic anhydrase. (iii) Chymotrypsin. (iv) Lysozyme (v) Carboxypeptidase
6. **Novel enzymes*:*** Characteristics and their utility, examples like Ribozymes, abzymes. Novel enzymes for the degradation of cellulose.
7 **Membrane bound enzymes*:*** Characteristic properties biological importance,

representative examples with their functional aspects including ATPases and retinol dehydrogenases.

8. **Enzymes in industries:** Brief idea about present use and future prospect. Enzymes in biofuel production.

9. **Enzymes in cell signaling:** Classification of signal transducing receptors with special reference to the following:
   (i) Receptor tyrosine kinases
   (ii) Receptor serine / threonine kinases (RSKS).

References:

1. Principles of Biochemistry by Nelson, D. L. and Cox, M.M. Lehninger, (2017)
2. Textbook of Biochemistry by Donald Voet, Judith G. Voet. (2012)
3. Biochemistry by Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. (2012)
4. Enzymes. M Dixon and EC Webb. Associated Press. (1979)

BMB-202: Carbohydrate Metabolism **4 Credits**

1. **Bioenergetics:** Bioenergetics and thermodynamic principle, high energy compounds, ATP cycle, ATP in metabolism

2. **General aspects of metabolism:** Characteristics, study of metabolic intermediates to determine metabolic pathway

3. **Carbohydrate metabolism:** Digestion and absorption of carbohydrates, availability of glucose to cells, receptor mediated glucose entry and involvement of hormone in entry process, types of GLUTs.

4. **Glycolysis and pentose phosphate pathway:** The pathway showing individual steps, aerobic and anaerobic aspects, energetics, regulation of glycolysis, anaerobic glycolysis and its physiological importance, glucose metabolism in premature babies, feeder pathways –entry of other mono- and di-saccharides in glycolytic pathway. Pentose phosphate pathway.

5. **TCA cycle:** Overview of tricarboxylic acid cycle, the cyclic pathway and its regulation, energetics of the total oxidation of glucose, anapleorotic pathways, amphibolic nature of TCA cycle, futile cycle. The glyoxylate cycle.

6. **Electron transport and oxidative phosphorylation:** Shuttles across mitochondrial membrane, mitochondrial structure and compartmentalization of respiratory metabolism, the evolution of electron transport chain, oxido-reduction and electron transport; oxidative phosphorylation, inhibitors and uncouplers of oxidative phosphorylation, disorders due to deficiencies of mitochondrial enzymes/proteins.

7. **Glycogen metabolism:** Biosynthesis and coordinated regulation of glycogen synthesis and breakdown, role of insulin and glucagon in glycogen metabolism.

8. **Biosynthesis of carbohydrates:** Gluconeogenesis and its regulation, biosynthesis of di- and oligo-saccharides, biosynthesis of glycoproteins, proteoglycans, interconversion of saccharides (sugars); glucuronic acid pathway; pathway for ascorbic acid biosynthesis.

9. **Carbohydrate metabolism disorders:** glycogen storage diseases; galactosemia; fructose intolerance; lactose intolerance, pyruvate metabolism disorders, hypoglycemia; hyperglycemia and diabetes (brief outline).

References:

1. Principles of Biochemistry by Nelson, D. L. and Cox, M.M. Lehninger, (2017)
2. Textbook of Biochemistry by Donald Voet, Judith G. Voet. (2011)
3. Biochemistry by Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. (2012)

BMB-203: Biological Membrane and Lipid Metabolism 3 Credits

1. **Biological membranes:** Membrane **s**tructure - chemical composition of membranes, micelles, lipid bilayers and liposomes, structure of biological membranes. Movement of molecules through membranes, ion channels and carriers, the membrane potential, K^+, Na^+ and Ca^{++} channels and their biological functions, aquaporins, uniporters, symporters and antiporters, specific transporters - the Na^+ transporter, the Ca^{++}-ATPase and the F_1F_O-ATPase.

2. **Lipid metabolism:** Brief overview of lipid metabolism, digestion; absorption; transportation of lipids; plasma lipoproteins - compositions and metabolism, fatty acid oxidation, ketone body formation and utilization, fatty acid biosynthesis, regulation of fatty acid metabolism, storage of fatty acids as triglycerides, utilization of fatty acids for energy production, metabolism and functional role of polyunsaturated fatty acids, cholesterol metabolism, arachidonate metabolism, prostagladins, prostacycline, thromboxane and leukotrienes, phospholipid metabolism, sphingolipid metabolism, bile acid metabolism.

3. **Disorders of lipid metabolism:** Stress, fatty acids and myocardial infarction, genetic deficiencies in carnitine or carnitine palmitoyl transferase, sudden infant death syndrome (SIDS), Refsum's disease, respiratory distress syndrome, sphingolipidoses, Gaucher's disease, diseases associated with lipoproteins and cholesterol metabolism.

References:

1. Text Book of Biochemistry with clinical correlation by Thomas M Devlin. (2010)
2. Principles of Biochemistry by Nelson, D. L. and Cox, M.M. Lehninger, (2017)
3. Textbook of Biochemistry by Donald Voet, Judith G. Voet. (2011)
4. Biochemistry by Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg, (2012)
5. Fundaments of Biochemistry (Life at the molecular level) by Donald Voet, Judith G. Voet & Charlotte W. Pratt. (1997)
6. Biochemistry (Lippincott Illustrated Reviews) by Richard A. Harvey, Denise R. Ferrier. (2011)

BMB-204: Endocrinology **3 Credits**

1. **Characteristics of the hormone system:** Introduction, overview of the endocrine system,
   chemical nature of hormones, classification and functions of hormones, endocrine glands,
   target-gland concept, negative and positive feedback, hormone receptors and its classifications, hormone-mediated intracellular signaling and intracellular messengers.

2. **Pituitary and hypothalamic hormones:** Anatomical location of hypothalamus and pituitary gland, hypothalamic-pituitary axis and portal system, biosynthesis, physiological and biochemical actions of hypothalamic, posterior-pituitary and anterior-pituitary hormones.

3. **Thyroid and parathyroid hormones:** Structure of thyroid stimulating hormones (TSH) and TSH-receptors, TSH signaling, structure and classification of thyroid hormones, biosynthesis of thyroid hormones, negative feed-back mechanism and function of thyroid hormones, pathological complications of thyroid hormones, Graves' disease. Physiological effects of parathyroid hormone, control of parathyroid hormone secretion, disease states associated with parathyroid hormone.

4. **Hormones of the adrenal cortex, adrenal medulla, gonads:** The hypothalamic-pituitary-adrenal axis, structure, classification, regulation, and functions of adrenal cortex and adrenal medulla hormones, hyperfunction of adrenal cortex, Cushing's syndrome, aldosteronism, gonadotropins, signaling pathways, regulations, and interactions of gonadotropins, hormonal regulation of male and female reproductive functions.

5. **Pancreatic hormones:** Structural features of pancreatic cells, sources and physiological functions of pancreatic hormones. Insulin biosynthesis, secretion and function, insulin signal transduction pathway. Pathophysiology and treatment of Type I and II diabetes mellitus. Glucagon biosynthesis, signaling pathway, and functions.

6. **Gastrointestinal (GI) hormones:** Cellular architecture of stomach and GI tract, secretion, regulation, signaling pathways and functions of gastrin, cholecystokinin (CCK), secretin, gastric inhibitory polypeptide (GIP), vasoactive intestinal polypeptide (VIP), glicentin, neurotensin, substance P and somatostatin, feedback mechanisms of GI hormones, Zollinfer-Ellison syndrome, impact of infection on GI hormones.

7. **Hormone assay techniques:** Assay of peptide and steroid hormones by radioimmunoassay (RIA), nonisotopic immunoassay - enzyme immunoassay (EIA), enzyme multiplied immunoassay (EMIT), enzyme-linked immunosorbent assay (ELISA), fluorescence immunoassay (FIA), fluorescence polarization immunoassay (FPIA)

References:

1. Harrison's Endocrinology by J. Larry Jameson. (2006)
2. Endocrinology - Basic and Clinical Principles by Shlomo Melmed and P. Michael Conn. (2005)
3. Text Book of Endocrinology. R H Williams. *W. B. Saunders Company.* (2011)

BMB-205: Molecular Biology-II **4 Credits**

1. **Structure and properties of DNA:** Different physicochemical properties; different conformations of DNA, tandem sequence, palindrome sequence, cruciform structure, hybridization kinetics, $C_o t$ values, sequence complexity,

2. **Packaging of DNA:** Genome organization of prokaryotes and eukaryotes; role of histones, non-histone and histone-like proteins; genomes of organelles.

3. **DNA replication:** DNA replication: Basic mechanism of DNA replication involving helicases, topoisomerases, primase, polymerases, ligases and other proteins. Replication process: initiation, elongation and termination both in prokaryotes and eukaryotes. Bidirectional, unidirectional and rolling circle replication. Role of telomerase in replication. Regulation of replication in eukaryotes: cell cycle checks points and CDKs.

4. **Transcription:** RNAs and their characteristics. Major steps in prokaryotic and eukaryotic transcription: pre-initiation, initiation, elongation and termination. Role of Promoter sequences, transcription factors and RNA polymerase. Post-transcriptional modification of primary transcripts. RNA transport; inhibitors of transcription.

5. **Structure and function of ribosome:** Prokaryotic and eukaryotic ribosomes; ribosomal proteins and RNAs; ribosome as seat of protein synthesis; major sites of ribosome; recent findings on structure and function of ribosome.

6. **Genetic code:** Discovery; codons and anticodons; codon dictionary: salient features; effect of mutations: point mutation and frame shift mutation; Wobble hypothesis; variations to the standard genetic code; redundancy.

7. **Translation:** Steps in protein synthesis: Activation: activation of amino acids and its specificity; Initiation: initiation factors; difference in initiation in prokaryotes and eukaryotes; Elongation: factors involved; elongation process along with translocation; Termination: factors involved.

References:

1. Lewin's GENES XII by Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. (2017)
2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. (2017)
3. Textbook of Biochemistry with Clinical Correlations by Thomas M. Devlin. (2010)
4. Molecular Biology of the Cell. Bruce. Alberts, Denneis Bray, Julian Lewis, Martin Raff, Keith, Roberts, James, D. Watson. *Garland Publishing Inc.*(2008)

5. Cell and Molecular Biology. E.D.P. DeRobertis and E.M.F. DeRobertis. *Wavertev*.(1987)

Extra-departmental courses:

BMB-251: Human Physiology **4 Credits**

Theory: 80 Marks

1. **Blood: C**ompositions and components of blood and their functions, origin of blood cells: hematopoesis and erythropoesis, Hemostasis: vascular constriction, platelet plug, biochemistry of blood clotting, total count (TC), differential count (DC). Blood grouping: the ABO system and Rh-factor, transfusion reaction and Rh-incompatibility.

2. **Heart:** Heart, chambers of heart and its valves, their functions and locations, specialized cardiac tissues, sinoaortic node (SA node), atrioventricular node (AV node), bundle of His, Purkinjee's fibers, pace maker, artificial and natural cardiac output, blood pressure, systemic, pulmonary and coronary blood circulation.

3. **Kidneys:** Structures, physiology and functions of kidney. Nephrons - types, structures and functions of their different parts, the basic renal processes - glomerular filtration, tubular reabsorption, and tubular secretion, the glomerular membrane, the juxtaglomerular apparatus**,** transepithelial transport - sodium, water and urea reabsorption; ion secretion - potassium, hydrogen and bicarbonate ion secretion, urinary buffer system: composition, formation and excretion of urine, renal failure and its causes.

4. **Body fluid and acid-base balance:** Balance concept, body fluids: types and ionic composition, acid–base balance: acidosis and alkalosis in the body, different buffer systems and their roles in the body.

5. **Lymphatic and lymphoid system:** Lymph and lymph vessels and tissues, lymphatic circulation, outline of primary and secondary lymphoid organs and their functions, structure and function of lymph nodes, spleen, thymus and bone marrow in immunity, lymph nodes and illness.

6. **Digestive system:** The gastrointestinal tract, digestive enzymes, digestion of food components and absorption of digested products, gut hormones.

7. **Hepatobiliary system:** Structural organization, functions and disorders of liver, gall bladder and pancreas, congenital anomalies and inflammation of gall bladder and bile duct.

8. **Respiratory System:** Mechanics of pulmonary ventilation, functions of respiratory passageways, blood flow through the lungs and its distribution, diffusion of gases through respiratory membrane, regulation of respiration, physiologic peculiarities of pulmonary abnormalities, artificial respiration.

9. **Reproductive system (male and female):** General structure and functions of the reproductive system, hormones and functions of the reproductive system, stages of reproduction, spermatogenesis and oogenesis and their hormonal control, the menstrual cycle and stages, pregnancy, placenta, lactation, menopause, hormonal factors in pregnancy, lactation and menopause, infertility.

10. **Nervous system:** Nerve cells, ionic basis of excitation and conduction, synaptic transmission, sense receptors, hypothalamus and temperature regulation.

Practical: 20 Marks

1. Total WBC count, differential count (DC).
2. Blood grouping.
3. Hemoglobin estimation.

References:

1. Textbook of Medical Physiology by Guyton and Hall. (2008)
2. Ganong's. Review of. Medical Physiology by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen L. Brooks (2019)
3. Human Physiology from cell to system by Lauralee Sherwood (2015)
4. Human Biology by Sylvia S. Mader (2017)

BMB-252: Computer Basics and Data Analysis **4 Credits**

Theory: 50 Marks **(20 + 30)**
(In course + Final)

1. **Introduction to computers:** Computer basics and organization (general properties of memory devices, memory hierarchies, read only memory, random access memory, and cache memory), components of a computer system, importance and limitations of computers, classification of computer (based on purpose, signals, capacity), history of computers, computer generations.

2. **Computer software:** Software, classification of software, commercial software, freeware, advantages of package programs, popular package programs, programming languages, programs with simple input output operations, high level languages e.g., Perl as scripting language

3. **System software and operating system:** System software, the role of BIOS, language translators, text editor, the tasks of an OS, OS characteristics, types of OS, Linux, UNIX, MS DOS, Windows.

4. **Database concepts:** Basic concepts, database software, database structures, database management system, benefits and limitations of database management.

5. **Computer networks and the internet:** Introduction to computer network, network terminologies, LAN topology.

6. **Introduction to Python (lectures and demonstrations)**
Basic concepts on programming, algorithm and scripting and its importance to biologists, Introduction to specific terms used in scripting e.g., variable, expression, statement,

function, debugging, syntax etc., Installation, editing and running Python, Using text editors, manipulating texts, Running the first command "Hello World", Working with files input and output

Practical: 50 Marks (20 + 30)
(In course + Final)

1. Simple exercises on WINDOWS and UNIX operating systems.
2. Power-point presentation.
3. Python lists and loops
   Creating lists, working with list and retrieving elements, Using string, Iteration, Looping
4. Conditions
   True and False, If, else, elif and while loop

References:

1. Introduction to Computer Science: A Textbook for Beginners in Informatics by Gilbert Brands. (2013)
2. Concepts in Programming Languages by John C. Mitchell (2013)
3. Basics of Computer Networking by Thomas G. Robertazzi (2013)