

**Syllabus
for
Bachelor of Science (Honours) in
Biochemistry and Molecular Biology
For The Session: 2017-2018**



**Department of Biochemistry and Molecular Biology
Faculty of Life and Earth Sciences
Jagannath University
Dhaka-1100**

Department of Biochemistry and Molecular Biology

Jagannath University

Syllabus for BSc (Honours) in Biochemistry and Molecular Biology (For the Session 2017-2018)

The department offers a full-time 4-year BSc (Honours) program in Biochemistry & Molecular Biology. The course aims to give detailed knowledge and understanding of important aspects of Biochemistry & Molecular Biology and as currently applied in medical sciences, agriculture, industry, food, health and environmental management as well as in research. To be eligible for admission in the 4-year BSc (Honours) program, the candidates must have biology, chemistry and physics including mathematics in their Higher Secondary Certificate (HSC) Examination in Science group or recognized equivalent examinations. The educational qualification of the candidate shall be decided as per university admission rules. For obtaining the bachelor degree a student have to earn total credit points successfully with the final CGPA of 2.5 on a scale of 4.

The 4-year BSc (Honours) will span over 8 semesters with 132 credits of which year-wise course distribution has been detailed in the following table. A minimum of 15 class hours will constitute one credit. There shall be three types of courses Theoretical, Practical/Research Project, and Viva-voce. Of the total 132 credits, 100 credits are allocated for Theoretical courses (departmental 81, and extra-departmental 19). Practical courses including research project contain 24 credits. Theoretical course will include class-teaching, open discussion, academic assignment etc. Each theoretical course will be evaluated by Continuous Assessment (30% marks) and Semester final Examination (70% marks). Practical courses for one credit point will be at least two contact hours in a week, and it will cover 10-20% of the total credit hours. During the final semester (8th semester), a research project will be assigned to the students and it will be decided by the departmental academic committee. Viva-voce examination will have 8 credit points and will be held at the end of 2nd semester-final examination in each academic year.

The year/semester-wise credit and marks distribution

Year	Semester	Theoretical courses		Practical		Viva-voce	Total Credit Point	Credit Hours	Total Marks
		Departmental	Extra-departmental	Departmental	Extra-departmental				
1 st	1 st	9	4	2	2	-	17	315	450
	2 nd	8	4	2	2	2	18	300	450
2 nd	1 st	8	6	2		-	16	270	450
	2 nd	8	3	3		2	16	255	450
3 rd	1 st	14	-	2		-	16	270	450
	2 nd	11	-	3		2	16	255	450
4 th	1 st	11	2	3		-	16	285	450
	2 nd	12	-	3		2	17	270	450
Grand Total		81	19	20	4	8	132	2220	3600

First Year First Semester (1st Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 1101	Basic Biochemistry-I	3	45	100
BMB 1102	Bioorganic Chemistry-I	2	30	50
BMB 1103	Biophysical Chemistry-I	2	30	50
BMB 1104	Molecular Biology-I	2	30	50
BMB 1105	Botany	2	30	50
BMBL 1106	History of Liberation War of Bangladesh	2	60	50
BMB 1107	Botany Practical	2	30	50
BMBL1108	Practical Biochemistry and Molecular Biology-I	2	60	50
	Total	17	315	450

First Year Second Semester (2nd Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 1201	Basic Biochemistry-II	2	30	50
BMB 1202	Bioorganic Chemistry-II	2	30	50
BMB 1203	Biophysical Chemistry-II	2	30	50
BMB 1204	Molecular Biology-II	2	30	50
BMB 1205	Zoology	2	30	50
BMBL 1206	Zoology Practical	2	60	50
BMB 1207	Computer Basics	2	30	50
BMBL 1208	Practical Biochemistry and Molecular Biology-II	2	60	50
BMBV 1209	Viva-voce	2	-	50
	Total	18	300	450

Second Year First Semester (3rd Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 2101	Enzymology-I	2	30	50
BMB 2102	Metabolism-I	2	30	50
BMB 2103	Human Physiology	3	45	100
BMB 2104	Basic Microbiology	3	45	100
BMB 2105	Plant Biochemistry	2	30	50
BMB 2106	Human Nutrition	2	30	50
BMBL 2107	Practical Biochemistry and Molecular Biology-III	2	60	50
	Total	16	270	450

Second Year Second Semester (4th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 2201	Enzymology-II	2	30	50
BMB 2202	Metabolism-II	2	30	50
BMB 2203	Endocrinology	2	30	50
BMB 2204	Molecular Genetics	2	30	50
BMB 2205	Biostatistics	3	45	100
BMBL 2206	Practical Biochemistry and Molecular Biology-IV	3	90	100
BMBV 2207	Viva-voce	2	-	50
	Total	16	255	450

Third Year First Semester (5th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 3101	Basic Immunology	3	45	100
BMB 3102	Fundamentals of Genetic Engineering and Biotechnology	3	45	100
BMB 3103	Molecular Biology-III	2	30	50
BMB 3104	Sports Nutrition	2	30	50
BMB 3105	Biochemistry & Molecular Biology of Diseases	2	30	50
BMB 3106	Environmental Biochemistry	2	30	50
BMBL 3107	Practical Biochemistry and Molecular Biology-V	2	60	50
	Total	16	270	450

Third Year Second Semester (6th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 3201	Cell Biology	3	45	100
BMB 3202	Clinical Biochemistry	2	30	50
BMB 3203	Pharmaceutical Chemistry	2	30	50
BMB 3204	Bioenergetics	2	30	50
BMB 3205	Plant Biotechnology	2	30	50
BMBL 3206	Practical Biochemistry and Molecular Biology-VI	3	90	100
BMBV 3207	Viva-voce	2	-	50
	Total	16	255	450

Fourth Year First Semester (7th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 4101	Molecular Biology Techniques	3	45	100
BMB 4102	Applied Immunology	2	30	50
BMB 4103	Pharmaceutical Biotechnology	2	30	50
BMB 4104	Oncology	2	30	50
BMB 4105	Molecular Biology-IV	2	30	50
BMB 4106	Virology	2	30	50
BMBL 4107	Practical Biochemistry and Molecular Biology-VII	3	90	100
	Total	16	285	450

Fourth Year Second Semester (8th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 4201	Biochemistry of Natural Products	2	30	50
BMB 4202	Neurobiochemistry	2	30	50
BMB 4203	Biochemistry of Drugs	2	30	50
BMB 4204	Industrial Biotechnology	2	30	50
BMB 4205	Agricultural Biotechnology	2	30	50
BMB 4206	Bioinformatics	2	30	50
BMB 4207	Research Project/Training	3	90	100
BMBV 4208	Viva-voce	2	-	50
	Total	17	270	450

Detailed Syllabus

First Year First Semester (1st Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 1101	Basic Biochemistry-I	3	45	100
BMB 1102	Bioorganic Chemistry-I	2	30	50
BMB 1103	Biophysical Chemistry-I	2	30	50
BMB 1104	Molecular Biology-I	2	30	50
BMB 1105	Botany	2	30	50
BMBL 1106	History of Liberation War of Bangladesh	2	60	50
BMB 1107	Botany Practical	2	30	50
BMBL 1108	Practical Biochemistry and Molecular Biology-I	2	60	50
	Total	17	315	450

Course: BMB 1101, Credit: 3

Title: Basic Biochemistry-I

1. Biochemistry and its scope: Historical development, Modern Biotechnology and future prospect of Biochemistry.
2. The cell and its evolution: Characteristics of living matters. Structure and function of sub-cellular organelles, their isolation and identification. Evolution from molecules to the first cell, from prokaryotes to eukaryotes.
3. Carbohydrates: Biological importance, chemical characteristics and classification of carbohydrates.
 - (a) Monosaccharides: Basic physico-chemical properties (structure, optical properties and confirmatory tests for monosaccharides), biologically important derivatives of monosaccharides (glycosides, amino sugars, and sugar acids).
 - (b) Disaccharides: Structural properties, biological importance.
 - (c) Polysaccharides: Physico-chemical properties of common storage and structural polysaccharides. Structures and function of starch, glycogen, and cellulose.
 - (d) Sugar alcohols: Definition, synthesis, characteristics and usage (i.e. medicinal importance of sugar alcohols).

4. Lipid: Nomenclature and classification of lipids; general reactions of fats, fatty acids and sterols. Structure and biological functions of different classes of lipids. The plasma membrane- The lipid bilayer, membrane fluidity, membrane-bound proteins and membrane transport.
5. Amino acids: Structural features, classification and physico-chemical properties (ionization, titration curves, isoelectric point) of amino acids. Isolation and separation of amino acids from protein hydrolysates and their confirmation (general reactions and color tests).
6. Vitamins and hormones: Introduction, classification, and biological importance of vitamins and hormones. Aspects of vitamin and hormone study in Biochemistry.

Books Recommended:

1. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman; November 21, 2012.
2. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman; April 8, 2015.
3. Harper's Biochemistry. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell; (30th Edition) McGraw-Hill Education / Medical; January 8, 2015.
4. Biochemistry. Pamela C. Champe; (2nd Edition) Lippincott-Raven Publishers, East Washington Square, USA, 1994.
5. Text Book of Biochemistry. E. S. West, W. R. Todd, H. S. Mason, J. T. Van Bruggen; 4th Edition.
6. Fundamentals of Biochemistry. Dr. A. C. Deb.

Course: BMB 1102, Credit: 2

Title: Bioorganic Chemistry-I

1. Introduction: Covalent bonds and shapes of molecules, electronic structure of atoms. The Lewis model of bonding, the octet rule, functional groups, bond length, bond angles, polar and non-polar molecules. Molecular orbital theory of covalent bonding.
2. Aliphatic compounds
 - a) Alkanes: Occurrence, structure, nomenclature, conformation, synthesis, physical and chemical properties (free radical substitution, stability of free radicals, halogenations).
 - b) Alkenes and alkynes: Occurrence, structure, nomenclature, synthesis, physical and chemical properties including electrophilic addition and free radical reactions, polymerization, free radical halogenation of alkenes etc. Dienes: structure, properties, addition reaction, polymerization, Diels Alder and other reaction of dienes.
 - c) Alkylhalides: Nucleophilic substitution reactions, S_N1 and S_N2 reactions and carbonations. Carbonation rearrangement E₁ and E₂ elimination reactions, Grignard reagents and other organometallic compounds.
 - d) Alcohols, ethers and diols: Occurrence, nomenclature, structure, synthesis, physical and chemical properties and uses.
 - e) Aliphatic aldehydes and ketones: Occurrence, nomenclature, structure, synthesis, physical and chemical properties and uses.
 - f) Aliphatic carboxylic acids: Occurrence, nomenclature, structure, synthesis, physical

and chemical properties and uses.

- g) Aliphatic amines: Occurrence, nomenclature, structure, synthesis, physical and chemical properties and uses.

3. Aromatic compounds

- (a) Aromatic hydrocarbons: Aromaticity, mechanism of orientation and substitution, structure of benzene, sources of aromatic hydrocarbons, industrially important aromatic compounds, nomenclature of benzene derivatives, electrophilic and nucleophilic aromatic substitution, chemistry of aromatic-aliphatic compounds.
- (b) Aldehydes and ketones: Nomenclature synthesis, nucleophilic addition elimination reactions, oxidation, reduction of carboxyl compounds, haloform reaction, aldol condensation, benzoin condensation, claisen condensation etc.
- (c) Carboxylic acids and their derivatives: Nomenclature, synthesis, classification, properties, reaction uses, decarboxylation reactions, dicarboxylic acids and esters.
- (d) Nitro-compounds and amines: Occurrence, nomenclature, synthesis, classification, properties, reactions, uses, diazonium compounds.
- (e) Phenols: Occurrence, nomenclature, synthesis, properties, and reactions, polyhydric phenols.

Books Recommended:

1. Organic Chemistry.I.L.Finar; (5th edition), John Wiley & Sons Inc. USA, 1997.
2. Organic Chemistry.Morrison& Boyd; (7th Edition) P; 2010.
3. Organic Chemistry. SolomonsFryhle; (12th edition) Wiley(April 11, 2016).
4. Advanced Organic Chemistry.B.S. Bahl and A. Bahl; S Chand & Co Ltd (December 1, 2010).
5. Introduction to Organic Chemistry. A. Streitweiser, C.H. Heathcock and E.M. Kosower; (4th Edition) Macmillan Pub. Co.
6. Organic Chemistry. W.H. Brown and C.S. Foote; (3rd Edition) Saunders College Pub.
7. Organic Chemistry.R.W. Griffin Jr., Modern, McGraw Hill.
8. A Guide Book to Mechanism in Organic Chemistry. P. Sykes; (6th Edition) Orient Longman.

Course: BMB 1103, Credit: 2

Title: Biophysical Chemistry-I

1. Atomic structure: Fundamental particles, atomic models (Rutherford's and Bohr's atom models) and Sommerfeld's modification. Quantum theory, Pauli's exclusion principle, Hund's rule, Aufbau principle, De-Broglie equation, Heisenberg uncertainty principle, Schrodinger wave equation.
2. The chemical bonds: Overview, types of bond, transition between main types of bonding, Lewis formula, octet rule and its exceptions.
 - (a) Ionic bond: General description, energy changes in ionic bond formation, limitations to form ions, Fajans's rule, partial covalent nature of ionic compounds, lattice energy and Born-Haber cycle, factors influencing formation of ionic bond.
 - (b) Covalent bond: General description, energy change during bond formation, covalency and maximum covalency of an element. Valence bond theory: general description, sigma and pi bonds, hybrid orbitals, molecular geometry and directional bonding-valence shell electron pair repulsion theory. Shapes of

different covalent molecules according to VSEPR theory, effect of electronegativity on bond angle. Resonance: resonance energy, conditions necessary for resonance. Dipole moment. Non-polar and polar covalent bonds. Molecular orbital theory: principles of molecular orbital theory, bonding and anti-bonding molecular orbitals, their significance and characteristics, stability of molecules, bond order, MO diagram of simple diatomic molecules.

(c) Coordination bond, Metallic bond, Hydrogen bond, Van der Waals forces.

3. Gaseous state: Gas laws, ideal gas equation, kinetic theory of gases, Van der Waals equation, critical phenomenon.
4. Properties of liquid and solution: Viscosity, surface tension and interfacial tension of liquids. Types of solution, concentration units and volumetric problems. Intermolecular forces in liquids, diffusion as properties of liquids.
5. Acids and bases: Modern concepts of acids and bases: Arrhenius concept, Bronsted-Lowry concept, Lewis concept, limitations. Conjugate acids and bases. Acid-base strength, pH, pOH. Hard soft acid base principle (HSAB principle), buffer solution and buffer action, Henderson-Hasselbalch equation. Acid-base indicator, pH curve and indicator range, choice of suitable indicator. Theories of acid-base indicators.
6. Chemical equilibrium: Nature of chemical equilibrium, equilibrium constant, relationship to free energy, effect of temperature, reaction involving hydrogen ion in buffer media, coupling of reactions. Kinetics of biochemical reactions and its applications in Biochemistry.
7. Chemical kinetics: Definition, reaction rate, rate laws, zero, first and second order reactions, molecularly 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.

Books Recommended:

1. Essentials of Physical Chemistry. ArunBhal, B S Bahl & G D Tuli; S Chand & Co Ltd (December 1, 2010).
2. Principle of Physical chemistry. Haque & Nawab, (Fully revised edition); Nawab Publications, Dhaka, 2005.
3. Basic Inorganic Chemistry. Cotton, Wilkisons & Gauss; (3rd Edition) John Wiley, 1987.
4. A biologist's Physical Chemistry. J Gareth Morris; (2nd edition) Chapman and hall Inc., USA, 1991.
5. Modern Inorganic Chemistry. R.D. Madan; S. Chand and company Ltd. 2005.
6. Introduction to Modern Inorganic Chemistry. S. Z. Haider; (6th rev. and enl. Ed), Edexcel Publishers, Dhaka.
7. Chemical Bonding and Shapes of Molecules. K. Kundu; Bangla Academy, Dhaka.
8. A text book of physical chemistry. K.K. Sharma & L.K. Sharma; (5th Edition) Vikas Publishing House (2012).

Course: BMB 1104, Credit: 2
Title: Molecular Biology-I

1. Heredity: Mendel's laws of inheritance, gene concept, conceptual relationship between gene and chromosomes, and gene and enzymes.
2. DNA as genetic material.
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 end nuclease, 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 molecular 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).

Books recommended:

1. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman; November 21, 2012.
2. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman; April 8, 2015.
3. Text Book of Biochemistry with Clinical Correlation. Thomas M. Devlin; (7th edition) John Wiley & Sons; (January 19, 2010)
4. The cell: A Molecular Approach. Geoffrey M. Cooper, (2nd edition) Sinauer Associates is an imprint of Oxford University Press; (October 8, 2015).
5. Molecular Biology of the Cell. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; (5th edition) Garland Science, November 14, 2007.
6. Principles of Genetics. Eldon John Gardner, D. Peter Snustad, Michael J. Simmons; (8th Edition) John Wiley & Sons (Asia) Pte. Ltd, Singapore, 2002.
7. Biochemistry. Pamela C. Champe; (2nd Edition) Lippincott-Raven Publishers, East Washington Square, USA, 1994.
8. Cell and Molecular Biology. Gerald Karp; (8th edition) Wiley, January 22, 2013.

Course: BMB-1105, Credit: 2
Title: Botany

1. Introduction to plant kingdom: Plant kingdom and important features of major plant groups.
2. Study of following plant families: Solanceae, Apocynaceae, Liliaceae, Zingiberaceae.
3. Plant growth regulators: Definition, classification and physiological effects of plant growth regulators (Auxins, Gibberellins, Abscicic acid and Cytokinins).
4. Physiology of flowering: Photoperiodism and Vernalization.
5. Photosynthesis: Definition, Light reaction, Electron transport system, photo-phosphorylation, Calvin cycle, C3 and C4 cycles and their importance.
6. Respiration: Definition; glycolysis, Kreb's cycle and their importance.
7. Plant pathology:
 - a. Introduction and general symptoms of plant diseases.
 - b. Detail study of following plant diseases (symptoms, pathogen characters and control measures) i) Brown spot disease of rice, ii) Tikka disease of groundnut, iii) Rust disease of wheat iv) Late blight of potato.
8. Cell division: Process of Mitosis, Meiosis and their significance.
9. Chromosomal aberrations: Numerical (Aneuploidy, euploidy, polyploidy) and structural aberrations (Deletion, duplication, inversion and translocation).
10. Mendelism: Mendel's laws of inheritance, causes of his success, apparent exceptions of Mendel's laws.
11. Hybridization: Definition, artificial technique and its importance.
12. Back cross breeding: Methods, merits and demerits

Books recommended:

1. Taxonomy of Angiosperms. Naik V.N.; (1984) McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Fundamentals of Plant Physiology. Jain V.K.; (2007) S. Chand & Company Ltd., New Delhi.
3. Plant Pathology. Mehrotra and R.S.; Mc Graw Hill India (2017).
4. Cytology. Verma P.S. and Agarwal V.K.; (8th edition) S. Chand & Company Ltd., New Delhi.
5. Plant Cytogenetics. Singh R.J.; (3rd edition) CRC Press, November 2, 2016.
6. Principles of Genetics. Gardner S. J., Simmons M.J. and Snustad D.P.; (6th edition) John Wiley and Sons (August 23, 2011).

Course: BMB 1106, Credit: 2

Title: History of Liberation War of Bangladesh

1. Introduction: Definition, comparative study of liberation war of Bangladesh with other countries.
2. Socio-economic, cultural and political background of liberation war.
3. Contribution of intellectuals (professionals) in creating the spirit of liberation war.
4. Election of 1970. Non-cooperation movement, and declaration of independence.
5. Operation search-light.
6. Mass killing, women abuse and torture.
7. Refugee crisis.
8. Written announcement of independence and formation of government of Bangladesh.
9. Spontaneous primary resistance and war.
10. Mass media and public opinion.
11. Freedom fighters: weapons, training, and youth camp.
12. Contribution of political parties: Bangladesh, India, Pakistan.
13. Contribution of students, women and general people in liberation war.
14. Contribution of superpowers and Muslim countries.
15. Anti-liberation activities of peace committee, Al-Bodor, Al-Shams, war criminals, killing of intellectuals.
16. Trial of “Bangabandhu” as prisoner in Pakistan and world reactions.
17. Responses of immigrant Bengali and citizens of other countries.
18. Contribution of India in liberation war: Government, people and mass media.
19. War of independence: United Nations (UN) and other international organizations.
20. Joint force formation and final victory.
21. Leadership and contribution of “Bangabandhu” in liberation war.
22. Return of “Bangabandhu” to homeland and legislation of constitution.

Books Recommended:

1. The Foreshadowing of Bangladesh. Harun-or-Rashid.
2. The Emergence of Nationalism in Bangladesh. Nehalkarim.
3. Sheikh Mujib’s 6-point Formula: An Analytical Study of the Breakup of Pakistan. Sayed Humayan.
4. A Social History of East Pakistan. Kamruddin Ahmed.
5. Bangabandhu, Bangali o Bangladesh. Dr. Mijanur Rahman (বঙ্গবন্ধু, বাঙ্গালি ও বাংলাদেশ। ড. মীজানুর রহমান).
6. Ebarer Songram Shadhinotar Songram. Abu Osman Chowdhury (এবারের সংগ্রাম স্বাধীনতার সংগ্রাম। আবু ওসমান চৌধুরী).
7. Bangladesher Mukti Songramer Itihash. Salahuddin Ahmed (বাংলাদেশের মুক্তি সংগ্রামের ইতিহাস (১৯৪৭- ১৯৭১), সালাহউদ্দিন আহমদ).
8. Muktijuddhe Bangali Buddhijibider Bhunika. Khodeja Khatun (মুক্তিযুদ্ধে বাঙালি বুদ্ধিজীবীদের ভূমিকা। খোদেজা খাতুন).

9. Bangladesher Itihash. Sirajul Islam (বাংলাদেশের ইতিহাস। সিরাজুল ইসলাম).

Course: BMBL 1107, Credit: 2

Title: Botany Practical

1. Study and handling of microscope (simple and compound).
2. Study of families covered in theory (Subjected to availability of materials).
3. Identification of different plant species.
4. Study of mitosis in onion root tip cells.
5. Study of different cell types (Stomata, stamina hair, bastfibre, pollen mother cell, pollen grain, epidermal cells, vascular cells).
6. Identification of different stages of cell division (mitosis and meiosis).
7. Evolution of oxygen during photosynthesis.
8. Effect of light intensity on the rate of photosynthesis.
9. Osmosis with potato osmoscope.
10. Study of symptoms of different plant diseases (Citrus canker, common scab of potato, Red rot of sugarcane, Brown spot of rice).
11. Study of pollen grain viability by acetocarmine.
12. Study of Emasculation technique.

Course: BMBL 1108, Credit:2

Title: Practical Biochemistry and Molecular Biology-I

1. Use of electronic balances.
2. Preparation of standard solutions.
3. Standardization of HCl.
4. Estimation of acetic acid content of vinegar.
5. Estimation of calcium from milk.
6. Estimation of iron from blood.
7. Estimation of ascorbic acid content of biological samples.
8. Identification of organic compounds and colour tests for biomolecules.

First Year Second Semester (2nd Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 1201	Basic Biochemistry-II	2	30	50
BMB 1202	Bioorganic Chemistry-II	2	30	50
BMB 1203	Biophysical Chemistry-II	2	30	50
BMB 1204	Molecular Biology-II	2	30	50
BMB 1205	Zoology	2	30	50
BMBL 1206	Zoology Practical	2	60	50
BMB 1207	Computer Basics	2	30	50
BMBL 1208	Practical Biochemistry and Molecular Biology-II	2	60	50
BMBV 1209	Viva-voce	2	-	50
	Total	18	300	450

Course: BMB 1201, Credit: 2
Title: Basic Biochemistry-II

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 destabilizing amino acids, α -keratins and β -keratins – conformation and structure, structures of collagen and elastin, filamentous proteins – actin, myosin and microtubules.

- (iii) Globular proteins: Tertiary 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, the 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.
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.

Books Recommended:

1. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman; November 21, 2012.
2. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman; April 8, 2015.
3. Harper's Biochemistry. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell; (30th Edition) McGraw-Hill Education / Medical; January 8, 2015.
4. Biochemistry. Pamela C. Champe; (2nd Edition) Lippincott-Raven Publishers, East Washington Square, USA, 1994.
5. Text Book of Biochemistry. E. S. West, W. R. Todd, H. S. Mason, J. T. Van Bruggen; 4th Edition.
6. Fundamentals of Biochemistry. Dr. A. C. Deb.

Course: BMB 1202, Credit: 2

Title: Bioorganic Chemistry-II

1. Organic Reactions and their Mechanism: The classical structural theory, electron displacement effects, bond fission, attacking reagents and their role, electrophiles, nucleophiles, carbonium ion, carbanions, types of reaction mechanism, energy requirements, substitution reactions (S_N2 and S_N1), elimination reactions ($E1$ and $E2$).
2. Stereochemistry: Definition, classification of isomerism, asymmetric carbon atom, asymmetric and dissymmetric molecules, chirality, criterion of enantiomerism, Fischer projections, absolute and relative configuration, R and S system, optical isomerism in compound with more than one asymmetric carbon atom, isomerism of tartaric acid, racemization, asymmetric synthesis, Walden inversion.
3. Heterocyclic compounds: Definition, nomenclature, preparation, properties and uses of furans, thiophene, pyrrole, pyridine, pyrimidine and quinoline.

4. Organophosphorus and organosulphur compounds: A general account of compounds in this category, their biological significance, synthesis and use.
5. Bifunctional compounds: 1,3-dienes, α -unsaturated carbonyl compounds, Hydroxy ketones; 1,2 and 1,3-diketones, Hydroxy acids.
6. Reaction mechanisms and their applications: Reaction mechanism of electrophilic and nucleophilic substitution reactions in aromatic ring, Aldol condensation, Wolf-Kishner reduction, Friedel-Crafts alkylation and acylation reaction, Clemenson reaction, Reimer-Tiemann reactions, Grignard reaction.

Books recommended:

1. Organic Chemistry. Morrison & Boyd; (7th Edition) P; 2010.
2. Organic Chemistry (Vol -I: The Fundamental Principles). L. Finar; (5th Edition) London 1986.
3. Organic Chemistry (Vol -II: Stereochemistry and Chemistry of Natural Products). L. Finar; Orient Longmans, London, 1986.
4. Organic Chemistry. Solomons Fryhle; (12th edition) John Wiley and sons, inc. USA, 2016.
5. Essentials of Bioorganic Chemistry. R. W. Hanson; (3rd edition) Springer (August 27, 1999).
6. Bioorganic Chemistry: A chemical approach to enzyme action. Herman Dugas and Christopher Penny; (3rd Edition) Springer Verlag, USA, 1981.
7. Advanced Organic Chemistry. B.S. Bahl and A. Bahl; S. Chand & Co. Ltd., New Delhi.

Course: BMB 1203, Credit: 2

Title: Biophysical Chemistry-II

1. Thermodynamics: Work, heat and energy. The first law of thermodynamics, expansion work, enthalpy, adiabatic changes, standard enthalpy changes, standard enthalpy of formation.
2. Second law of thermodynamics: Thermodynamic reversibility and irreversibility, spontaneous processes, entropy, thermodynamic efficiency, statements of second law. Entropy changes: phase transition, heating, irreversible processes. Free energy: variation with temperature and pressure, Gibbs-Helmholtz equation, Clapeyron-Clausius equation. Applications of thermodynamics in biochemistry.
3. Photochemistry: Laws of photochemistry. Quantum yield and its significance. Light source. Actinometer and its working principles. Fates of photo excited species. Photodissociation, photoionization. Some typical photochemical reactions. Photosensitization and photocatalysis. Mechanism of photocatalytic reactions. Formation and depletion of ozone in the stratosphere. Ozone hole.
4. The colloids: Classification, types of colloidal systems, characteristics of lyophilic and lyophobic sols, preparation and purification of sols, different properties of sols, stability of sols, Gold number. Emulsions: types and properties of emulsions, emulsification. Gels, application of colloids.
5. Coordination complexes: Classifications, structure of complex compounds, Werner's coordination theory, Sidgwick's electronic interpretation, Pauling theory, role of metal ions in biological system, metallobiosite structure, blue copper proteins (plastocyanin, azurin etc.), iron-sulphur proteins, cytochromes.

Books Recommended:

1. Essentials of Physical Chemistry. Arun Bhal, B S Bahl & G D Tuli; S. Chand & Company, New Delhi, 2008.
2. Principle of Physical chemistry. Haque & Nawab; (Fully revised edition) Nawab Publications, Dhaka, 2005.
3. A biologist's Physical Chemistry. J Gareth Morris; (2nd edition) Chapman and hall Inc., USA, 1991.
4. Basic Inorganic Chemistry. Cotton, Wilkison & Gaus; (3rd Edition) John Wiley, 1987.
5. A text book of physical chemistry. K.K. Sharma & L.K. Sharma; (5th Edition) Vikas Publishing House (2012).
6. Biocoordination Chemistry. D.E. Fenton; Oxford University Press.
7. Inorganic Biochemistry: An Introduction. J.A. Cowan; Wiley-VCH; New York.
8. Principles of Bioinorganic Chemistry. S.J. Lippard and J.M. Berg; University Science Books, Mill Valley, California, USA.
9. Bioinorganic Chemistry. I. Bertini, H.B. Gray, S.J. Lippard, J.S. Valentine; University Science Books, Mill Valley, California, USA.

Course: BMB 1204, Credit: 2

Title: Molecular Biology-II

1. Structure of DNA: Different physicochemical properties, such as T_m value, C_{ot} values, hybridization kinetics, different conformations of DNA, sequence complexity, tandem sequence, palindromic sequence, cruciform structure, mention about DNA chips.
2. DNA sequencing: Simple methods such as Sanger's di-deoxy method and Maxam and Gilbert's method, next generation sequencing.
3. DNA replication: Basic mechanism of visualization of DNA replication by autoradiography. Basic mechanisms of DNA replication involving helicases, topoisomerases, polymerases, ligases, methylases, nucleases, labeling and modification. Semiconservative replication, semi-discontinuous replication, priming of DNA synthesis, bidirectional replication, unidirectional replication and rolling circle replication, fidelity and regulation of replication. Speed of replication, initiation, priming in eukaryotes, elongation, termination, disentangling daughter DNAs. Separate DNA polymerases for initiation and elongation, creating the replication fork at an origin, methylation at the origin of replication and regulation of replication.
4. Recombinant DNA: Vectors, plasmids; λ -phage DNA, M13-based expression vectors for eukaryotic expression, genomic and cDNA libraries, restriction enzymes and other enzymes involved in recombinant DNA technology, RT-PCR, DNA fragments screening and finding right clone. Characterization of cloned

genes by DNA sequencing, data bank entries and annotation analysis of sequence, sequence compression, protein structure and function.

Books recommended:

1. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman; November 21, 2012.
2. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman; April 8, 2015.
3. Text Book of Biochemistry with Clinical Correlation. Thomas M. Devlin; (7th edition) John Wiley & Sons; (January 19, 2010)
4. The cell: A Molecular Approach. Geoffrey M. Cooper, (2nd edition) Sinauer Associates is an imprint of Oxford University Press; (October 8, 2015).
5. Molecular Biology of the Cell. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; (5th edition) Garland Science, November 14, 2007.
6. Principles of Genetics. Eldon John Gardner, D. Peter Snustad, Michael J. Simmons; (8th Edition) John Wiley & Sons (Asia) Pte. Ltd, Singapore, 2002.
7. Biochemistry. Pamela C. Champe; (2nd Edition) Lippincott-Raven Publishers, East Washington Square, USA, 1994.
8. Cell and Molecular Biology. Gerald Karp; (8th edition) Wiley, January 22, 2013.

Course: BMB 1205, Credit: 2

Title: Zoology

1. Introduction: Animal kingdom. Relation between Biochemistry and Zoology. Importance of Zoology in Biochemistry.
2. Introducing noncordates and cordates: Classification of all major phyla up to classes, distinguishing features and distribution.
3. Embryology: Gametogenesis, egg type and cleavage, blastulation, gastrulation, organogenesis, embryonic development of any mammal.
4. Anatomy: Major system of rabbit and their function.
5. Ecology: Environment and its components, concept of ecosystem, energy flow, biogeochemical cycle, habitat adaptation and adaptability, environmental pollution, conservation of environment with social emphasis on biological resources, zoogeographical regions, food chain, food energy transfer.
6. Biodiversity : Concept, Bangladesh fauna, beneficial and harmful insects, pest control methods, human parasites (brief morphology, life-cycle, mode infection of *Plasmodium falciparum*), fish and shellfish resources, major wild animals of Bangladesh, values and conservation of biodiversities.

Books recommended:

1. Integrated Principles of zoology. Hickman, Roberts, Keen, Larson, I, Anson and Eishenour; (14th Edition) McGraw-Hill Science/Engineering/Math.
2. General zoology. T. & R. Usinger. Storer; (14th Edition) McGraw-Hill Book Company, textbook edition (1957).
3. General zoology. Charles F. Lytle; McGraw-Hill.
4. Fundamentals of Ecology. Eugene P. Odum; (5th Edition) Cengage Learning Editores S.A. de C.V (December 30, 2008).

5. Zoogeography (The Geographical Distribution of Animals). Philip. J. Darlington, JR.; Krieger Pub Co (June 1980).
6. Entomology and Pest Management. Larry P. Pedigo; (6th Edition) Waveland Press, Inc.; 2014.
Biology. K. Arms and P.S. Camp, Holt Rinehart & Winston, W.B.Saunders Company.
7. Biology. K. Arms and P.S. Camp, Holt Rinehart & Winston; W.B.Saunders Company.

Course: BMBL 1206, Credit: 2

Title: Zoology Practical

1. Study of museum specimen: Non chordates and chordates: (At least 20 specimens from non-chordate and 20 specimens from chordate should be studied)
2. Study of permanent slides:
 - (a) Whole mounts: (At least 10 whole mount slides including Protozoa, body parts of invertebrate and parasites should be studied)
 - (b) Study of permanent slides: (At least 5 histological permanent slides should be studied)
3. External morphology and dissection of various organ of-
 - (a) Prawn: Digestive system, nervous, circulatory system and appendages.
 - (b) Lata/Rui fish: Digestive, circulatory, nervous system, brain and cranial nerves.
4. Practical note book
5. Attendances
6. Viva

Course: BMB 1207, Credit: 2

Title: Computer Basics

1. Introduction to computers: Computer basics, components of a computer system, importance and limitations of computers, classification of computer (based on purpose, signals, capacity), history of computers, computer generations.
2. Microcomputer system: Microcomputer basics, PC and PC clones, hardware organizations of microcomputer, bus architecture, motherboard and its components, adapter boards.
3. Input and output devices: I/O operations and interfaces, keyboard, reading devices, pointing devices, scanning devices, monitor, printer, plotters, voice output system.
4. Microprocessors: Functions of microprocessors, organization of a microprocessor, arithmetic logic unit, control unit, classification based on generations, classification based on characteristics, RISC versus CISC, special processors.
5. Memory organization: Classification of memory, general properties of memory devices, memory hierarchies, read only memory, random access memory, and cache memory. Secondary memory -floppy disk, hard disk, optical disk, comparisons of primary memory and secondary memory.
6. 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, MatLab, R.

7. 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.
8. Database concepts: Basic concepts, database software, database structures, database management system, benefits and limitations of database management.
9. Computer networks and the internet: Introduction to computer network, network terminologies, LAN topology, transmission media, general characteristics of WAN, bandwidth, communication over telephone lines, evolution of the internet, internet services, internet address, electronic mail, the world wide web, introduction to some protocols.
10. IT applications: Concepts and applications of IT, multimedia hardware and software, compression and decompression, electronic commerce, access control, security, privacy. Introduction to the security of computer network, computer and its impact on society.
11. Computer viruses and troubleshooting.

Books Recommended:

1. Introduction to Computers. Peter Norton; (6th Edition) McGraw-Hill/Irwin (January 14, 2005).
2. Introduction to Computer Science. ITL Education Solutions Limited, Pearson Education (Singapore) Pte. Ltd., 2004; (1st edition) Pearson Education Canada (August 10, 2009).
3. Introduction to Information Technology. ITL Education Solutions Limited, Pearson Education (Singapore) Pte. Ltd., 2005; (2nd edition) Pearson Education India (June 1, 2012).
4. Learn Computers Step by Step. Monica D'souza & Jude D'souza; Dorling Kindersley (India) Pvt. Ltd., 2006, ISBN 81-7758-369-7.
5. Schaum's Outline of Theory and Problems of DATA STRUCTURES. Seymour Lipschutz adapted by G A VijayalakshmiPai; (2nd edition) McGraw-Hill Education (July 22, 1998).
6. Introduction to Algorithms. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein; (3rd edition) PHI Learning Pvt. Ltd. (Originally MIT Press), February 2, 2010.

Course: BMBL 1208, Credit: 4

Practical Biochemistry and Molecular Biology -II

1. Determination of saponification number of fat or oil.
2. Determination of iodine number of fat or oil.
3. Determination of lactose content of milk.
4. Proteins from natural sources and their partial purification by dialysis.
5. Hydrolysis of proteins and isolation and identification of amino acids by TLC.
6. Preparation of buffer and determination of pK of acetic acid.

Course: BMBV 1209, Credit: 2

Title: Viva-voce

Second Year First Semester (3rd Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 2101	Enzymology-I	2	30	50
BMB 2102	Metabolism-I	2	30	50
BMB 2103	Human Physiology	3	45	100
BMB 2104	Basic Microbiology	3	45	100
BMB 2105	Plant Biochemistry	2	30	50
BMB 2106	Human Nutrition	2	30	50
BMBL 2107	Practical Biochemistry and Molecular Biology-III	2	60	50
	Total	16	270	450

Course: BMB 2101, Credit: 2

Title: Enzymology-I

1. Introduction: Brief history, enzyme as biological catalysts, classification, nomenclature. Enzyme assay, specific activity, enzyme activity units
2. Enzymes as biological catalysts: Does not alter reaction equilibrium accelerate the reaction by stabilizing transition states, immense catalytic power, high specific and regulatory properties, transform different forms of energy
3. Factors affecting the rate of enzymatic reactions: substrate concentration, enzyme concentration, pH, temperature, coenzymes and cofactors.
4. Enzyme kinetics: Mono-substrate reactions, Michaelis-Menten equation and its linear transformations, K_m and V_{max} : definition, determination, and significance.
5. Enzyme Inhibition: Reversible inhibition; Competitive, non-competitive and uncompetitive inhibition. Irreversible inhibition, specific examples, Identification of functional groups essential for catalysis general methods, ribonuclease and chymotrypsin as specific examples.

Books Recommended:

1. Text Book of Biochemistry. Albert L. Lehninger; (2nd Edition) Kalyani Publishers, New Delhi, 2000.
2. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman (April 8, 2015).
3. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman (November 21, 2012).

Course: BMB2102, Credit: 2

Title: Metabolism-I

1. Introduction: General aspects of metabolism, experimental approaches to study metabolism, metabolic and energy transfer pathway, survey of intermediary metabolism.
2. Glycolysis: The glycolytic pathway, aerobic and anaerobic fate, regulation of glycolytic pathway, metabolism of disaccharides, pentose and hexose sugar, physiological importance of anaerobic glycolysis, anaerobic glycolysis and tumor cells, anaerobic glycolysis and heart attack, fructose intolerance, galactosemia, diabetes mellitus, hemolytic anemia, hypoglycemia and premature infants.
3. Glycogen metabolism: Glycogenolysis and glycogenesis, metabolism and regulation.
4. Tricarboxylic acid (TCA) cycle: Cycle overview, amphibolic nature of TCA cycle, anaplerotic reaction, regulation of TCA cycle, pyruvate dehydrogenase deficiency, mitochondrial myopathy, glyoxalate cycle.
5. Electron transport and oxidative phosphorylation: Evolution of electron transport chain, oxidative phosphorylation, disorder due to deficiency of mitochondrial protein, Lufftssyndrome, deficiency of electron transfer protein, brown adipose tissue and thermogenesis, diet induced thermogenesis.
6. Other pathways of carbohydrate metabolism: The pentose phosphate pathway, glucose to glucuronic acid and ascorbic acid.
7. Biosynthesis of carbohydrate: Gluconeogenesis and its regulation, biosynthesis of di, oligo and polysaccharide, glycoprotein, proteoglycans, sugar interconversion and nucleotide sugar formation.
8. Lipid metabolism: Lipoprotein metabolism, fatty acid oxidation, ketone body formation and utilization, fatty acid biosynthesis, regulation of fatty acid metabolism, storage of fatty acid as triglyceride, utilization of fatty acid for energy production, metabolism and functional role of polyunsaturated fatty acid, cholesterol biosynthesis, arachidonate metabolism, prostaglandin, prostacyclin, thromboxanes and leukotrienes, phospholipid and glycolipid metabolism, biosynthetic hormone. Disorders of lipid metabolism

Books Recommended:

1. Text Book of Biochemistry with Clinical Correlation. Thomas M. Devlin; (7th Edition.) John Wiley & Sons (January 19, 2010).
2. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman (November 21, 2012).
3. Text Book of Biochemistry. Albert L. Lehninger; (2nd Edition) Kalyani Publishers, New Delhi, 2000.
4. Harper's Biochemistry. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell; (30th Edition) McGraw-Hill Education / Medical; January 8, 2015.
5. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman (April 8, 2015).
6. Biochemistry. Pamela C. Champe; (2nd Edition.) Lippincott-Raven Publishers, East Washington Square, USA, 1994.

Course: BMB 2103, Credit: 3

Title: Human Physiology

1. Organization of Human Body: Tissues, types of tissues (epithelial tissues, connective tissues, muscular tissues and neuronal tissues), organs and systems.
2. Blood: Properties and composition of blood, plasma and serum, formation of blood cells, structure, properties and function of erythrocytes, hemoglobin, quantities of erythrocytes and hemoglobin, blood grouping, blood transfusion and cross matching test, erythrocyte disorders, erythroblastosis fetalis, ESR; types of leukocytes, structure, properties and functions of different leukocytes, abnormalities of leukocyte count; structure, properties and functions of platelets, platelet plug formation, mechanisms of platelet aggregation, coagulation, the fate of blood clots, coagulation disorders.
3. The Heart and the Circulatory System: Gross anatomy of the heart, systemic, pulmonary and coronary blood circuits, cardiac muscle and the conduction system, electrical and contractile activity of the heart, blood flow, heart sounds and the cardiac cycle, cardiac output, general anatomy of blood vessels, arteries and arterioles, veins and venules, capillaries, capillary exchange, coronary atherosclerosis, blood pressure, primary hypertension and secondary hypertension.
4. Lymphatic System: Lymph, lymphatic vessels, lymphatic tissues, lymph nodes, tonsils, thymus and spleen.
5. Digestive System: General anatomy, digestive processes and functions, digestive enzymes; saliva and salivary glands; gastric secretions; the liver (Gross anatomy and microscopic anatomy, functions and diseases); bile; absorption and chemical digestion of carbohydrates, lipids, proteins and nucleic acids.
6. Excretory System: The kidney, gross anatomy of kidney, ultra-structure and functions of the nephron, renal functions and regulation of glomerular filtration, composition and properties of urine, renal clearance and glomerular filtration rate, renal insufficiency and hemodialysis, role of kidney in water, electrolyte and acid base balance, disorders of acid-base balance.
7. Respiratory System: Anatomy of respiratory system, inspiration and expiration, composition of air, alveolar gas exchange, gas transport, systemic gas exchange, the effects of hydrogen ions, carbon dioxide, and oxygen on respiration, oxygen imbalance, chronic pulmonary diseases, smoking and lung cancer, infectious diseases (Pneumonia and Tuberculosis).
8. Nervous System: Structure and function of central nervous system and peripheral nervous system, neuron structure, nerve impulse, action potential, synaptic transmission, neurotransmitters.
9. Reproductive System: Male reproductive system, spermatogenesis and regulation of spermatogenesis, female reproductive system, oogenesis and its regulation, puberty, menstruation, menstrual cycle and its regulation, sterility and infertility, birth control strategies.
10. Aging: The theory of aging.

Books Recommended:

1. Human Biology. Sylvia S. Mader; (15th Edition) McGraw Hill, Boston, USA, 2017.

2. Anatomy & Physiology: The Unity of Form and Function. Kenneth S. Saladin; (8th Edition), McGraw Hill, Boston, USA, 2017.
3. Textbook of Medical Physiology. C Guyton and J. E Hall; (13th edition) W.B Saunders, Philadelphia, USA, 2017.
4. Review of Medical Physiology. W.F. Ganong; (10th edition) Prentice-Hall International, London 1997.
5. Human Physiology (vol.-I and vol.-II). C. C Chatterjee; Medical Allied Agency, Calcutta, India, 1997.

Course: BMB 2104, Credit: 3

Title: Basic Microbiology

1. Introduction: Historical development of Microbiology, Microorganisms, origin of microorganisms, types of microorganisms - bacteria, viruses, fungi, algae, protozoa, microscopy, characteristics of different types of microscope.
2. Bacteria: General features of bacteria, classification, nutritional aspects of bacterial cultivation, media composition, type and sterilization, growth and reproduction, isolation of pure culture from natural sources, enumeration and preservation of culture.
3. Viruses: General features of viruses, classification with representative examples, TMV and λ -phage, lytic cycle and lysogeny.
4. Fungi: General features of fungi, brief outline of growth and reproductive characteristics of major groups of fungi.
5. Microbes and Diseases: Pathogenicity and virulence, microbial toxins, common microbial infections such as diarrhea, respiratory infections, tetanus and tuberculosis, their transmission and prevention.
6. Microbial Metabolism and Physiology: Comparative study of the glucose catabolic pathways in microbes, the use of these pathways for various fermentation products such as ethanol, propanol, propionate, butyrate, butanol, formate and methane; metabolism of amino acids.
7. Microbes of Industrial Importance: Industrially important microbes, their sources.
8. Microbes and Environment: Nitrogen cycle, carbon cycle, sewage disposal, biogas production and microbial greenhouse gases.

Books Recommended:

1. Microbiology. James G. Cappuccino and N. Sherman; (4th Edition) Addison-Wesely, London, 1999.
2. Modern Medical Microbiology. M. R. Chowdhury; (5th Edition) BishwaParichaya, Dhaka, Bangladesh, 1999.
3. Text Book of Microbiology. R. Anathanarayan and C. K. JayaramPaniker; (5th Edition) Orient Longman Ltd., Hyderabad, India, 1996.
4. Modern Concepts of Microbiology. H. D. Kumar and S. Kumar; Vikash Publishing House, New Delhi, India, 1998.
5. Microbiology. Michael J. Pelczar, E.C.S. Chan and N. R. King; (5th edition) Tata McGrawHill Publishing Company Ltd, New Delhi, 1993.
6. A Textbook of Microbiology. R. C. Dubey and D. K. Mahehwari; S. Chand & Co., New Delhi, 1999.
7. Microbiology an introduction. Gerard J. Tortora, Berdell R. Funke, Christine L. Case; (12th edition) Pearson (2016).

Course: BMB 2105, Credit: 2

Title: Plant Biochemistry

1. Energy Transduction in Plants: Capture of energy, main organelles involved (chloroplast and mitochondria) and their fine structure; plant-light interaction in photosynthesis, different photoreceptors; biochemical mechanism of photosynthesis, chemistry and significance of photosystems, ATP biosynthesis, C3 and C4 metabolism, CAM metabolism by xerophytes, ecological significance of photosynthesis, Release of energy, nature of oxidoreduction, hydrogen and electron transfer, genesis of NADPH, photorespiration mechanism, hydrogen peroxide as end product of respiration.
2. The Phytochrome System: Chemistry and function of phytochromes in plant development, mechanism of phytochrome action; gene expression as influenced by phytochromes.
3. Biochemistry of Nitrogen Fixation: Biology of symbiotic nodule formation; biochemistry of dinitrogen splitting, mechanism of dinitrogenase action, energy cost of dinitrogen splitting; biochemistry of nitrogen assimilation by plants, molecular genetics of nitrogen fixation.
4. Plant Hormones: Type of plant hormones; structure, biosynthesis and mode of action of auxins, gibberellins, cytokinin, abscisic acid, ethylene hormones in signal transduction mechanism of hormone-gene interaction role in differentiation, embryogenesis organogenesis, micropropagation.
5. Secondary Metabolites: Types of major plant secondary metabolites, biosynthesis and biological significance of major terpenes, phenolic compounds and alkaloids; carotenoids; molecular mechanism of plant resistance to pests and pathogens.
6. Stress Metabolism: General effects of water and temperature stress; high temperature-induced stress. Heat shock proteins, regulation and functions of heat shock proteins; biochemistry of salt tolerance; salt-induced gene expression.

Books recommended:

1. Introduction to Plant Physiology. William G.Hopkins; (4thEdition) John Wiley & Sons, New York, 2008.
2. Cell Physiology. Arthur C. Giese; (5th Edition) W.B. Saunders Company. Philadelphia, USA.1998.
3. Plant Physiology. Lincoln Taiz and EdurradoZeiger; Benjamin/Cummings Publishing Co., California, U.S.A.2000.
4. Plant Biochemistry and Molecular Biology. Hans-Walter Heldt; (1st edition) Oxford University Press, Oxford, UK, 1997.
5. Fundamentals of plant Physiology. V. K. JAIN; S. Chand & Company, 1999.

Course: BMB 2106, Credit: 2

Title: Human Nutrition

1. Components of an adequate diet: Carbohydrate, fat, protein, vitamins and minerals in diet, interrelationship between fat, protein and carbohydrate metabolism.
2. Role of carbohydrates in human nutrition: Different forms of starch in food, their changes during food processing and cooking.
3. Role of proteins in human nutrition: Essential amino acids, limiting amino acid, mutual supplementation, protein quality and its evaluation, protein requirement.

4. Fats and oils in human nutrition: Saturated, monounsaturated and polyunsaturated fatty acids, omega-3 and omega-6 fatty acids in health, essential fatty acids.
5. Vitamins: Fat-soluble and water-soluble vitamins; coenzyme activities of vitamins.
6. Mineral and trace elements: Ca, P, Mg, Mn, Fe, Cu, I, F, Zn, Se, arsenic and other trace elements; role of trace elements in enzyme functions.
7. Energy metabolism: Energy balance, regulation of food intake, body composition (understanding fatness and weight, BMI, body fat distribution), energy requirement and major components of energy expenditure, obesity, basal metabolic rate, specific dynamic action of foods, measurement of energy metabolism, respiratory quotient.
8. Balanced diet: Diet in altered physiological conditions, pregnant and lactating mothers, growing children and elderly persons, Food supplementation.
9. Malnutrition: Over nutrition and under nutrition, classification and causes of protein energy malnutrition, Kwashiorkor and Marasmus (symptoms, and management) nutritional problem in Bangladesh, micronutrient (iron, iodine and zinc) deficiencies and public health concerns in Bangladesh.
10. Dietary management of diseases: Diabetes mellitus, gout, arteriosclerosis, obesity and goiter.
11. Life cycle nutrition: Maternal and infant nutrition, nutrition during childhood, adolescence and elderly stages of life.
12. Complementary nutrition (functional foods and dietary supplements): Functional foods, claims for functional foods, strategies for functional food use, food additives and preservatives, natural toxins in foods, dietary supplements: vitamins and minerals, natural health products.

Books Recommended:

1. Human Nutrition and Dietetics. J. S. Garrow, W. P. T. James and A. Ralph; (10th Edition) Churchill-Livingstone, 2002.
2. Introduction to Human Nutrition. Michael J. Gibney, Hester H. Vorster and Frans J. Kok; Blackwell Science, Oxford, UK, 2002.
3. Advanced Textbook on Food and Nutrition (Vol. I & II). M. Swaminathan; Bangalore Printing and Publishing Co. Ltd, Bangalore, 2003.
4. Perspective in Nutrition. Gordon M. Wardlaw, Paul M. Insel; (3rd Edition) WBC McGraw-Hill. USA, 1995.
5. Nutrition. Margaret S. Chaney, Margaret L. Ross; (8th Edition) Surjeet Publications. New Delhi, 1996.
6. Trace elements in Human and animal nutrition. Underwood; (4th edition) Academic Press (1977).
7. Human nutrition and dietetics. Davidson and Passmore; (8th Sub edition) Churchill Livingstone (February 1986).
8. Vitamins and coenzymes. L. Wegner and Folker; (1st edition) Academic Press (October 8, 1997).

Course: BMB 2107, Credit: 2

Title: Practical Biochemistry and Molecular Biology-III

1. Separation of pigments from plants by adsorption chromatography and determination of A_{\max} .
2. Determination of serum protein content by the biuret method.
3. Determination of glucose content of serum by Nelson -Somogyi method.

4. Determination of creatinine content of a urine sample.
5. Isolation of DNA.
6. Determination of the rate of a chemical reaction - iodination of acetone.
7. Isolation and determination of cholesterol from egg.
8. Determination of distribution coefficient of iodine in aqueous and organic layers.
9. Chemical synthesis of oil of wintergreen.
10. Chemical synthesis of aspirin.
11. Determination of pH of a solution.
12. Preparation of buffer and demonstration of buffer action.
13. Determination of pKa of a protein.
14. Determination of pI of glycine or alanine.

Course: BMBV 2108, Credit: 2

Title: Viva-voce

Second Year Second Semester (4th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 2201	Enzymology-II	2	30	50
BMB 2202	Metabolism-II	2	30	50
BMB 2203	Endocrinology	2	30	50
BMB 2204	Molecular Genetics	2	30	50
BMB 2205	Biostatistics	3	45	100
BMBL 2206	Practical Biochemistry and Molecular Biology-IV	3	90	100
BMBV 2207	Viva-voce	2	-	50
	Total	16	255	450

Course: BMB 2201, Credit: 2

Title: Enzymology-II

1. Regulatory enzyme: Allosteric enzymes: Properties, pattern of allosteric regulation (feedback inhibition and feed forward stimulation), kinetics (Hill equation), co-operativity, Monod and Koshland models of co-operativity, and study of an allosteric enzyme (aspartate transcarbamoylase).
2. Covalently modified enzymes: Phosphorylation and dephosphorylation, adenylation and deadenylation, Enzyme activation by proteolysis.
3. Isoenzymes: Lactate dehydrogenase, hexokinase with their characteristics and biological importance.
4. Mechanism of action of specific enzymes: Chymotrypsin, lysozyme, ribonuclease A, and carboxypeptidase A.
5. Membrane bound enzymes: Introduction, properties and biological significance of these enzymes.
6. Novel enzymes: Ribozymes.
7. Cofactors and coenzymes: Nature and source of co-factors and co-enzymes, examples of reactions using specific co-enzymes and co-factors.
8. Bioenergetics: Bioenergetics and thermodynamics, free energy, standard free energy change, high-energy compounds and their free energy change, the ATP cycle, occurrence and properties of ATP, central role of ATP in metabolism, other high energy compounds.

Books Recommended:

1. Text Book of Biochemistry. Albert L. Lehninger; (2nd Edition) Kalyani Publishers, New Delhi, 2000.
2. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman (April 8, 2015).
3. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman (November 21, 2012).

Course: BMB 2202, Credit: 2

Title: Metabolism-II

1. Amino acid metabolism: Overview of catabolism of amino acids, metabolic fates of amino groups, Nitrogen excretion and the urea cycle, link between urea cycle and citric acid cycle, glucogenic and ketogenic amino acids, oxidative degradation of amino acids to specialized products, amino acid biosynthesis, regulation of amino acid metabolism, metabolism of branched-chain amino acids, propionate and methylmalonate metabolism, nitrogen fixation, folic acid and one-carbon metabolism, glutathione metabolism. Clinical correlations: Phenylketonuria, alkaptonuria, folic acid deficiency, hyperammonemia and hepatic coma, and deficiencies of the urea cycle enzymes.
2. Heme metabolism: Biosynthesis and degradation of heme, regulation of heme metabolism, metabolic abnormalities.
3. Nucleotide metabolism: Overview, metabolic functions of nucleotides, synthesis of purine and pyrimidine nucleotides, formation of deoxyribonucleotides, nucleotide degradation, biosynthesis of nucleotide coenzymes, nucleotide metabolizing enzymes as a function of cell cycle and rate of cell division, antimetabolites of purine and pyrimidine nucleotide metabolism, regulation of nucleotide metabolism, Lesch-Nyhan syndrome, gout, orotic aciduria.
4. Metabolic interrelationships: Overview, starve-feed cycle, mechanisms involved in switching the metabolism of the liver between the well-fed state and the starved state, metabolic interrelationships of tissues in various nutritional and hormonal states, metabolism in physical exercise.
5. Metabolism of specialized tissues: Skeletal muscle, adipose tissues, liver, kidney, nervous tissue, lung, eye, blood cells and skin.
6. Metabolism of Xenobiotics: Introduction, general properties of xenobiotics, metabolism of xenobiotics, cell injury induced by xenobiotics, biological effects of xenobiotics, characteristics of Cyt.b450 conjugation, reduction, hydrolysis and oxidation as methods of xenobiotic metabolism.

Books Recommended:

1. Text Book of Biochemistry with Clinical Correlation. Thomas M. Devlin; (7th Edition.) John Wiley & Sons (January 19, 2010).
2. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition) W.H. Freeman (November 21, 2012).
3. Text Book of Biochemistry. Albert L. Lehninger; (2nd Edition) Kalyani Publishers, New Delhi, 2000.
4. Harper's Biochemistry. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell; (30th Edition) McGraw-Hill Education / Medical; January 8, 2015.
5. Biochemistry. Lubert Stryer; (8th Edition) W. H. Freeman (April 8, 2015).
6. Biochemistry. Pamela C. Champe; (2nd Edition.) Lippincott-Raven Publishers, East Washington Square, USA, 1994.

Course: BMB 2203, Credit: 2

Title: Endocrinology

1. Characteristics of hormone: Introduction, general functions of hormones, major endocrine glands, paracrine, autocrine, juxtacrine and intracrine actions of hormone, hormone receptors and its abnormalities, factors affecting hormonal secretion.
2. Hormone action: Intracellular messengers, synthesis of mode of action of 3', 5' cyclic AMP and functions of 3', 5' 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, release, metabolism and mechanism of action.
7. Hormones of gonads: Structure, biosynthesis, metabolism, mechanism of action.
8. Pancreatic hormones (Insulin, glucagons): Structure, synthesis, secretion, distribution and degradation and mode of action.
9. Gastrointestinal hormones: Gastrin, cholecystokinin (CCK), secretin, glucagon, gastric inhibitory polypeptide (GIP), vasoactive intestinal polypeptide (VIP), glicentin, neurotension, substance P and somatostatin.
10. Hormone assay techniques: Assay of peptide and steroid hormones by radio immunoassay (RIA) and enzyme – linked immunosorbent assay (ELISA).

Books Recommended:

1. Harper's Biochemistry. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell; (30th Edition) McGraw-Hill, International Edition, 2015.
2. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6th Edition.) Worth Publishers, USA, 2012.
3. Text Book of Biochemistry. Albert L. Lehninger; (2nd Edition) Kalyani Publishers, New Delhi, 2000.
4. Text Book of Biochemistry with Clinical Correlation. Thomas M. Devlin; (7th edition) John Wiley & Sons (January 19, 2010).
5. Human Physiology. Chakrabarti, Gosh & Sahana.
6. Textbook of Biochemistry. A.S. Saini.
7. Lecture Notes on Endocrinology. William Jeffcoate.

Course: BMB 2204,Credit: 2

Title: Molecular Genetics

1. Principles of inheritance: Allelic variation and genetic function, generation: genotype and phenotype, chromosome and chromosomal basis of inheritance, chromosome structure and function.
2. General nature of mutation : Types of mutation (mis-sense, same-sense and nonsense mutation, deletion and lethal mutation and frame shift mutations), physicochemical mutagens, molecular mechanism of mutation, *in vitro* mutagenesis, site-directed mutagenesis, mutation by transposons and retroposons, mutations induced by radiation, repair mechanism in mutation, mutation rate and its measurement, mutations in human (deleterious and recessive). Screening of carcinogens (Ames Test).
3. Recombination: Various models for recombination, biochemistry of recombination system and site specific recombination.
4. Genetics of viruses, bacteria and fungi: Mechanisms of genetic exchange in bacteria, conjugation, transduction, transformation and transfection, restriction mapping, chromosome walking, genetics of lambda phage, assembly of T phage.
5. Linkage and chromosome mapping in higher organism: Recombination and crossing over, exception to Mendelian principles of independent assortment, frequency of recombination as a measure of linkage intensity, crossing over as physical basis of recombination, chiasma and time of crossing over, recombination with two and three point cross over, recombination frequency and genetic map distance, Linkage analysis in chromosome (human), gene and pedigree patterns.
6. Cytogenetics: Cytological techniques: Analysis of mitotic chromosome, the human karyotype, Cytogenetic variation: an overview, polyploidy, aneuploidy, trisomy and monosomy and mosaicism, deletion and duplication of chromosome segments, invasion translocation, compound chromosomes and Robertsonian chromosomes.
7. Gene expression: Constitutive, inducible and responsible gene expression, positive and negative control of gene expression, attenuation of *trp* operon, autogenous regulation of – operon. The *lac* and *trp* operons, control of gene expression for both prokaryotic and eukaryotic systems. Autogeneous regulation of gene expression.

Books recommended:

1. Gene Function. Robert E Glass; Croom Helm Ltd, 1982.
2. Genetics of Bacteria and their Viruses. W. Hayes; Oxford, Blackwell. 1968.
3. Genetics. U. Goodenough and R.P. Levine; Holt, Reinhert and Winston Inc., New York, 1973.
4. Molecular Biology of the Gene. J. D. Watson; USA, 1998.
5. Principles of genetics. Snustad, Simons and Jenkins; (6th edition) John Wiley and Sons (August 23, 2011).
6. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (6thEdition.) Worth Publishers, USA, 2012.
7. Biochemistry. LubertStryer; (8th Edition) W. H. Freeman and Company, New York, 2012.
8. Text Book of Biochemistry with Clinical Correlation. Thomas M. Devlin; (7th Edition) A John Wiley & Sons Inc., New York, 2010.

Course: BMB 2205, Credit: 3

Title: Biostatistics

1. Introduction: Meaning of biostatistics, need and scope of biostatistical analysis in biochemistry, concept of variable, measurement and measurements scales.
2. Descriptive Statistics: Methods of collection of data, construction of frequency distribution and relative frequency distribution, graphical representation of data, measures of central tendency, measures of dispersion, methods of computation, uses, merits and demerits of all these measures, stem-and-leaf plot, box-and-whisker plot, skewness and kurtosis and their measures.
3. Probability and Probability Distributions: Basic concepts of Probability, elementary properties of probability, conditional probability, Bayes theorem and its application, screening tests, sensitivity, specificity, random variable, probability mass function, probability density function, mathematical expectation and variance of a random variable, Probability distributions: Binomial distribution, Poisson distribution, Normal distribution, Exponential distribution and their applications.
4. Sampling and Sampling Distributions : Concepts of population, sample, parameter, statistic, random sample, different sampling methods and their applications, sampling distribution, standard error and their uses, sampling distribution of the sample means, determination of sample size for estimating means.
5. Test of Hypothesis: Definition of statistical hypothesis, simple and composite hypothesis, procedure of a test, errors in testing of hypothesis, level of significance, one and two tailed tests, p-value, confidence interval, tests based on usual normal, chi-square (χ^2), t and F statistic, Nonparametric and distribution-free tests.
6. Analysis of Variance: Introduction, completely randomized design, randomized block design, latin square design, repeated measures design, factorial experiment.
7. Regression and Correlation: Introduction, regression model, simple regression, evaluating the regression equation, multiple regression, correlation analysis, simple, multiple and partial correlation, logistic regression.
8. Chi-Square Distribution: Introduction, tests of goodness-of fit, tests of independence, tests of homogeneity, the fisher exact test, relative risk, odds ratio and the Mantel-Haenszel statistic, survival analysis.
9. Vital Statistics: Introduction, death rates and ratios, measures of fertility and measures of morbidity.

Books Recommended:

1. Biostatistics: A Foundation for Analysis in the Health Sciences. Daniel, Wayne W; (7th Edition) John Wiley, New York, 1993.
2. Manual of GraphPad Prism, Statview 4.0, GBStat5, SPSS 12.
3. Biostatistics. Lewis, Alvin Edward; (2nd Edition) Van Nostrand Reinhold, NewYork, 1984.
4. Fundamental of Biostatistics. Rosner, Bernard; (2nd Edition) Duxbury Press, Boston, 1986.
5. Statistics: A Biomedical Introduction. Brown, Byron Wm and Myles Hollander; John Wiley, New York, 1977.
6. Methods in Biostatistics for Medical Students and Research Workers. B K Mahajan; (6th Edition) Jaypee Brothers Medical Publishers Pvt. Ltd, India, 1997.
7. Statistical Methods for Survival Data Analysis. Lee, Elisa T; (2nd Edition) John Wiley, New York, 1992.
8. Introductory Practical Biostatistics. Misra, B. N. and M. K. Misra; Nayaprokash, Calcutta, 1983.

Course: BMB 2206, Credit: 3

Title: Practical Biochemistry and Molecular Biology -IV

1. Determination of K_m and V_{max} of urease, glucose oxidase or alkaline phosphatase.
2. Collection of serum and plasma from human peripheral blood.
3. Determination of serum triglycerides by the enzymatic method.
4. Determination of serum total cholesterol by the cholesterol oxidase method.
5. Determination of serum HDL cholesterol by precipitation and the cholesterol oxidase method.
6. Determination of serum alanine aminotransferase by the enzymatic method.
7. Determination of serum aspartate aminotransferase by the enzymatic method.
8. Determination of serum total bilirubin by colorimetry.
9. Determination of serum alkaline phosphatase by colorimetry.
10. Determination of serum urea by the enzymatic method.
11. Determination of serum creatinine by colorimetry.
12. Determination of the total red blood cell count from a blood sample.
13. Determination of hCG from urine.
14. Estimation of inorganic phosphate.

Course: BMBV 2207, Credit: 2

Title: Viva-voce

Third Year First Semester (5th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 3101	Basic Immunology	3	45	100
BMB 3102	Fundamentals of Genetic Engineering and Biotechnology	3	45	100
BMB 3103	Molecular Biology-III	2	30	50
BMB 3104	Sports Nutrition	2	30	50
BMB 3105	Biochemistry and Molecular Biology of Diseases	2	30	50
BMB 3106	Environmental Biochemistry	2	30	50
BMBL 3107	Practical Biochemistry and Molecular Biology-V	2	60	50
	Total	16	270	450

Course: BMB 3101, Credit: 3

Title: Basic Immunology

1. Introduction: Adaptive and innate immunity cells of the immune system, soluble mediators of immunity- complement, cytokines, antigens and antibodies, immune responses, clonal selection, immune effector mechanisms-inflammation, chemotaxis, phagocytosis, defense against intracellular and extracellular pathogens, vaccination, immunopathology.
2. Cells involved in immune response: Lymphoid cells, morphological heterogeneity of lymphocytes, cell surface markers. T cells, B cells, Natural killer cells, lymphocyte activation and proliferation, mononuclear phagocytes, antigen-presenting cells, polymorphonuclear granulocytes and platelets, neutrophils, eosinophils, basophils, and mast cells.
3. Immunoglobulins: Distribution, classes and subclasses, physicochemical properties and functions of human immunoglobulin classes, general properties and structure of immunoglobulins in relation to function, Antibody structure and its effector functions,

enzymatic cleavage of human Ig, structure in relation to antigen binding, genetic basis of antibody heterogeneity.

4. Antigens: Antigenicity and immunogenicity, antigenic determinants, haptens, antigen antibody binding, antibody affinity and avidity, antibody specificity and cross reactivity, physiological significance of high and low affinity antibodies.
5. Complement: Activities of complement proteins, activation of complement, classical pathway, regulation of classical pathway activation, alternative pathway of complement activation, the lectin pathway, regulation of amplification loop, formation and regulation of membrane attack complex, biological effects of complement.
6. Techniques to study antigen-antibody interactions: Precipitation, agglutination, Immunodiffusion, single-radial Immunodiffusion, double Immunodiffusion, immuno-electrophoresis, countercurrent electrophoresis, rocket electrophoresis, immunofluorescence, complement fixation, radio-immuno assay, Enzyme linked immunosorbent assay (ELISA).

Books Recommended:

1. Immunology. Ivan Roitt, Jonathan Brostoff, and David Male; (8th Edition) Mosby- Elsevier Science Ltd, London, 2002.
2. Essential Immunology. I. M. Roitt; (13th edition) Blackwell Scientific Publication. London 2017.
3. Basic Immunology. Abul A,abbas and Andrew H. Lichtman; (5th Edition), Elsevier, a division of Reed Elsevier Private Ltd., 2015.

Course: BMB 3102, Credit: 3

Title: Fundamentals of Genetic Engineering and Biotechnology

1. Enzymes used in genetic engineering, DNA-polymerases, ligases, reverse-transcriptases, SI nuclease, exonucleases and endonucleases.
2. Gene linkage and chromosomes mapping, gene mapping of human chromosomes.
3. Transposons and retrotransposons: Bacterial transposons: definitions, differences among transposons, retrotransposons and IS elements, general features of transposons, structures of typical transposons (T_n3, T_n9), model for the transpositions, transposons in eukaryotes (T_y element in yeast), mobile elements in eukaryotes (pseudogenes and Alu sequences).
4. Gene manipulation:
 - (a) Genetic recombination: General recombination by base pairing, interactions between complementary strands of two homologous DNA molecules, recA protein.
 - (b) Genetic engineering: Joining of DNA molecules, cohesive and blunt end joining, addition of linker, adaptors and homopolymers, constructions of genomic and cDNA library, screening, cloning and plaque hybridization, cloning of a particular fragment of gene in different vectors, expression of the recombinant DNA molecules.
 - (c) Applications of genetic engineering in medicine and agriculture (Production of insulin, growth hormones and vitamins).
5. Techniques in molecular biology: Polymerase chain reaction (PCR), Sanger's dideoxy chain termination method for DNA sequencing, radio labeling of DNA fragments, agarose and acrylamide gel electrophoresis. Southern, northern and western blotting. Site directed mutagenesis, mutagenesis of cloned genes, importance of site directed

- mutagenesis, PCR mutagenesis.
6. Cloning Vectors: Construction of plasmid vectors, Lambda phage DNA and M13-based expression vectors for eukaryotic expression, genomic and cDNA libraries.

Books Recommended:

1. Molecular Biology. P.C. Turner, A.G. McLennan and M.R.H. White.
2. Recombinant DNA. J.D. Watson and M. Zoller.
3. Molecular Biology of Cell. Bruce Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, J. D. Watson.
4. Genes VI and VII. Benjamin and Lewin.
5. Molecular cell biology. Darnell J; Loddis H. and Baltimore D.
6. Principles of Gene Manipulation. R. W. Old and S. B. Primrose; (5th Edition) Blackwell Science, 2002.
7. Gene Cloning. T. A. Brown; Chapman and Hall, 1990.
8. An Introduction to Genetic Analysis. A.J. F. Griffiths, J. H. Miller, David T. Suzuki, Pichard. Lewontin and William C. Gelbart; (6th Edition) Freeman and Company, New York, 1996.
9. Gene Cloning and Genetic Manipulation. Christopher Howe; Cambridge University Press, 1995.
10. Molecular Cloning. T. Maniatis, E. F. Fritsch and J. Sambrook; Cold Spring Harbour Laboratory, 1982.

Course: BMB 3103, Credit: 2

Title: Molecular Biology-III

1. DNA damage and repair: DNA damage by mutagens and repair by different enzymes.
2. Nucleic acid hybridization principles and application: Preparation of nucleic acid probes, fluorescence labeling and detection system, standard and reverse nucleic acid hybridization assays, Southern blotting.
3. Genetic codes: Introduction, codons and triplet words, codon-anticodon interactions, sporadic alterations in the genetic code, nonsense and their suppressors, recoding and changes of the meaning of codon, codon redundancy.
4. Transcription: Prokaryotic and eukaryotic transcriptions, RNA polymerases, regulation of transcription, eukaryotic transcription factors, transport of eukaryotic mRNA, UTRs, promoters, transcription activators and transcription factors, enhancers and terminators, mechanism of RNA splicing and RNA processing, mRNA structure and its relation to stability, tissue specific gene expression. Transcriptional and posttranscriptional regulation. Introduction to protein-protein and other macromolecular interactions.
5. Protein biosynthesis: Ribosome structure, active sites in each subunit, protein synthesis - initiation, elongation and termination; control of translation in both prokaryotes and eukaryotes, peptidyltransferase activity of 23S rRNA, polysomes and their importance.
6. Application of DNA markers: RFLP, AFLP, SSR, RAPD and SNP (including assay).

Books recommended:

1. Genes VII. Lewin B; (8th edition) Oxford University Press.
2. Molecular Cell Biology. Darnell, J., Lodish, H. and Baltimore D.; (5th edition) W.H. Freeman and Company, New York.

3. Molecular Biology of the Cell. Alberts, B. Bray, D. Lewis, J.; (4th edition) Garland Publishing, Inc. New York.
4. Molecular and Cellular Biology. Wolfe, S.L., Wardsworth, Belmont, CA.
5. Cell and Molecular Biology. Gerald Karp; 8th edition.

Course: BMB 3104, Credit: 2

Title: Sports Nutrition

1. Basic Nutrition:
 - a. Role and importance of nutrition
 - b. Energy: Energy balance, Basal metabolism, factors affecting BMR, methods of determination factors affecting respiratory quotient (RQ). Factors affecting RQ
 - c. Macronutrients and Micro nutrients
 - d. Interrelation between nutrients.
2. Sports science, Exercise Physiology:
 - a. Human Anatomy: Musculo skeletal system, Types of contraction, Body temperature & control and its effects on sports performance.
 - b. Aerobic capacity, RQ, anaerobic threshold using various protocol, athletic heart, determination of energy expenditure in sports & non-sports activity using various methods.
 - c. Effect of training on heart & lung performance, importance of heart rate monitoring, index of training, over training & detraining, basis of fatigue & recovery
 - d. Tests for monitoring of sports training, endurance, strength, flexibility, & reaction time
 - e. Effect of Exercise on Various Body Systems: Body Composition, Respiratory system, cardiovascular system, Nervous system, excretory system, Endocrine system.
3. Energy system and exercise.
4. Psychological theories and principles applied to performance/participation in sport/exercise.
5. Understand the nutritional requirements for physical activity and the relationships between diet and training for optimum performance.
6. Sports Nutrition:
 - a. Carbohydrates, Protein and Lipid in Sports Nutrition
 - b. Micro Nutrients in Sports Nutrition
 - c. Energy Requirements
 - d. Water & electrolytes balance
 - e. Ergogenic aids and Doping, Injury Supplementation
 - f. Training nutrition, pre-competition nutrition, competing nutrition and recovery nutrition.

7. Plan diets for achievement of optimum weight and peak performance.
8. Athletes and eating disorders.

Books recommended:

Nutrition for Sport and Exercise. Dunford and Doyle; (2008) Thomson/Wadsworth Publishing.

Course: BMB 3105, Credit: 2

Title: Biochemistry and Molecular Biology of Diseases

1. Diseases: Interpretation, diagnosis of diseases using specific parameters, true positive, false positive, true negative and false negative; use of different approaches for disease diagnosis - microbial and parasitic infection, reliability of diagnostic approach.
2. Biochemistry of various diseases: Biochemical interpretation of the causes and possible treatment options - hepatitis, diabetes, obesity, gout, rheumatoid arthritis, malabsorption syndrome, acidosis and alkalosis. Major lipid metabolism in vascular dysfunction and its contribution to oxidative stress and platelet function in lipoprotein influx and efflux in protein oxidation, atherosclerosis, and other diseases. Thyroid dysfunction, HRT.
3. Genetic basis of biochemical disorders:
 - (i) Karyotyping for uneven chromosome distribution - Down syndrome, Turner syndrome, Klinefelter syndrome and other diseases.
 - (ii) Genetic basis of autosomal and X-linked dominant and recessive disorders citing specific examples of each type.
4. Microbial and viral diseases: Introduction to bacterial and viral diseases - cholera, shigellosis, viral hepatitis, AIDS, influenza.
5. Parasitic diseases: Identification by using biochemical and molecular markers and immuno techniques.

Books Recommended:

1. Text Book of Medical Physiology. John E. Hall;(3rd Edition) Elsevier.
2. Medical Biochemistry (Human Metabolism in Health & Disease). Miriam D. Rosenthal and Robert H. Glew, John Wiley.

Course: BMB 3106, Credit: 2

Title: Environmental Biochemistry

1. Introduction: Concept of environment and its relation to society and principles of environment.
2. Ecological concept and natural resources: Introduction to ecological perspectives, environmental components, levels of organization of environmental components, eco system processes, environmental changes and climate changes.
3. Air pollution: Particulate matter, compounds of carbon, sulphur, nitrogen and their interactions, methods of their estimation, their effect on atmosphere.
4. Water pollution: Types of water bodies and their general characteristics, major pollutants in domestic and industrial water, methods of their estimation, effects of pollutants on plants and animals. Pollution of water by microorganisms, bacteriological analysis of water-sewage treatment-home and industrial.
5. Agricultural pollution: Introduction, nutrient cycle, nutrient losses, waste production in agricultural farms.
6. Chemical toxicology: Toxic chemicals in the environment, impact of toxic chemicals on enzymes. Biochemical effects of Ar, Pb, Cd. Hg. Biochemical effects of CO, NO_x, SO_x, pesticides. Bioremediation for environmental cleanup. Biomass utilization and microbial degradation of Xenobiotics.
7. Minimization of pollution: Benefits of pollution minimization, elements of pollution minimization, controlling of life cycle in pollution minimization and pollution minimization techniques.

Books recommended:

1. Comprehensive Biotechnology (Vol. 1-4). M. Y. Young (Eds.); Pergamon Press, Oxford.
2. Environmental Microbiology. W.D. Grant & P.E. Long, Blakie; Glasgow and London.
3. Microbial Gene Technology. H. Polasa (ED.); South Asian Publishers, New Delhi.
4. Environmental Biotechnology: Principles and Applications; Bruce Rittmann and Perry McCarty.
5. Environmental Biotechnology. Alan Scargg; (2nd edition) OXFORD international Press.
6. Molecular Biotechnology: Principles & Applications of Recombinant DNA. B. R. Glick & J. J. Pasternak; 4th edition.
7. Molecular Biotechnology. S.B. Primrose; (2nd edition) Blackwell Scientific Pub. Oxford.

Course: BMBL 3107, Credit: 2

Title: Practical Biochemistry and Molecular Biology-V

(a) Isolation/separation and assay of biomolecules:

1. Liver glycogen extraction and estimation.
2. Thin layer chromatographic separation of amino acids.

(b) Enzymology:

1. Determination of serum GOT and GPT activity.
2. Study on the activity of salivary amylase.
3. Assay of heart succinic dehydrogenase and cytochrome oxidase.

(c) Study on the solubility and precipitation of proteins:

1. Effect of ionic strength on protein solubility.
2. Determination of total globulin in serum by precipitation.
3. Effect of pH on protein solubility (precipitation of serum albumin and globulin at their respective pI).
4. Isolation of casein by precipitation at its isoelectric point.

(d) Study on the separation and determination of fatty acids/lipids:

1. Determination of non-esterified fatty acids from serum.
2. Determination of brain phospholipid.
3. Separation of components of a lipid mixture by TLC.

Third Year Second Semester (6th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 3201	Cell Biology	3	45	100
BMB 3202	Clinical Biochemistry	2	30	50
BMB 3203	Pharmaceutical Chemistry	2	30	50
BMB 3204	Bioenergetics	2	30	50
BMB 3205	Plant Biotechnology	2	30	50
BMBL 3206	Practical Biochemistry-VI	3	90	100
BMBV 3207	Viva-voce	2	-	50
	Total	16	255	450

Course: BMB 3201, Credit: 3

Title: Cell Biology

1. The cytoskeleton: Muscle contraction, ciliary movement, general features of microtubules and actin filaments as dynamic assemblies, microtubule organizing centers and microtubule associated proteins, actin filaments and actin binding proteins in nonmuscle cells, intermediate filaments, organization of the cytoskeleton.
2. Cell growth and cell division: Control of cell division, tumor viruses as tools for studying the control of the cell cycle events in the S phase, the logic of the cycle, cell division. Cell-cell adhesion: The extracellular matrix, intercellular recognition and cell adhesion, cell junctions.
3. Chemical signaling between cells: Three different strategies of chemical signaling, local chemical mediators, hormones and neurotransmitter, signaling mediated by intracellular receptors; mechanism of steroid hormone action, signaling mediated by cell surface receptors, cyclic AMP and calcium ions as second messengers, involvement of G-proteins in signal transduction, target cell adaptation.
4. Germ cells and fertilization: The benefits of sex, meiosis, gametes, and fertilization.
5. Cellular mechanisms of development: Cleavage and blastula formulation, gastrulation, neurulation and somite formation, early steps in pattern formation; Determination and differentiation, patterns in space, positional information, limb development, inductive interactions in the development of epithelia.

6. Differentiated cells and the maintenance of tissues: Maintenance of the differentiated state, tissues with permanent cells, renewal by simple duplication, renewal by stem cells, epidermis, renewal by pluripotent stem cells, blood cell formation, quiescent stem cells, skeletal muscle, soft cells and tough matrix, growth turnover, repair of skeletal connective tissue, territorial stability in the adult body.

Books Recommended:

1. The Cell: a molecular approach. Geoffrey M. Cooper, Robert E. Hausman; (3rd Edition) ASM Press, Washington, D.C., 2004.
2. Molecular Biology of the Cell. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; (4th Edition) Garland Science, New York, 2002.
3. Biochemistry. Lubert Stryer; 3rd edition.
4. Lehninger's Principle of Biochemistry. David L. Nelson and Michael M. Cox.
5. Genes VI. Benjamin Lewin.
6. Cell and Molecular Biology, E.D.P. De Robertis and E.M.F. De Robertis, Jr.; 8th edition.

Course: BMB 3202, Credit: 2

Title: Clinical Biochemistry

1. Disease and its Diagnosis: Diseases, causes of diseases, parameters of diseases (symptoms, sign and lesion), Significance of diagnostic test, hazards in diagnostic tests, quality control of laboratory services, characteristics of laboratory data (accuracy and precision), reference values, unexpected test results, strategies and cautions taken in such cases.
2. Specimen collection and preservation for diagnostic tests: Biochemical analysis in body fluids (in blood, urine, cerebrospinal fluid, transudates and exudates, amniotic fluid and synovial fluids), collection and preservation of specimen in laboratory, use of preservatives.
3. Clinical application of enzymes, metabolites and electrolytes:
 - (a) Enzymes: Preference of enzymes as diagnostic tools, plasma enzymes, factors considered in enzyme diagnosis, mechanism of leakage of enzyme from tissue, some diagnostically important enzymes: creatine kinase (CK), alanine amino transferase (ALT), aspartate amino transferase (AST), lactate dehydrogenase (LDH), acid phosphatase (ACP), alkaline phosphatase (ALP), amylase and lipase.
 - (b) Metabolites: Creatinine, CCR, Urea, BUN, Uric acid, Cholesterol, Bilirubin and glucose.
 - (c) Electrolytes: Na^+ , K^+ , Cl^- and HCO_3^- .
4. Introduction to genetic disorders: Mutation, effect of mutation, general classification of diseases, metabolic disorders, basis of metabolic disorders, mode of expression, diagnosis and treatment/preventative measures of genetic/metabolic disorders, inheritance of genetic disorders: autosomal dominant inheritance, autosomal recessive inheritance, X-linked dominant inheritance, and X-linked recessive inheritance, structural genetic disorders; Down's syndrome, Turner's syndrome and Klinefelter's syndrome.

5. Genetic/metabolic disorders: Hemophilia, Hemolytic anemia, Sickle cell anemia, Pernicious anemia, Thalassemia, PKU, Alkaptonuria, Galactosemia, Fructose intolerance, Glycogen storage diseases, Lipid storage diseases, Malabsorption syndrome, Hyperuricemia and Gout.
6. Common diseases: Diabetes mellitus, obesity, jaundice, cirrhosis, hepatitis, rheumatoid arthritis, atherosclerosis, acidosis and alkalosis.

Books Recommended:

1. Clinical chemistry: Interpretation & Technique. Alex Kaplan & Laverne L. Szabo; (2nd Edition) Lea & Febiger, Washington square, Philadelphia, U.S.A., 1998.
2. Robbins Pathologic Basis of Disease. Ramzi S. Cotran, Vinay Kumar, Stanley L. Robbins; (4th Edition) W. B. Saunders Company, Philadelphia, 1989.
3. Applied Biochemistry of Clinical Disorders. Allan G. Gornall; (2nd Edition) J. B. Lippincott Company, Philadelphia, 1986.
4. Text Book of Biochemistry with Clinical Correlation. Thomas M. Devlin; (5th Edition) A John Wiley & Sons Inc., New York, 2002.
5. Harper's Biochemistry. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell; (25th Edition) McGraw-Hill, 2003.

Course: BMB 3203, Credit: 2

Title: Pharmaceutical Chemistry

1. Drug: Definition, dosage forms, administration of drugs and routes of administration.
2. Pharmacokinetics: Definition, drug absorption and bioavailability, distribution of drugs, metabolism of drug: pathways of drug metabolism, factors affecting drug metabolism; methods of studying drug metabolism, new aspects of drug metabolism; excretion of drugs.
3. Pharmacodynamics: Definition, mechanisms of drug action, cellular sites of drug action, drug receptors, structure-activity relationship, binding forces in the drug receptor interaction, receptors for physiological regulatory molecules, physiological receptors, regulation of receptors, consequence of drug receptor interaction, receptor pharmacology, analysis of the graded dose response relationship, classical receptor theory, actions of drugs that are not directly mediated by receptors.
4. Toxicology: Principles of toxicology, dose-response relationship, drug toxicity, risk assessment, acute versus chronic exposure, chemical forms of drugs that produce toxicity, spectrum of undesired effects, evaluation of drug toxicity in lower animals, LD₅₀, ED₅₀, TD₅₀, design of toxicity tests, toxicological procedures in animals.
5. Drug Allergy: Key features of drug allergy, immunologic basis of drug allergy, types of drug allergy, tests for prediction of drug allergies, desensitization and management of drug allergies in man.
6. Drug design:
 - (i) Design of drug by molecular modification (general process, special process-ring closure or opening, introduction of double bond/chiral centre, introduction of removal or replacement of bulky groups. introduction of alkylating moieties, isoteric substitution); methods of lead optimization (Tobli's sequential method).
 - (ii) Drug latentiation, pro-drugs.
 - (iii) Rational drug design, Anti-metabolites and enzyme inhibitors.

7. Pilot Plant Scale Up Techniques: Primary functions of the pharmaceutical pilot plant, factors to be considered during development, reporting responsibilities, personnel requirements, space requirements, review of the formula, raw materials, relevant processing equipments, production rates, process evaluation, master manufacturing procedures, GMP consideration.

Books Recommended:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics. J G Hardman and LE Limbird; McGraw Hill Inc.USA 2000.
2. Lippincott's Illustrated Reviews: Pharmacology. Mary J. Mycek, Richard A. Harvey and Pamela C. Champe; (2nd Edition), Lippincott-Raven Publishers, 2000.
3. Principles of Drug Action. A Goldstein, L Aronow and S.M. Kalman; (2nd Edition) John Wiley & Sons Inc. New York.Chichester.Brisbane.Toronto.Singapore, 1974.
4. Essentials of Medicinal chemistry. Korolkovas; USA, 1998.

Course: BMB 3204, Credit: 2

Title: Bioenergetics

1. Bioenergetics and metabolism: The cycling of carbondioxide and oxygen between autotroph and heterotrophs, cycling of nitrogen in the biosphere, energy relationship between catabolic and anabolic pathways.
2. Bioenergetics and thermodynamics: Biological energy and laws of thermodynamics; Free energy, entropy and heat content and their impact on biology, free energy changes and equilibrium constant in biochemical systems, phosphate group transfer and ATP; other phosphorylated compounds and free energy of hydrolysis, utilization of ATP in firefly flashes, assembly of informational macromolecule, active transport and muscle contraction, energetics of glucose and fatty acid metabolism and thermodynamic efficiency, comparison of the energetics of fermentation and respiration.
3. Biological oxidation-reduction reaction: Flow of electron and biological work, oxidation-reduction reaction and half reaction, ways of electron transfer from one molecule to another, measurement of reduction potential, relationship of standard reduction potentials with free energy, universal electron carriers.
4. Energetics of oxidative phosphorylation: Salient feature of oxidative phosphorylation,structure of mitochondria, redox potential and free-energy change, description of electron transport chain, three dimensional structure of cytochrome-c and its structural conservation, the chemiosmotic hypothesis and its evidence, evidence of generation of proton gradient, structure of ATP synthase, binding change mechanism for ATP synthase, glycerol phosphate and malate-aspartate shuttles for entry of electrons from cytoplasmic NADH into mitochondria, function of ATP-ADP translocase, Respiratory control, short-circuit of proton gradient, power transmission by proton gradient, energy coupled regulation of oxidative phosphorylation.

5. Photosynthesis: Definition, thylakoid membrane, discovery of equation of photosynthesis, trapping of solar energy by chlorophyll, photosynthetic unit, O₂ evolution in photosynthesis, Hill reaction, photosystem I and II, mechanism of formation and release of O₂, pathway of electron flow from H₂O to NADP⁺, electron flow in cyclic photophosphorylation, ATP synthase of chloroplast, Calvin cycle, dark and light reaction, C₄ pathway of tropical plants.

Books Recommended:

1. Text Book of Biochemistry. Albert L. Lehninger; (2nd Edition) Kalyani Publishers, New Delhi, 2000.
2. Biochemistry. Lubert Stryer; (4th Edition) W. H. Freeman and Company, New York, 1995.
3. Lehninger's Principles of Biochemistry. David L. Nelson and Michael M. Cox; (4th Edition.) Worth Publishers, USA, 2005.
4. Biochemistry. J. David Rawn.
5. Text Book of Biochemistry. Thomas M. Devlin.

Course: BMB 3205, Credit: 2

Title: Plant Biotechnology

1. Plant cell culture and applications: Manipulation at cellular level, totipotency of plant cells, somatic embryogenesis, organogenesis, recalcitrant plants, micropropagation and applications, disease-free plants, protoplast culture and fusion with reference to cybrids and cytoplasmic male sterility, anther culture and applications for breeding, commercialization of tissue culture technology, plant tissue culture as a basis for genetic engineering.
2. DNA markers and application for breeding: Fingerprinting for assessment of germplasm, concept of polymorphism, mapping and breeding populations, linkage of marker to trait of interest, marker-aided selection for breeding.
3. Plant genetic transformation – prospects and potential: Current status, characters transformed, techniques for plant transformation such as agrobacterium-mediated and biolistics, use of constitutive, tissue-specific and stress-specific promoters for transformation, molecular assessment of transgenic status and inheritance of transgenes, gene silencing, current status of chloroplast transformation and advantages, plants as bioreactors and vaccine production systems, biosafety issues, GM crops.
4. Discovery/cloning of plant genes: Probe-based-screening, genomic and proteomic approaches, map-based cloning, transposon tagging, isolation by T-DNA insertion, functional characterization by gene mutagenesis/silencing.

Books recommended:

1. Introduction to Plant Physiology. William G. Hopkins; (2nd Edition) John Wiley & Sons, New York, 1999.
2. Cell Physiology. Arthur C. Giese; (5th Edition) W.B. Saunders Company. Philadelphia, USA. 1998.
3. Plant Physiology. Lincoln Taiz and Eduardo Zeiger; Benjamin/Cummings Publishing Co., California.

U.S.A.2000.

4. Plant Biochemistry and Molecular Biology. Hans-Walter Heldt; Oxford University Press, Oxford, UK, 1997.
5. Fundamentals of plant Physiology. V. K. JAIN; S. Chand & Company, 1999.
6. Plant Biotechnology and Development, SRC Series of Current Topics in Plant molecular Biology. Gresshoff, P.M.
7. Plant Cell Culture. Advances in Biochemical Engineering and Biotechnology. Anderson, L.A.
8. Recombinant DNA. Watson, 1992.
9. Plant Tissue Culture: Application and Limitations. Bhowjwani, S.S., 1990.
- 10 Plant Cell Culture: A practical approach. Dixon, 1994.

Course: BMBL 3206, Credit: 3

Title: Practical Biochemistry and Molecular Biology-VI

A : General Biochemistry

- (a) Isolation/separation and assay of biomolecules:
 1. Thin layer chromatographic separation of amino acids.
 2. Estimation of acetoaminophen and salicylate in serum.
- (b) Enzymology:
 1. Determination of K_m and V_{max} of bovine kidney alkaline phosphatase.
 2. Determination of serum acid phosphatase.
 3. Assay of muscle lactate dehydrogenase and coenzyme NAD^+ .
 4. Assay of pancreatic lipase.
- (c) Study on the separation and determination of fatty acids/lipids:
 1. Determination of total fatty acids in a lipid extract.
 2. Determination of unsaturated fatty acids in a lipid extract.
 3. Determination of cholesterol in a lipid extract.
 4. Isolation of cholesterol from gallstones.
 5. Determination of serum cholesterol.

B : Molecular Biology

1. Isolation of plasmid DNA from *E. coli*.
3. Agarose gel electrophoresis of DNA.

Course: BMBV-3207, Credit: 2

Title: Viva-voce

Fourth Year First Semester (7th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 4101	Molecular Biology Techniques	3	45	100
BMB 4102	Applied Immunology	2	30	50
BMB 4103	Pharmaceutical Biotechnology	2	30	50
BMB 4104	Oncology	2	30	50
BMB 4105	Molecular Biology-IV	2	30	50
BMB 4106	Virology	2	30	50
BMBL 4107	Practical Biochemistry and Molecular Biology-VII	3	90	100
	Total	16	285	450

Course: BMB 4101, Credit: 3

Title: Molecular Biology Techniques

1. Isolation, detection and quantification of DNA, RNA and protein from bacteria, virus, plant and animal cells.
2. Stand polymerase chain reaction (PCR) and real-time PCR; RFLP; AFLP; RAPD.
3. Basic principles and uses of agarose and polyacrylamide gel electrophoresis.
4. Hybridization; Southern, Western and Northern blotting; micro-array.
5. Restriction digestion of DNA/plasmid, ligation and transformation; recombinant protein expression; protein extraction; protein purification.
6. DNA sequencing; next generation DNA sequencing (whole genome, ChIP-seq, RNA-seq, methyl-seq; Exome-seq); RNA interference (RNAi).
7. DNA-protein and RNA-protein interaction studies (EMSA, REMSA, ChIP, ChIP on chip, DNAase foot-printing, DNase protection, *in vitro* transcription); Y2H and B2H systems.
8. Chromatographic techniques: Hydrophobic column chromatography; ion-exchange chromatography; affinity chromatography; HPLC; GLC.
9. Flow cytometry.

10. Mutation analysis; recombination models; Rec system; conjugation, transduction, transfection and transformation.

Books Recommended:

1. Practical Skills in Biomolecular Sciences. Rob Reed, David Holmes, Jonthan, Weyers and Allan Jones; Addison Wesley Longman Ltd. 1998.
2. Spectroscopic Methods in Organic Chemistry. Williams and Fleming, 1980.
3. Techniques in Molecular Biology. Walker, 1987.
4. Introduction to HPLC. Hamilton and Sewell, 1982.
5. Short protocols in molecular biology. Ausubel, 1995.
6. Genes VIII. Benjamin Lewin; Oxford University Press Inc., New York, 2004.

Course: BMB 4102, Credit: 2

Title: Applied Immunology

1. Development of immune system: Myeloid and lymphoid cells, development of memory B cells.
2. Cytokines: Functions of cytokines in immune system, cytokine receptors and antagonists.
3. Major histocompatibility complex (MHC): Production of inbred mouse strains, arrangement of H2 and HLA complexes, genetic map, tissue typing.
4. Transplantation and rejection: Barriers of transplantation, histocompatibility antigens, laws of transplantation, role of T lymphocytes in graft rejection.
5. Activation of T and B cells: T cell antigen receptors, antigen recognition, processing and presentation, cell cooperation in the antibody response, role of cytokines in B and T cells activation, cell-mediated immune responses.
6. Immunogenetics: Ig gene structure and expression, mechanism and regulation of Ig gene assembly, generation of antibody diversity, class switching.
7. Hypersensitivity:
 - a) Type I - Immediate hypersensitivity: Historical introduction of Type I hypersensitivity, Immunoglobulin E (IgE), IgE levels in atopic disease, role of T cells in the immune response to inhalant allergens, cytokine regulation of IgE production, characteristics and types of allergens, mast cells and basophils, mast cell triggering mechanisms, mast cell mediators, genetics of allergic disease, skin tests for diagnosis, factors that influence the symptoms of allergic disease, actions of steroids in allergic disease, immunotherapy, new treatments for allergic diseases, the biological role of IgE.
 - b) Type II - Antibody dependent cytotoxic hypersensitivity: Mechanism of damage, reactions against blood cells and platelets, haemolytic disease of the newborn, autoimmune haemolytic anaemia, hyperacute graft rejection.
 - c) Type III - Immune complex mediated hypersensitivity: Types of immune complex disease, inflammatory mechanisms in type III hypersensitivity, experimental models of immune complex disease, persistence of complexes, deposition of complexes in tissues, detection of immune complexes.
 - d) Type IV - Delayed type hypersensitivity: Contact hypersensitivity, tuberculin-type hypersensitivity, granulomatous hypersensitivity, cellular reactions in type IV hypersensitivity, and diseases manifesting type IV hypersensitivity.

8. Immunological techniques: Isolation of pure antibodies using affinity chromatography, monoclonal antibody production, application of monoclonal antibodies, assays for complement, isolation of lymphocyte populations and subpopulations, effector cell assays, immunoprecipitation, Immunodiffusion, Immuno-electrophoresis, Immunoblotting, Radioimmuno assay (RIA), Enzyme-Linked Immunosorbent Assay (ELISA).

Books Recommended:

1. Immunology. Ivan Roitt, Jonathan Brostoff and David Male; (6th Edition) Mosby- Elsevier Science Ltd, London, 2002.
2. Essential Immunology. I. M. Roitt; (5th edition) Blackwell Scientific Publication. London 2002.
3. Basic Immunology. Abul A. Abbas and Andrew H. Lichtman; (3rd Edition), Elsevier, a division of Reed Elsevier Private Ltd., 2009.

Course: BMB 4103, Credit: 2

Title: Pharmaceutical Biotechnology

1. Introduction to biopharmaceuticals: Biotechnology versus Pharmaceutical biotechnology, Historical perspective of pharmaceutical biotechnology. Traditional pharmaceuticals of biological origin: Pharmaceuticals of animal, Plant and microbial origin. Pharmacokinetics.
2. Drug development: Drug discovery, Impact of genomics, Proteomics and related technologies upon drug discovery; Transforming new molecular entities into drug, Application of biotechnologies in drug development; Biologic drug development and approval: pre-clinical and clinical trials;
3. Therapeutics based on biotechnology: Interferons, Hormones, Enzymes, Antibiotics, Antibodies, Vaccines, Adjuvant technology, Blood products, Nucleic acid therapeutics.
4. Advanced drug delivery: Basic principles; Controlled and sustained release: Polymer-based drug carriers, Lipid-membrane-based drug carriers; Permeation enhancement; Molecular approaches of drug delivery
5. Integration of pharmacokinetics and Pharmacogenetics: Historical perspective, Metabolism and transport, Therapeutic response.

Books recommended:

1. Biopharmaceuticals: Biochemistry and Biotechnology. Gary Walsh.
2. Biotechnology and Biopharmaceuticals. Rodney J.Y. Ho and Milo Gibaldi.
3. Pharmaceutical Microbiology. Hugo and Russel.

Course: BMB 4104, Credit: 2

Title: Oncology

1. Introduction: Definitions, terminologies, benign and malignant tumor, tumor cell growth and kinetics of tumor cell growth, host factors affecting tumor cell growth.
2. The spread of tumors: Pathways and mechanisms, mechanisms of tumor invasion, dissemination of tumor cells via lymphatic and blood vessels, pattern of metastatic spread, role of immune system in modulation of metastasis, experimental approaches to metastasis.
3. Carcinogens and mutagens:
 - a) Chemical agents: Carcinogenic chemicals and mechanism of chemical carcinogenesis.
 - b) Radiations: UV rays, X-rays, mechanism of radiation carcinogenesis.
 - c) Oncogenes: DNA and RNA oncogenic viruses, retroviruses, oncogenes (product of proto-oncogenes), their functions, activation of proto-oncogenes, mechanism of viral oncogenesis, cancer suppressor genes (antioncogenes).
4. Host-tumor interactions: Effect of tumor on host, host defense against tumors, and cell-mediated immune response to cancer.
5. Hormones and cancer: Mechanism of hormone action, and action of hormones in carcinogenesis.
6. Human cancer: Human cancers, laboratory diagnosis, treatments and management.

Books Recommended:

1. Robbin's Pathologic Basis of Disease. Ramzi S. Cotran, Vinay Kumar, Stanley L. Robbins; (4th Edition) W. B. Saunders Company, Philadelphia, 1989.
2. Genes VIII. Benjamin Lewin; Oxford University Press Inc., New York, 2004.
3. Molecular Biology of the Cell. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; (4th Edition) Garland Science, New York, 2002.

Course: BMB 4105, Credit: 2

Title: Molecular Biology-IV

1. Gene structure: Interrupted genes, organization of exons and introns, distribution of genes, organization of gene families, variations in individual genomes, organization of genes in the organelles. Repetitive genes, the special features of metaphase chromosome, DNA-protein interaction in centromere and telomere.
2. Mechanism of DNA loss and amplification: Gene regulation, DNA rearrangement and gene shuffling.
3. Mobile genetic elements: Transposons and retroposons - characteristics and functions, evolution of these elements.
4. Gene expression: Tissue specific expression of proteins and messenger RNAs, post transcriptional events.
5. Regulation at the transcriptional level: Regulation of RNA splicing, RNA editing, regulation of RNA transport, stability and translation.
6. Transcriptional control of DNA sequence elements: Short sequence elements located within or adjacent to the gene promoter, enhancers, negative-acting sequence elements, locus control regions. Regulation by RNA pol I and III, DNA binding transcription factors.

7. Transcription control of chromatin structure: Changes in DNA methylation, alteration in histones, changes in chromatin structure.
8. Protein localization: Introduction, passage across membrane, protein translocation, chaperons, signal sequences of translocation.
9. Epigenetics: Epigenetics and chromatin dynamics, silencing, transcriptional landscapes and genomes, memory of transcriptional states, stem cells and reprogramming, maintenance of (Epi) genome integrity. Epigenetics and cancer.

Books Recommended:

1. Genes VII. Lewin B; (8th edition) Oxford University Press.
2. Molecular Cell Biology. Darnell, J., Lodish, H. and Baltimore, D.; (5th edition) W.H. Freeman and Company, New York.
3. Molecular Biology of the Cell. Alberts, B. Bray, D. Lewis, J.; (4th edition) Garland Publishing, Inc. New York.
4. Molecular and Cellular Biology. Wolfe, S.L., Wardsworth, Belmont, CA.
5. Cell and Molecular Biology. Gerald Karp; 8th edition.

Course: BMB 4106, Credit: 2

Title: Virology

1. Major groups of viruses: Bacterial, plant and animal viruses, nomenclature and classification.
2. Bacterial and plant virus: Bacteriophages, their expression and assembly, TMV, virion structure, infection, mode of replication and assembly.
3. 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, picornavirus, vesicular stomatitis virus or rabies virus, reovirus and retrovirus).
4. Viral replication and pathogenesis: Host range, susceptibility and permissivity of viral infection, initiation of infection (attachment, penetration and uncoating), strategies of viral replication, viral pathogenesis, stages of pathogenesis, transmission of viral infections.
5. Host-virus interactions: Cytopathic effects, virus interactions with cell uptake mechanisms, with cellular transcription apparatus, with RNA processing pathways, with translational apparatus, with cell DNA replication apparatus, and with cell protein maturation pathways, effect of viruses on cell structure, release of progeny virus.
6. Protection against viral infection: Immunization with vaccines; and use of antiviral drugs.
7. Interferon: Chemical nature & classification, induction of interferon synthesis & development of antiviral state by interferon, basis of interferon action, viral interference not mediated by interferon.

Books Recommended:

1. Basic Virology. Edward K. Wagner; (2nd edition) Blackwell Publishing, USA, 2004.
2. Fundamental Virology. B. N. Fields, D. M. Knipe; (2nd Edition) Raven Press, New York, 1991.
3. Genes VIII. Benjamin Lewin; Oxford University Press Inc., New York, 2004.

Course: BMBL 4107, Credit: 4

Title: Practical Biochemistry and Molecular Biology-VII

Fourth Year Second Semester (8th Semester)

Course code	Course title	Credits	Credit Hours	Marks
BMB 4201	Biochemistry of Natural Products	2	30	50
BMB 4202	Neurobiochemistry	2	30	50
BMB 4203	Biochemistry of Drugs	2	30	50
BMB 4204	Industrial Biotechnology	2	30	50
BMB 4205	Agricultural Biotechnology	2	30	50
BMB 4206	Bioinformatics	2	30	50
BMB 4207	Research Project/Training	3	90	100
BMBV 4208	Viva-voce	2	-	50
	Total	17	270	450

Course: BMB 4201, Credit: 2

Title: Biochemistry of Natural Products and Antibiotics

1. Natural products: Sources (plant, animal, microbial, marine), classification on chemical basis, role of natural products in development of medicinal chemistry.
2. Spectroscopic techniques: UV, IR, Mass Spectroscopy - principle, electron impact and chemical ionization, mass fragmentations of some natural products, interpretation of mass spectrum, McLafferty rearrangement. NMR - principle, instrumentation, solvents used, internal standard, chemical shifts (position of signals), integration, multiplicity and intensity, deshielding and shielding effects, coupling constant, interpretation of NMR spectra of some important compounds and natural products.
3. Alkaloids: Classification, extraction, isolation and identification from plant sources, structures of some medically important alkaloids - ephedrine, atropine, morphine, quinine, vincristine and vinblastine. Taxol - anticancer agent, mechanisms of alkaloid actions, biosynthesis of some alkaloids.
4. Antibiotics: Classification of antibiotics on the basis of sources, spectrum and structures, structure determination of penicillins, chloramphenicol, tetracyclines, streptomycin, erythromycin, structure activity relationship, semisynthetic antibiotics, biosynthesis of penicillin and streptomycin.
5. Steroids: Functions of steroids, structure determination of some important steroids - cholesterol and ergosterol.
6. Flavonoids: Biological functions, classification, structure determination of flavones, flavonol and isoflavonol, medicinal role of some important flavonoids as antioxidant,

biosynthesis of flavonoids.

7. Bioactive compounds: Curacin A (from marine sources) and epibatidine (from animal sources).

Books Recommended:

1. Spectroscopy of organic compounds. P. S. Kalsi; (4th Edition) New Age International(P) Ltd., New Delhi, 2001.
2. Elementary organic spectroscopy. U.R. Sharma; (3rd Edition) S. Chand & Company Ltd., New Delhi, 2002.
3. Advanced Organic Chemistry. Bahl & Bahl; (2nd Edition) S. Chand & Company Ltd., New Delhi, 1999.
4. Biochemistry and Genetic regulation of Commercially Important Antibiotics. L. C. Vining; Addison-Wesley Publishing Company, USA, 1993.
5. Principles of Medicinal Chemistry. William O. Foye, Thomas L. Lemke and David A. Williams; Lippincott Williams & Wilkins, USA, 1995.
6. Antibiotics: An Introduction. Roland Reiner; ROCHE, Basle, Switzerland, 1982.

Course: BMB 4202, Credit: 2

Title: Neurobiochemistry

1. Brain as a specialized tissue: Structural, chemical and metabolic peculiarities - difference between growing and adult brain.
2. Gross and fine structure of the brain:
 - (i) Gross structure – different parts of the brain, their functions and growth characteristics (brief treatment).
 - (ii) Fine structure - cells of the brain, classification of neurons and glia, their structure, location and function.
3. Synapse: Structure, their types – chemical and electrical, chemistry of neurotransmission (brief treatment).
4. Nerve impulse: Action potential, its ionic basis, sodium channel.
5. Conduction of nerve impulse: Mechanism of conduction along myelinated and unmyelinated nerve fibres, comparison of conduction velocity along myelinated fibres.
6. Neurotransmission: Neurotransmitters, their metabolism, storage and release; calcium channel, post synaptic receptors - their modulation with agonists and antagonists, neuropeptides.
7. Brain growth and development: Species, structural and cell type differences, neurogenesis and gliogenesis, neuronal death and nervous system development.
8. Myelination: Myelin composition and maturation.
9. Metabolism of the developing brain: Energy metabolism, changes during development, susceptibility of developing and adult brain to energy supply.
10. Brain development during malnutrition: Effect on cell proliferation, myelination and synaptogenesis.
11. Malnutrition and brain metabolism: Energy metabolism, protein and lipid metabolism.
12. Brain diseases: Parkinson's, Wilson's, Huntington's and Alzheimer's diseases.

13 Biochemistry of memory: Short-term memory, long-term memory.

Books Recommended:

1. Understanding the Brain and its Development: A Chemical Approach. Harun K.M. Yusuf; World Scientific Publishing Co. Pte. Ltd, Singapore, 1992.
2. Basic Neurochemistry; Molecular, Cellular, & Medical Aspects. Siegel George J; Agranoff Barnard W, Alberts R. Wayne; Fisher Stephen K; Uhler Michael D; (6th Edition). Lipincott Williams and Wilkins, USA, 1999.
3. Fundamental Neuroscience. Michael J. Zigmond, Floyd E. Bloom, Story C. Landis, James L. Roberts, Larry R. Squire; (2nd Edition) Elsevier Science, USA, 2003.

Course: BMB 4203, Credit: 2

Title: Biochemistry of Drugs

1. Drugs: Definition, drugs against common diseases, chemical synthesis, physicochemical properties such as ionization and absorption of drugs.
2. Routes of administration: Intravascular, intramuscular and subcutaneous administration. Absorption of drugs through skin and inhalation of drugs.
3. Drugs distribution: Binding of drugs with albumin, passage of drugs through biological membrane, CNS and placenta.
4. Major routes of elimination of drugs: Renal and biliary excretion of drugs.
5. Drug action: Rate of drug absorption and elimination - zero order and first order elimination, plateau, principle rate of equilibration of drugs in body fluids, influence of body fat on drug distribution.
6. Drug metabolism: Biochemical pathways of drug metabolism, inhibition of drug metabolic pathways.
7. Drug resistance.
8. Toxicology: Toxic substances and how they affect our health – characteristics, exposure risks, associated health effects.

Books Recommended:

1. Goodman & Gilman's The Pharmacological Basis of Therapeutics. JG Hardman & LE Limbird; McGraw Hill Inc.
2. Pharmacokinetics Made Easy. DJ BirKett; McGraw Hill Inc.
3. The Principle of Drug Action. N B Pratts & P Taylor; Churchill Livingstone.

Course: BMB 4204, Credit: 2

Title: Industrial Biotechnology

1. Fermentation technology: Principles of microbial growth kinetics, different types of fermentation, stages of fermentation process, downstream processing. Isolation, preservation and improvement of industrial microorganisms. Metabolic engineering of microorganisms for the production of amino acids, organic acids and antibiotics. Production of single cell protein (SCP); biofuel – ethanol, methane.
2. Immobilized biocatalysts: Different types of biocatalysts, different immobilization processes of biocatalysts - adsorption, covalent binding, entrapment, encapsulation and covalent binding, applications of immobilized biocatalysts, multienzyme systems.
3. Bioremediation and biomass utilization: Agro-industrial waste recycling, genetic engineering of biodegradative pathways, aerobic and anaerobic biodegradation of xenobiotics. Utilization of starch and cellulose for commercial production of important compounds – fructose, alcohol. Biosorption, bioaugmentation, biofiltration, vermicomposting, bioleaching.
4. Animal Cell Culture: Animal cell culture characteristics, culture design and significance, application in monoclonal antibody production, hybridoma technology, antibody engineering. Manipulation of reproduction in animals – artificial insemination, embryo transfer technology, *in vitro* fertilization (IVF) technology, embryo cloning. Stem cells and their applications. Production of transgenic animals.
5. Microbial toxins and insecticides: Insecticidal toxin of *B. thuringiensis*, mode of action and use, engineering of *B. thuringiensis* toxin gene, baculoviruses as biocontrol agents.
6. Traditional application of food biotechnology: Fermented foods - dairy products, oriental fermentations, alcoholic beverages, food ingredients.

Food toxicology: Introduction to food toxicology - toxicity testing, natural toxicants present in foods (plants, animal, marine and microbial toxins).

Food processing and control: Food preservation by heating, chilling, freezing, dehydration and ionizing radiation; packaging materials; processing of selected food products. Food laws and standards. Concepts of food quality and safety - food hazards, process control, application of principles of food hygiene and relevant codes of practice/guidelines to ensure quality and safety. Product development and sensory perception. Food flavors, additives and supplements.

7. Ethical perspectives of food biotechnology: Environmental impact, safety, intellectual property rights, animal welfare, risk analysis, consumer perceptions, industry perspectives, producer perspectives around the world. Regulations of food biotechnology.

Books recommended:

1. Prescott and Dunn's Industrial Microbiology. Reed G.
2. Biotechnology, Vol. I. Rehm HJ & Reed G.
3. Industrial Applications of Microbiology. Riviere J.
4. Applied Biochemistry and Bioengineering. Wingard LB Jr, Katchalski-Katzir E & Goldster L.
6. Comprehensive Biotechnology, Vol. I-IV. Moo-Young M.

Course: BMB 4205, Credit: 2

Title: Bio-safety regulation and Environment management

1. Bio-safety regulations: Concept and understanding for protection of nature, growers and consumers as national interest. Transgenesis; Transgenic organisms-history; Methods of production and use; improving desired characteristics and productivity of domestic animals; Transgenic animals in agricultural & nutritional science and research.
2. Risk for animal and human health: toxicity and safety of food quality, allergies, drug resistance of pathogens,
3. Risk for agriculture: Effect on biodiversity, weeds, alteration of nutritional value, reduction of cultivars, and higher cost of agricultural products.
4. Risk on environment: Persistence of transgenes in transgenic organisms, tolerance of target organism, susceptibility of non-targeted organism, increased use of chemicals in agriculture, unpredictable genes exposed in environment.
5. Environmental management: Control of pollution caused by toxic metals (arsenic, lead, mercury, chromium, nitrate, phosphorus). Mechanism of metal resistance of microbial species, innovative microbial approaches for remediation of polluted waters.
6. Recalcitrant molecules in environment: Microbial activity in water and soil and biodegradation of recalcitrant substances (pesticides and other xenobiotic molecules).

Isolation, enrichment and genetic modification of chemical resistant microbes for detoxifying the pollutants.

Use of biosensors to detect environmental pollutants. Biological control of pesticides.

Biotechnological approaches for treatment of industrial waste and toxic effluents.

Books Recommended:

1. Biological Resource Management in Agriculture Challenges and Risks of Genetically Engineered Organisms. OECD Publishing, 2004.
2. The Regulation of Genetically Modified Organisms: Comparative Approaches. Luc Bodiguel, Michael Cardwell.

Course: BMB 4206, Credit: 2

Title: Bioinformatics

1. Introduction to Bioinformatics: Definition of Bioinformatics. The fundamentals of protein and nucleic acid sequence analysis, Data-base searching, pair-wise alignments, database searching including BLAST, Sequences analysis with PERL, Multiple sequences alignments; phylogenetic analysis, Profile searches of databases, revealing protein motifs, 3D structural comparisons, predictions and modeling.
2. Networks in Bioinformatics: Communication networks, Biological networks (Protein interaction networks, Gene regulation networks), Databases and search tools for biological network analysis, Genomic circuits: in single genes, Complex integrated Genomic circuits, modeling whole genome circuits: Genomics vs. Proteomics.
3. IPR Issues in Bioinformatics: Human genome wealth of humankind, genome databases in public and private domain, and the debate continues.

Books Recommended:

1. Bioinformatics for DUMMIES. Jean-Michel Claverie and Cedric Notredame; Wiley Publishing Inc. New York, 2002.
2. Bioinformatics and Functional Genomics. J. Pevsner; Wiley-Liss, 2003.
3. Bioinformatics and Genomes: Current Perspectives. M. A. Andrade; Horizon Scientific Press, 2003.
4. Bioinformatics. D. Higgins; Oxford University Press, 2000.
5. Bioinformatics, Methods of Biochemical Analysis Series Vol. 43. Baxevanis & Ouellette; John Wiley & Sons, 2001.
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis & B.F. Francis Ouellette; (3rd Edition). Wiley & sons, 2004.

Course: BMB 4207, Credit: 2

Title: Research project/Training

Course: BMBV 4208, Credit: 2

Title: Viva-voce