ANDHRA KESARI UNIVERSITY ::ONGOLE

Model Syllabus for 4-Year UG Honours in B.Sc. (Biotechnology) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Introduction to Cell Biology and Genetics	3	3
			Introduction to Cell Biology and Genetics-Practical	2	1
		2	Biological Chemistry	3	3
			Biological Chemistry-Practical	2	1
	II	3	Microbiology	3	3
			Microbiology-Practical	2	1
		4	Basic Immunology	3	3
			Basic Immunology-Practical	2	1
II	III	5	Biophysical Techniques	3	3
			Biophysical Techniques-Practical	2	1
		6	Basic Molecular Biology	3	3
			Basic Molecular Biology-Practical	2	1
		7	Genetic Engineering	3	3
			Genetic Engineering-Practical	2	1
	IV	8	Bioinformatics, Biostatistics & Bioethics	3	3
			Bioinformatics, Biostatistics & Bioethics-Practical	2	1
		9	Basics of Plant Biotechnology	3	3
			Basics of Plant Biotechnology-Practical	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
		10	Basics of Animal Biotechnology	**3**	**3**
			Basics of Animal Biotechnology-Practical	**2**	**1**
III	**V**	**11**	Industrial Biotechnology	**3**	**3**
			Industrial Biotechnology-Practical	**2**	**1**
		12 A	Medical Biotechnology	**3**	**3**
			Medical Biotechnology-Practical	**2**	**1**
		OR			
		12 B	Marine Biotechnology	**3**	**3**
			Marine Biotechnology-Practical	**2**	**1**
		13 A	Nano Biotechnology	**3**	**3**
			Nano Biotechnology-Practical	**2**	**1**
		OR			
		13 B	Biofertilizers and Biopesticides Production	**3**	**3**
			Biofertilizers and Biopesticides Production-Practical	**2**	**1**
	VI	**14 A**	Pharmaceutical Biotechnology	**3**	**3**
			Pharmaceutical Biotechnology-Practical	**2**	**1**
		OR			
		14 B	Food and Nutritional Biotechnology	**3**	**3**
			Food and Nutritional Biotechnology-Practical	**2**	**1**
		15 A	Genomics & Proteomics	**3**	**3**
			Genomics & Proteomics-Practical	**2**	**1**
		OR			
		15 B	Environmental Biotechnology	**3**	**3**
			Environmental Biotechnology-Practical	**2**	**1**

Note: In the III Year (during the V and VI Semesters), students are required to select a pair of electives from one of the Two specified domains. For example: if set 'A' is chosen, courses 12 to 15 to be chosen as 12 A, 13 A, 14 A and 15 A or if set 'B' is chosen, It is to be chosen as 12 B, 13 B, 14 B and 15 B to ensure in-depth understanding and skill development in the chosen domain, students must continue with the same domain electives in both the V and VI Semesters.

Syllabus approved & forwarded by
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SEMESTER - I

COURSE 1: INTRODUCTION TO CELL BIOLOGY AND GENETICS

Theory **Credits: 3** **3 hrs/week**

Course Objectives:

1. To introduce students to the structure and function of prokaryotic and eukaryotic cells.
2. To provide knowledge on cellular organelles and their roles in cell physiology.
3. To explain the principles of genetics, including Mendelian laws and chromosome organization.
4. To describe mutagenesis, DNA damage, and repair mechanisms.
5. To create awareness about the cell cycle, cancer biology, and cell signaling processes.

Learning Outcomes:

After completing this course, students will be able to:

1. Identify and describe the structure of different types of cells and their components.
2. Explain the functions of cell organelles and mechanisms of cell transport.
3. Apply Mendelian principles and recognize deviations in inheritance patterns.
4. Analyze causes of mutations and describe DNA repair mechanisms.
5. Compare normal and cancer cells, and explain the regulation of cell cycle and apoptosis.

Syllabus

Unit I
Cell as a basic unit of living organism; Cell wall Structure, chemical composition and function. Glycocalyx. Structure and Function of Cell membranes; Brief description of viral, bacterial, fungal, plant and animal cells.

Unit II
Sub-cellular organization of eukaryotic cell: Nucleus, nuclear envelope, transport across nuclear membrane; Nucleolus; cytosol, endoplasmic reticulum, chloroplast, mitochondria, vacuoles, ribosomes, peroxisomes, lysosome and golgi complex; Cell Transport: Active and Passive transport, phagocytosis, pinocytosis, exocytosis. Chromosomes: Morphology, Structural Organization; Specialized chromosomes- Salivary gland & lamp brush chromosomes.

Unit III
Mendel Experiments, Mendel Laws and Deviations: Incomplete Dominance and Co-dominance; Concept of multiple alleles; Structure of prokaryotic and Eukaryotic chromosomes. Eukaryotic chromosome organization, histone proteins.

Unit IV

Mutagenesis - Spontaneous and induced (Chemical and physical) mutations; Mutations- point mutations, frameshift mutations; Factors affecting DNA damage; Repair Mechanisms - Light induced repair, Excision repair and mismatch repair and SOS repair.

Unit V

Phases of the eukaryotic cell cycle - Mitosis and Meiosis; Regulation of cell cycle-checkpoints. Basics of Cancer Development (Concept of Angiogenesis and Metastasis) and Cancer causative agents. Proto- oncogenes, oncogenes. Differences between cancer cell and normal cell. Programmed Cell Death. Introduction to cell signaling.

Reference books:

- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter – *Molecular Biology of the Cell* – Garland Science.
- Geoffrey M. Cooper and Robert E. Hausman – *The Cell: A Molecular Approach* – ASM Press & Sinauer Associates.
- Gerald Karp – *Cell and Molecular Biology: Concepts and Experiments* – John Wiley & Sons.
- De Robertis, E.D.P. and De Robertis, E.M.F. – *Cell and Molecular Biology* – Saunders College Publishing.
- Snustad, D.P. and Simmons, M.J. – *Principles of Genetics* – John Wiley & Sons.
- Gardner, E.J., Simmons, M.J. and Snustad, D.P. – *Principles of Genetics* – John Wiley & Sons.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. – *Molecular Cell Biology* – W.H. Freeman and Company.

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SEMESTER - I

COURSE 1: INTRODUCTION TO CELL BIOLOGY AND GENETICS

Practical	**Credits: 1**	**2 hrs/week**

Practical Component:

1. Principle and utilization of microscope
2. Preparation of blood smear and observation of cells
3. Study of divisional stages in mitosis
4. Study of divisional stages in meiosis
5. Observation of differences between stained bacterial cells and cells in onion peels
6. Observation of permanent slides of bacterial, fungal, plant and animal cells
7. Problem solving in genetics
8. Human Karyotype analysis
9. Simple Mendelian traits in humans and pedigree analysis

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SEMESTER - I

COURSE 2: BIOLOGICAL CHEMISTRY

Theory	**Credits: 3**	**3 hrs/week**

Course Objectives:

1. To introduce students to the structure and properties of nucleic acids and their biological significance.
2. To explain the chemistry and classification of carbohydrates, lipids, porphyrins, heme, and chlorophylls.
3. To provide knowledge on amino acids, protein structure, and conformational analysis.
4. To develop understanding of enzyme classification, kinetics, inhibition, and mechanisms of action.
5. To describe bioenergetics, ATP, and central metabolic pathways including glycolysis, TCA cycle, and oxidative phosphorylation.

Learning Outcomes:

After completing this course, students will be able to:

1. Describe the chemical structure and structural variations of nucleic acids.
2. Classify and explain the structures and functions of carbohydrates, lipids, and porphyrins.
3. Explain the properties and structural organization of proteins using the Ramachandran plot.
4. Analyze enzyme kinetics, substrate specificity, and different types of enzyme inhibition.
5. Understand the principles of bioenergetics and summarize major energy-yielding metabolic pathways.

Syllabus

UNIT I

Nucleic Acids: Chemical structure and base composition of nucleic acids (DNA and RNA). Chargaff's rules. Watson Crick Model (B-DNA), deviations from Watson-Crick model. Alternative forms of DNA (A-DNA and Z-DNA). Forces stabilizing nucleic acid structures, (hydrogen bonds and hydrophobic associations).

UNIT II

Carbohydrates: Definition, classification, nomenclature of carbohydrates, structures of monosaccharides, disaccharides and polysaccharides. Concept and examples of heteropolysaccharides.

Lipid: Structure of saturated and unsaturated fatty acids, triglycerides, phospholipids, Chemistry of Porphyrines, Heme and Chlorophylls.

UNIT III

Amino acids and Proteins: Structure of amino acids occurring in proteins, classification of amino acids (pH based, polarity based and nutrition based) physico-chemical properties of amino acids. Primary, Secondary, Tertiary & Quaternary structure of proteins. Ramachandran Plot.

UNIT IV

Enzymes: Terminology: Active site, allosteric site, Holoenzyme, apoenzyme, coenzyme, substrate, inhibitor, activator, modulator etc. Classification and nomenclature of enzymes. Substrate Specificity (bond specificity, group specificity, absolute specificity, stereospecificity), lock and key and induced fit models. Enzyme kinetics: Michaelis-Menten equation, effect of substrate concentration, effect of enzyme concentration, effect of pH and temperature, temperature. Enzyme inhibition (reversible inhibition types – competitive, uncompetitive and non-competitive), brief idea of irreversible inhibition.

UNIT V

Bioenergetics: Concept of free energy, Entropy, Enthalpy & Redox Potential. Concept of high energy bonds (structure of ATP). Glycolysis, Kreb's cycle, Gluconeogenesis: Bypass reactions., Electron transport chain, Oxidative phosphorylation.

Reference books:

- Lehninger, A.L., Nelson, D.L. and Cox, M.M. – *Principles of Biochemistry* – W.H. Freeman and Company.
- Voet, D. and Voet, J.G. – *Biochemistry* – John Wiley & Sons.
- Stryer, L. – *Biochemistry* – W.H. Freeman and Company.
- Satyanarayana, U. and Chakrapani, U. – *Biochemistry* – Elsevier / Books and Allied (Indian edition).
- Zubay, G. – *Biochemistry* – Wm. C. Brown Publishers.
- Garrett, R.H. and Grisham, C.M. – *Biochemistry* – Brooks/Cole, Cengage Learning.
- Conn, E.E. and Stumpf, P.K. – *Outlines of Biochemistry* – John Wiley & Sons.

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SEMESTER - I

COURSE 2: BIOLOGICAL CHEMISTRY

Practical	**Credits: 1**	**2 hrs/week**

Practical Component:

1. Introduction to basic instruments (Principle standard operation procedure) demonstration and record
2. Calculation of molarity, normality, and molecular weight of compounds.
3. Qualitative analysis of carbohydrates (sugars)
4. Quantitative analysis of carbohydrates
5. Quantitative estimation of protein - Lowery method
6. Estimation of DNA by diphenylamine reagent
7. Estimation of RNA by orcinol reagent
8. Assay of protease activity
9. Preparation of starch from potato and its hydrolyzation by salivary amylase

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SEMESTER - II

COURSE 3: MICROBIOLOGY

Theory	**Credits: 3**	**3 hrs/week**

Course Objectives:

1. To introduce the history and development of microbiology along with contributions of key scientists.
2. To explain the principles and applications of different types of microscopy.
3. To study the structure, morphology, and special features of bacteria, including staining techniques.
4. To provide knowledge on microbial nutrition, growth, cultivation, and methods of microbial control.
5. To introduce viruses, their structure, replication, classification, and transmission with examples of human diseases.

Learning Outcomes:

After completing this course, students will be able to:

1. Summarize the historical contributions of Pasteur, Koch, and Jenner in microbiology.
2. Differentiate between light, phase contrast, dark field, fluorescent, and electron microscopy.
3. Describe bacterial morphology, cell structures, plasmids, endospores, and staining methods.
4. Identify nutritional requirements, growth phases, and apply sterilization and disinfection techniques.
5. Explain the structural organization, replication strategies, and transmission of viruses including modern examples.

Syllabus

UNIT I
History, Development and Microscopy
History and development of microbiology: contributions of Louis Pasteur, Robert Koch and Edward Jenner. Microscopy: Compound microscopy: Numerical aperture and its importance, resolving power, oil immersion objectives and their significance. Principles and applications of dark field, phase contrast, fluorescent microscopy. Electron microscopy: Principle, ray diagram and applications, TEM and SEM, comparison between optical and electron microscope, limitations of electron microscopy.

UNIT II
Bacteria: Bacterial morphology and subcellular structures, general morphology of bacteria, shapes and sizes, generalized diagram of typical bacterial cell. Slime layer and capsule, difference between the structure and function. Cell wall of Gram +ve and Gram -ve cells. General account of flagella and fimbriae. Chromatin material, plasmids; definition and kind

of plasmids (conjugative and non-conjugative) F, R, and Col plasmids. Endospores: Detailed study of endospore structure and its formation, germination, basis of resistance.
Staining: Acidic, Basic and Neutral stains. Simple and Gram Staining, Acid fast staining, Flagella staining, Endospore staining.

Unit III

Microbial Nutrition: Basic nutritional requirements. Composition of Natural and Synthetic Media. Selective and Differential media, Enriched media, Enrichment media. Factors Affecting Growth of Microbes: pH, Temperature, Salinity. Classification of microorganisms based on nutrition and temperature.

UNIT IV
Microbial growth and control: Growth rate and generation time, details of growth curve and its phases. Measurement of growth. Pure cultures and cultural characteristics. Maintenance of pure culture. Microbial Control: Sterilization (Physical and chemical methods of sterilization), disinfection, sanitization, germicide, microbistasis, antiseptics and antimicrobials.

UNIT V:
Viruses: Properties and General characteristics of Viruses. Classification of viruses on the basis of nucleic acids composition. Basic Structure of Lamda and M13 DNA Virus. Brief idea of lytic cycle and lysogeny. **Viral Transmission:** Different modes (dengue, SARS-CoV-2) and their preventive measures.

Reference books:

- Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. – *Microbiology* – Tata McGraw-Hill Publishing Company.
- Prescott, L.M., Harley, J.P. and Klein, D.A. – *Microbiology* – McGraw-Hill Higher Education.
- Cappuccino, J.G. and Sherman, N. – *Microbiology: A Laboratory Manual* – Pearson Education.
- Willey, J.M., Sherwood, L.M. and Woolverton, C.J. – *Prescott's Principles of Microbiology* – McGraw-Hill.
- Tortora, G.J., Funke, B.R. and Case, C.L. – *Microbiology: An Introduction* – Pearson Education.
- Powar, C.B. and Daginawala, H.F. – *General Microbiology* – Himalaya Publishing House.
- Ananthanarayanan, R. and Paniker, C.K.J. – *Textbook of Microbiology* – Universities Press (for medical aspects).

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SEMESTER - II

COURSE 3: MICROBIOLOGY

Practical	**Credits: 1**	**2 hrs/week**

Practical Component:

1. Cleaning and preparation of glassware
2. Observation of permanent slides using microscope
3. Preparation of nutrient agar medium for bacteria
4. Preparation of PDA medium for fungal culture
5. Sterilization techniques (autoclave, hot air oven, filter)
6. Isolation of bacteria from soil
7. Simple staining technique
8. Differential staining technique
9. Microbial counting by Haemocytometer
10. Identification of different bacteria
11. Motility test by hanging drop
12. Biochemical identification of bacteria
13. Preparation of pure culture by slab, slant, streak culture

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SEMESTER - II

COURSE 4: BASIC IMMUNOLOGY

Theory	**Credits: 3**	**3 hrs/week**

Course Objectives:

1. To introduce the fundamentals of the immune system, immune cells, and immune organs.
2. To explain the structure, types, and diversity of antibodies and the nature of antigens.
3. To describe mechanisms of humoral and cell-mediated immunity, cytokines, and MHC molecules.
4. To provide knowledge about hypersensitivity, autoimmunity, vaccination, and different types of vaccines.
5. To familiarize students with immunological techniques and applications of monoclonal antibodies.

Learning Outcomes:

After completing this course, students will be able to:

1. Explain the organization of the immune system and differentiate innate and acquired immunity.
2. Describe antibody structure, types, and antigenic determinants.
3. Analyze mechanisms of humoral, cell-mediated, and NK cell-mediated immune responses.
4. Differentiate between types of hypersensitivity and explain the principles and applications of vaccination.
5. Apply knowledge of immunological techniques for antigen-antibody interactions and monoclonal antibody production.

Syllabus

UNIT I

Immune System: History and Scope of Immunology. Types of Immunity: Innate and Acquired. Cells of immune system: T cells, B cells. Organs of the Immune system: Bone marrow, spleen, thymus, MALT, lymph node.

UNIT II

Antibody and Antigen: Antibodies: Structure and Types of Antibodies (IgG, IgM, IgA, IgE, IgD). Monoclonal and Polyclonal antibodies. Antibody diversity. Antigens: Types of Antigens. Antigenicity (factors affecting antigenicity). Antigenic determinants – adjuvants and haptens, epitopes.

UNIT III

Immunity: Humoral immunity. Cell-mediated immunity – T Cell-mediated immunity, NK cell-mediated immunity, ADCC. Brief description of cytokines and interleukins. Major Histocompatibility Complex (MHC) – Structure and functions of Class I and Class II MHC molecules.

UNIT IV

Hypersensitivity and Vaccination: General features of hypersensitivity, various types of hypersensitivity. Autoimmunity. Vaccination: Discovery, principles, and significance. Types of Vaccines – Live, attenuated, killed, toxoids, recombinant-based (mRNA and Protein).

UNIT V

Immunological Techniques: Antigen-antibody reactions: Precipitation, agglutination, complement fixation, immunodiffusion – Radial immune diffusion, Ouchterlony double immune diffusion, ELISA, RIA, immunoelectrophoresis, Rocket electrophoresis. Hybridoma technology: Monoclonal antibodies and their applications in immunodiagnostics.

Reference books:

- Kuby, J. – *Immunology* – W.H. Freeman & Company.
- Abbas, A.K., Lichtman, A.H. and Pillai, S. – *Cellular and Molecular Immunology* – Elsevier.
- Roitt, I., Brostoff, J. and Male, D. – *Immunology* – Mosby Publications.
- Ananthanarayanan, R. and Paniker, C.K.J. – *Textbook of Microbiology* – Universities Press (for immunology basics).
- Kindt, T.J., Goldsby, R.A. and Osborne, B.A. – *Kuby Immunology* – W.H. Freeman.
- Delves, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. – *Roitt's Essential Immunology* – Wiley-Blackwell.

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SEMESTER - II

COURSE 4: BASIC IMMUNOLOGY

Practical	**Credits: 1**	**2 hrs/week**

Practical Component:

1. Antigen–antibody reaction–determination of Blood group, Cross reactivity
2. Pregnancy test
3. Widal test
4. Ouchterlony immunodiffusion
5. Radial immuno diffusion
6. ELISA
7. Production of antibodies and their titration

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