VIKRAMA SIMHAPURI UNIVERSITY :: KAKUTUR
DEPARTMENT OF BIOTECHNOLOGY

M.Sc. Biotechnology (Two-Year Course)

(*Choice-Based Credit System*)

SYLLABUS, COURSE PATTERN AND SCHEME OF EXAMINATION

(*Effective from the Academic Year 2017-18*)

Code	Title of the Paper	Workload/week	No. of credits	Examination		
				Internal	External	Maximum Marks
SEMESTER - I (FIRST YEAR)						
Theory						
BT T-101	**Microbiology and Cell Biology**	4	4	30	70	100
BT T-102	**Molecular Genetics**	4	4	30	70	100
BT T-103	**Chemistry of Biomolecules**	4	4	30	70	100
BT T-104	**Biochemical and Biophysical Techniques**	4	4	30	70	100
BT T-105	*Human Values and Professional Ethics - I (CBCS)*	4		30	70	100
Practical						
BT P-101	Microbiology, Cell Biology and Molecular Genetics	6	4			100
BT P-102	Biomolecules and Biological Techniques	6	4			100

VIKRAMA SIMHAPURI UNIVERSITY :: KAKUTUR

M.Sc. BIOTECHNOLOGY (Two-Year Course)

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FIRST SEMESTER SYLLABUS

(*Effective from the Academic Year 2017-18*)

BT T–101: MICROBIOLOGY AND CELL BIOLOGY

UNIT – I

Historical development of microbiology – Spontaneous generation, germ theory of disease. General characteristics of protozoa, fungi, microalgae, cyanobacteria, rickettsiae, mycoplasma, spirochetes and archaebacteria. Outline classification of bacteria as per Bergey's Manual of Systematic Bacteriology. Nomenclature of bacteria. Chemotaxonomy of bacteria. Nucleic acid-based classification of bacteria. Ultrastructure of bacteria – An account of variant (capsule, flagellum, pilus, plasmids, endospore) and invariant (cell wall, cell membrane, mesosomes, nucleoid, ribosome) components of bacterial cell. Introduction to virology – Outline classification and nomenclature of viruses. Biology and multiplication of Lambda bacteriophage, T4, M13 and HIV. Biology of sub-viral particles – Prions, viriods, satellite viruses.

UNIT – II

Nutritional groups in bacteria – Photoautotrophs, chemoautotrophs, photoheterotrophs, organotrophs, methylotrophs, mixotrophs, auxotrophs. Different methods of sterilization. Preparation of culture media. Isolation of pure cultures of bacteria. Culture collection and maintenance of cultures. Microbial growth – Growth curves, measurement of growth and growth yields. Synchronous growth, continuous culture by chemostats and turbidostats. Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen. General account of microbial diseases – Disease reservoirs, epidemiological terminologies. Chemotaxis. Quorum sensing in bacteria. Sexually-transmitted diseases: Syphilis and AIDS. Other diseases – Tuberculosis, rabies, kalazar, hepatitis, filarial, malaria. Antibiotics – Penicillin and cephalosporin. Broad-spectrum antibiotics.

UNIT – III

Diversity of cell size and shape. Cell theory. Prokaryotic and eukaryotic cell. Nucleus – Ultrastructure of nucleus and nuclear envelope. Nomenclature of chromosome, C-value paradox, dosage compensation. Euchromatin and heterochromatin (constitutive and facultative). Nucleolus. Polytene and Lampbrush chromosomes. Cell cycle – Overview of eukaryotic cell cycle, regulation of cell cycle and extra cellular signals. Cell cycle check points. Regulators of cell cycle progression – MPF, cyclins and cyclin-dependent kinases. Cell differentiation. Cell death and proliferation – Apoptosis: definition, mechanism and significance. Necrosis. Brief account of biology of cancer.

UNIT – IV

Cell Communication – General principles: Cell surface receptors (ion channel-linked, G-protein-linked and enzyme-linked receptors) and intracellular receptors. Forms of intracellular signaling – Autocrine, paracrine, contact-dependent, synaptic and endocrine signaling. Response of cell to signals. Intracellular signaling proteins: Types and their role. Second messengers – cAMP pathway and role of calcium. Extracellular matrix, cell-matrix

interactions. Cell-cell interactions – Adhesion junctions, tight junctions, gap junctions. Electrical coupling, connexon, factor-mediating cell-self recognition (aggregation factor). Cytoskeleton – Structure and functions of microtubules, microfilaments and intermediary filaments. Structure of microvillus.

***Recommended Books*:**

1. Basic Microbiology, Volk. W.A. and M.F. Wheeler. 1980. J.B. Lippincott Company, Bombay.
2. Cell and Molecular Biology. De Robertis, E.D.P and E.M.F. De Robertis. 2001. Lippincott Williams and Wilkins, Bombay.
3. Cell and Molecular Biology: Concepts and Experiments, Karp, G. 2005. 4th Edn. John Wiley and Sons, USA.
4. Cell Biology: Organelle Structure and Function, Sadava, D.E. 1993. Jones and Bartlett Publishers, USA.
5. Experiments in Microbiology, Plant Pathology and Biotechnology, K.R. Aneja. 2000, 4th Edn. Wishwa Prakashan, New Delhi.
6. General Microbiology, Stainer. R.Y., F.A. Adelberg and J.L. Ingraham . 1984. 4th Edn. Mc Millan Press, New York.
7. General Microbiology, Powar, C.B. and H.F. Daginwala. 1989. Vol. I & II, Himalaya Publishing House, New Delhi.
8. Microbial Biology, Rosenbeng, E. and I.R. Chohan. 1983. HS International Editions.
9. Microbial Genetics, Freifelder, D. 1987. Jones and Bartlett Publishers, London.
10. Microbiology, Buffaloe, H.D. and D.V. Ferguson. 1981. Houghton Mfflin Company
11. Microbiology, Pelczar. M.J., E.C.S. Chan and, N.R. Krieg.1993. 5th Edn. McGraw Hill Publishing Company, New Delhi.
12. Microbiology, Prescott, L.M., J.P. Harley and D.A. Klein. 1990. WCB Publishers.
13. Molecular Biology of the Cell, Alberts A et al. 1994. Garland Publishers, New York
14. Molecular Cell Biology, Lodis, H., A. Berk, C.A. Kaiser, M.P. Scott. 2000. 6th Edn. Ploegh and Paul Matsudaria.
15. The Cell – A Molecular Approach, Cooper Geoffrey, M. 2000. 2nd Edn. ASM Press, Washington.
16. The Genetics of bacteria and their viruses. Hayes. W. 1988. John Wiley and Sons, USA.
17. The World of the Cell, Becker, W.M., L.J. Kleinsmithand J.H. Hardish. 2007. 6th Edn. Pearson Education, Delhi.

BT T–102: MOLECULAR GENETICS

UNIT – I

Genetic notations, conventions and terminology. Diversity in eukaryotic and prokaryotic genomes. Comparison of *E. coli* and human genome. Organization of DNA in a metaphase chromosome. Mitochondrial and chloroplast genomes. Concept of gene structure – Classical geneticist view to modern concept. Experimental evidences for colinearity of the gene and its product. Genetic material – DNA and RNA. Organization of histone genes, rRNA and tRNA genes in prokaryotes and eukaryotes.

UNIT – II

Genetic recombination – Types of recombination: homologous, reciprocal and nonreciprocal, site-specific and illegitimate. Different models for mechanism of homologous recombination. Molecular mechanism of site-specific recombination. Coefficient of coincidence of double crosses, chiasma interference. Plasmids – Types, properties, functions, detection, amplification, incompatibility and isolation of plasmids. Episomes. Replication and transfer of F plasmid. Transposable elements – Insertion sequences, types of bacterial transposons, Spm and dSpm in maize, Ty elements of yeast, P and Copia elements of *Drosophila*. Mechanism of transposition. Relevance/importance of transposable elements.

UNIT – III

Modes of gene transfer in bacteria: Transformation – Discovery, and molecular mechanism of natural transformation and recombination. *In vitro* transformation – Cold $CaCl_2$ technique, electroporation and triparental mating. Transduction – Discovery, types of transduction: generalized, specialized, abortive, co-transduction. Mechanism for the development of defective virus particles (λdg and λpbio) during specialized transduction. Conjugation – Discovery of sex in bacteria. Development of Hfr strains. $F^+ \times F^-$, Hfr × F^- and F' × F^- (sexduction) crosses and their significance.

UNIT – IV

Genetic mapping – Map units, mapping by recombination analysis and mapping of circular chromosomes. Mapping of bacterial chromosome by interrupted mating and transduction. Recombination in bacteriophages. Genetics of yeast and *Neurospora*. Benzer's studies on r-II locus of T4 bacteriophage to establish the units recon, muton and cistron. Eukaryotic viral genetics – Recombination, reassortment, genetic drift and shift, transcapsidation. Mutagenesis – Mutagens (physical, chemical and biological), types of mutations, molecular mechanism of mutation. Isolation and analysis of mutants. Transposon mutagenesis and their applications.

***Recommended Books*:**

1. Bacterial and Bacteriophage Genetics, 4th Ed.2000.E.A.Birge, Springer publication.
2. Chromosome Techniques: Theory and Practice. Sharma, A.K and A. Sharma. 1980. Butterworth.
3. Genetics – A Molecular Approach. Russell, P.J. 2006. Pearson Education, USA.
4. Genetics – A Conceptual Approach. Pierce, B. A.2006. 2nd Edn. W.H.Freeman and Company, New York.
5. Genetics Analysis of Genes and Genomes. Hartl, D.L and E.W.Jones. 2001. 5th Edn. Jones and Bartlett Publishers, London.
6. Genetics. Sambamurthy, A.V.S.S. 1999. Narosa Publishing House, New Delhi.
7. Genetics. Strickberger, M.W. 1996. 3rd Edn. McMillan, New York.
8. Genetics. Winchester, A.M. 1967. Oxford and IBH., New Delhi.

9. Microbial Genetics. Maloy, S. R., J.E. Cronan and D. Freifelder. 1994. Jones and Bartlett Publishers, UK.
10. Microbial Genetics.1995. David Freifelder. Narosa Public. House.
11. Molecular Biology. Freifelder, D. 1990. Narosa Publication House, New Delhi
12. Principles of Genetics. Sinnot, E.W., L.C Dunn and T. Dobzhansky 1958. McGraw Hill, New York.
13. Principles of Genetics. Gardner, E. J., M. J. Simmons and D. P. Snustad. 2004. 8th Edn. John Wiley and Sons, New York.
14. Principles of Genetics. Gardner, E.J and D.P. Snustad. 1996. John Willey, New York.
15. Theory and Problems in Genetics. Stansfield, W.D. 1991. McGraw Hill, New York.

BT T–103: CHEMISTRY OF BIOMOLECULES

UNIT – I

Carbohydrates – Classification and properties of carbohydrates, mono (glucose, galactose, fructose) disaccharides (lactose, maltose, sucrose), polysaccharides (starch, glycogen, cellulose). Sugar acids, alcohols, deoxysugars and amino sugars. Structure and functions of mucopolysaccharides.

UNIT – II

Amino Acids and Proteins - Chemistry of amino acids and proteins - Classification of amino acids, Structures of amino acids, Chemical reactions of amino acids. Peptide bond - Nature of peptide bond, pi/φ rotation. Ramachandran plot, Secondary structure predictions, helices and beta-sheets, Determination of primary structure. Proteins and their classification, properties of proteins, determination of amino acid sequences (N and C terminus) Tertiary/quaternary structure of proteins (myoglobin/hemoglobin model). Structural organization of proteins - Outline structures and biological functions. Protein folding and significance.

UNIT – III

Lipids – Classification; structure and biological functions of fatty acids, glycolipids, triacylglycerols, phospholipids, terpenes and steroids. Physico-chemical properties and analysis of fats and oils. Structure and functions of prostaglandins, leukotrienes, thromboxanes. Types and functions of vitamins.

UNIT – IV

Nucleic Acids – Structure of purines, pyrimidine, nucleosides, and nucleotides.Watson and Crick double helix structure. Properties and functions of nucleic acids (DNA, RNA). Different forms of DNA (A, B and Z forms) and RNA (mRNA, rRNA, tRNA and snRNA). DNA base composition and Chargoff's rule. Three-dimensional structure of tRNA. Chemical difference of DNA, RNA and significance. Isolation of nucleic acids. Denaturation and renaturation of nucleic acids, cot curves and chemical synthesis of DNA.

***Recommended Books*:**

1. Biochemistry, Berg, J.M., L.J. Tymcozko and L. Stryer 2002. 5th Edn. W.H.Freeman and Company, New York.
2. Biochemistry, Garrett and Girisham, 2010, Cengage Learning.
3. Biochemistry, Lehninger. A.L. 1978. 2nd Edn. Kalyani Publishers, New Delhi.
4. Biochemistry, Voet, D and J. Voet.1995. 2nd Edn.1995. John Wiley and Sons, USA.
5. Harper's Biochemistry, Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2002. McGraw Hill Publishing Company, New Delhi.
6. Introductory Practical Biochemistry, Sawhney, S.K and R. Singh. 2001. Narosa Publishing House. New Delhi.
7. Practical Biochemistry: Principles and Techniques, Wilson and Walker. 1986. Cambridge University Press, New York.
8. Principles of Biochemistry, Lehninger, A. L. 1993. C. B.S., India.
9. Textbook of Biochemistry with Clinical Correlation, Devlin, T.M.1997. 4th Edn. Wiley-Liss, New York.
10. Textbook of Biochemistry, West and Todd. 1968. MacMillan, New York.

BT T–104: BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES

UNIT – I

Measurement of pH, biochemical buffers, selection of biochemical buffer and oxygen electrode. Cell disruption methods – French press, sonication, freeze-thaw techniques, enzymatic method, use of liquid nitrogen in cell disruption. Centrifugation **–** Basic principles of sedimentation, types of centrifuges and rotors. Preparative ultracentrifugation – Differential centrifugation, density-gradient, analytical ultracentrifugation and applications in determination of molecular weight, purity and detection of conformational changes in macromolecules.

UNIT – II

Separation methods – General principles and definitions. Methods based on polarity – Partition chromatography (paper chromatography), adsorption chromatography (thin-layer chromatography), gas-liquid chromatography, reverse-phase liquid chromatography. Methods based on size – Principle of Gel filtration, methodology and applications. Dialysis, ultra filtration, lyophilization. Methods based on affinity – Principle of Affinity chromatography, methodology and applications (purification of proteins, nucleic acids). High-performance liquid chromatography – Principle, instrumentation, practical procedure and applications. Ion-exchange chromatography – Principle, ion-exchangers, methodology, pH and salt gradients for elution of proteins, amino acids and nucleotides. Amino acid analyzer.

UNIT – III

Electrophoresis – General principles and definitions. PAGE – Native and SDS-PAGE, Isoelectricfocussing, 2D electrophoresis, identification of novel proteins in 2D gels, capillary electrophoresis. Agarose gel electrophoresis – Preparation, separation and determination of molecular size of DNA, denaturing agarose gel electrophoresis and their applications, recovery of DNA from agarose gels. Pulse-field gel electrophoresis – Principle, methodology and applications in separation of large DNA fragment. Blotting techniques- Western, Southern and Northern.

UNIT – IV

Spectroscopy **–** Principles, laws of light absorption. Instrumentation and applications of UV-visible spectrophotometer, fluorescence spectroscopy, NMR, ESR. Mass spectroscopy – MALDI-TOF, ESI-MS. Radioisotope techniques – Types of isotopes, radioactive decay. Detection and measurement of radioactivity – GM counter, scintillation counter, autoradiography. Preparation of labelled compounds **–** Pulse chase studies and tracer techniques, isotopes used in biology, safety methods in handling radioisotopes. Optical activity of biomolecules – CD and ORD: principles and applications. X-Ray diffraction and Crystallography – Basic principle, applications in the determination molecular structure of protein and nucleic acids.

***Recommended Books*:**

1. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, 2nd edition Ed. by BL. Williams and K. Wilson (Edward Arnold)
2. Analytical Biochemistry by David J. Holmes and Hazel peck
3. Biochemical Research Technique: A Practical Introduction by Ed. John M. Wriggles worth
4. Biological Spectroscopy by Iain D. Campbell and Raymond A. Dwek, the Benjamin/Cumming Pub. Co., California, London.

5. Biophysical Chemistry by C.R. Cantor and P.R. Schimmel, W.H. Freeman & Co., NY.
6. Biophysical Chemistry D. Freifelder, W.H. Freeman
7. Biophysics – Edited by W. Hoppe, W. Lehman Hi. Maskal and H. Ziegler (Springer-Verlag, Berlin) 1983
8. Experimental Techniques in Biochemistry by Drewer, AJ. and Asworth, R.B.
9. Introduction to Biophysical Methods for Protein and Nucleic Acid Research, Ed. J.A. Glasel and M.P. Deutscher, (Academics Press), 1995.
10. Manometer and Biochemical Techniques by W.W Umbrit and R.H. Burris (Burgens
11. Molecular Biophysics – R.B. Setlow and E.C. Pollard (Addison Wiley publishing Co. USA)1962
12. Practical Biochemistry: Principles & Techniques – Edited by Wilson & Walker, Cambridge Univ. Press, New York) 1986.
13. Principles of Physical Biochemistry by K.E. Vanholdem W.C. Johnson, P.S. Ho, (Prentice Hall), 1998.
14. Separation Methods in Biochemistry by S.J. Morris and P. Morris (Pitman)
15. The Determination of Molecular Structure by P.J. Wheatly (Oxford Clarenders press) 1968
16. The Tools of Biochemistry by Terrance G. Cooper (Wiley)

BT P – 101: MICROBIOLOGY, CELL BIOLOGY AND MOLECULAR GENETICS

Microbiology

1. Study of typical compound microscope
2. Micrometry – measurement of a fungal spore
3. Determination of cell density by counting chamber
4. Isolation of bacteria from soil, air and water
5. Isolation of fungi from soil
6. Contact slide technique
7. Pour plate technique
8. Development of a single colony of a bacterium
9. Preservation of microorganisms
    a) Subculturing on agar slants
    b) Preservation in soil
    c) Preservation by overlaying cultures with mineral oil
    d) Preservation in glycerol stocks
10. Enrichment by Winogradsky column
11. Stab culturing technique for motility demonstration
12. Hanging drop technique
13. Simple staining of a bacterium
14. Negative staining of a bacterium
15. Gram staining – Positive and negative
16. Bacterial spore staining
17. Lactophenol-Cotton blue mounting of fungi
18. Oligodynamic action of metals
19. Isolation and quantification of phages
20. Estimation of chlorophyll in virus-infected and non-infected leaves
21. Symptomatic observation of plant virus infection.

Cell Biology

1. Preparation of cytological studies for identification of stages of mitosis using root tips
2. Examination of cells isolated from chick epithelium
3. Demonstration of chromosomal (structural and numerical) aberrations
4. Study of polytene chromosomes
5. Isolation of mitochondria by density gradient centrifugation
6. Karyotypic study

Molecular Genetics

1. Demonstration of Mendelian laws using color marbles or beads
2. Evaluation of segregation and random assortment using Chi square test or test of fitness.
3. Construction of genetic maps based on problems in two and three factor crosses

4. Assay of antibiotics and demonstration of antibiotic resistance
5. Bacterial transformation
6. Bacterial conjugation
7. Induction of mutation in bacteria by UV
8. Isolation of bacterial mutants
9. Problems related to molecular genetics

BT P – 102: BIOMOLECULES AND BIOLOGICAL TECHNIQUES

Biomolecules

1. Preparations of buffers and pH measurement of buffers
2. General reactions of monosaccharides and specific reactions of individual sugars (glucose, fructose, galactose and ribose)
3. General reactions of amino acids (solubility, ninhydrin reaction)
4. Specific reactions for different amino acids - Xanthoproteic reaction, Millon's test, Glyoxylic reaction
5. Pauly's test, nitroprusside test and Ehrlich's test
6. General reactions (solubility) and tests of fatty acids, glycerol and terpenes
7. Tests for unsaturation
8. Titration of fatty acids
9. Titration curve of an amino acid and calculation of pK and pI values
10. Quantification of monosaccharides
11. Quantitative estimation of amino acids using the ninhydrin reaction and titration curves of amino acids
12. Spectra and quantitative estimation of base and nucleotides
13. Quantitative analysis of lipids
    a) Determination of acid value of fat
    b) Saponification value of fat
    c) Iodine number of fat
    d) Estimation of cholesterol

Biological Techniques

1. Preparation of buffers and measurement of pH
2. Separation and identification of amino acids by paper chromatography.
3. Separation and identification of sugars by TLC.
4. Separation and identification of lipids by TLC.
5. Separation of amino acids by Ion-exchange chromatography.
6. Separation of proteins by Gel filtration
7. Absorption spectra of amino acids, Proteins and nucleic acids
8. Verification of Beer's law.
9. Determination of molar extinction coefficient of p-nitrophenol.
10. Measurement of inversion of sucrose by polarimetry.
11. Dialysis of crude protein.
12. HPLC demonstration
13. Separation of proteins by PAGE
14. Separation of protein by paper electrophoresis
15. Isolation and spectrophotometric characterization of plant pigments
16. Separation of Nucleic acids by using Agarose gel electrophoresis