ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Programme: B.Sc. Honours in Biotechnology (Major)

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	*Semester*	*Course*	*Title of the Course*	*No. of Hrs /Week*	*No. of Credits*
I	I	1	Introduction to Classical Biology	5	4
		2	Introduction to Applied Biology	5	4
	II	3	Biomolecules and Analytical Techniques – (T)	3	3
			Biomolecules and Analytical Techniques – (P)	2	1
		4	Microbiology, Cell Biology – (T)	2	3
		5	Microbiology, Cell Biology – (P)	3	1
II	III	6	Plant and Animal Biotechnology -(T)	2	3
		7	Plant and Animal Biotechnology – (P)	3	1
		8	Molecular Biology – (T)	2	3
		9	Molecular Biology – (P)	3	1
		10	Genetic Engineering –(T)	2	3
		11	Genetic Engineering –(P)	3	1
		12	Metabolism – (T)	2	3
		13	Metabolism – (P)	3	1
	IV	14	Immunology – (T)	2	3
			Immunology – (P)	3	1
			Bioinformatics and Biostatistics – (T)	2	3
			Bioinformatics and Biostatistics – (P)	3	1
			Medical Biotechnology – (T)	2	3
			Medical Biotechnology – (P)	3	1
III	V		Industrial Biotechnology – (T)	2	3
			Industrial Biotechnology – (P)	3	1
			Food & Nutritional Biotechnology – (T)	2	3
			Food & Nutritional Biotechnology – (P)		1
			Gene Biotechnology (OR) Genomics & Proteomics – (T)		3
			Gene Biotechnology (OR) Genomics & Proteomics – (T)		1
		15	Nanotechnology & Pharmaceutical Biotechnology (OR) Applications of Biotechnology - (T)	3	3
			Nanotechnology & Pharmaceutical Biotechnology (OR) Applications of Biotechnology - (P)	2	1
	VI	***Internship***			
IV	VII	Courses will be available in due course of time			
	VIII	Courses will be available in due course of time			

SEMESTER-I

COURSE 1: INTRODUCTION TO CLASSICAL BIOLOGY

Theory Credits: 4 5 hrs/week

Learning objectives

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

Learning Outcomes

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

Unit 1: Introduction to systematics, taxonomy and ecology.

1.1. Systematics – Definition and concept, Taxonomy – Definition and hierarchy.

1.2. Nomenclature – ICBN and ICZN, Binomial and trinomial nomenclature.

1.3. Ecology – Concept of ecosystem, Biodiversity and conservation.

1.4. Pollution and climate change.

Unit 2: Essentials of Botany.

2.1. The classification of plant kingdom.

2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones).

2.3. Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos.

2.4 Mushroom cultivation, floriculture and landscaping.

Unit 3: Essentials of Zoology

3.1. The classification of Kingdom Animalia and Chordata.

3.2 Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders

3.3 Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis)

3.4 Economic Zoology – Sericulture, Apiculture, Aquaculture

Unit 4: Cell biology, Genetics and Evolution

4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle.

4.2. Chromosomes and heredity – Structure of chromosomes, concept of gene.

4.3. Central Dogma of Molecular Biology.

4.4. Origin of life

Unit 5: Essentials of chemistry

5.1. Definition and scope of chemistry, applications of chemistry in daily life.

5.2. Branches of chemistry

5.3. Chemical bonds – ionic, covalent, noncovalent – Vander Waals, hydrophobic, hydrogen bonds.

5.4. Green chemistry

References

1. Sharma O.P., 1993. Plant taxonomy. 2nd Edition. McGraw Hill publishers.

2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4th edition. S. Chand publishers, New Delhi, India.

3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.

4. Rastogi, S.C., 2019. Essentials of animal physiology. 4 Edition. New Age International Publishers.

5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.

6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4 Edition. Elsevier publishers.

7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.

8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5th Edition. Pearson publishers.

9. Subrata Sen Gupta, 2014. Organic chemistry. 1st Edition. Oxford publishers.

ACTIVITIES:

1. Make a display chart of life cycle of nonflowering plants.
2. Make a display chart of life cycle of flowering plants.
3. Study of stomata
4. Activity to prove that chlorophyll is essential for photosynthesis
5. Study of pollen grains.
6. Observation of pollen germination.

7. Ikebana.

8. Differentiate between edible and poisonous mushrooms.

9. Visit a nearby mushroom cultivation unit and know the economics of mushroom cultivation.

10. Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell

11. Visit to Zoology Lab and observe different types of preservation of specimens

12. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow

13. Visit to Zoo / Sericulture / Apiculture / Aquaculture unit

14. List out different hormonal, genetic and physiological disorders from the society

SEMESTER-I

COURSE 2: INTRODUCTION TO APPLIED BIOLOGY

Theory Credits: 4 5 hrs/week

Learning objectives

The student will be able to learn the foundations and principles of microbiology, immunology, biochemistry, biotechnology, analytical tools, quantitative methods, and bioinformatics.

Learning Outcomes

1. Learn the history, ultrastructure, diversity and importance of microorganisms.
2. Understand the structure and functions of macromolecules.
3. Knowledge on biotechnology principles and its applications in food and medicine.
4. Outline the techniques, tools and their uses in diagnosis and therapy.
5. Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

Unit 1: Essentials of Microbiology and Immunology

1.1. History and Major Milestones of Microbiology; Contributions of Edward Jenner, Louis Pasteur, Robert Koch and Joseph Lister.

1.2. Groups of Microorganisms – Structure and characteristics of Bacteria, Fungi, Archaea and Virus.

1.3. Applications of microorganisms in – Food, Agriculture, Environment, and Industry.

1.4. Immune system – Immunity, types of immunity, cells and organs of immune system.

Unit 2: Essentials of Biochemistry

2.1. Biomolecules I – Carbohydrates, Lipids.

2.2. Biomolecules II – Amino acids & Proteins.

2.3. Biomolecules III – Nucleic acids -DNA and RNA.

2.4. Basics of Metabolism – Anabolism and catabolism.

Unit 3: Essentials of Biotechnology

3.1. History, scope, and significance of biotechnology. Applications of biotechnology in Plant, Animal, Industrial and Pharmaceutical sciences.

3.2. Environmental Biotechnology – Bioremediation and Biofuels, Biofertilizers and Biopesticides.

3.3. Genetic engineering – Gene manipulation using restriction enzymes and cloning vectors; Physical, chemical, and biological methods of gene transfer.

3.4. Transgenic plants – Stress tolerant plants (biotic stress – BT cotton, abiotic stress – salt tolerance). Transgenic animals – Animal and disease models.

Unit 4: Analytical Tools and techniques in biology – Applications

4.1. Applications in forensics – PCR and DNA fingerprinting

4.2. Immunological techniques – Immunoblotting and ELISA.

4.3. Monoclonal antibodies – Applications in diagnosis and therapy.

4.4. Eugenics and Gene therapy

Unit 5: Biostatistics and Bioinformatics

5.1. Data collection and sampling. Measures of central tendency – Mean, Median, Mode.

5.2. Measures of dispersion – range, standard deviation and variance. Probability and tests of significance.

5.3. Introduction, Genomics, Proteomics, types of Biological data, biological databases- NCBI, EBI, Gen Bank; Protein 3D structures, Sequence alignment

5.4. Accessing Nucleic Acid and Protein databases, NCBI Genome Workbench

REFERENCES

1. Gerard J., Tortora, Berdell R. Funke, Christine L. Case., 2016. Microbiology: An Introduction. 11th Edition. Pearson publications, London, England.

2. Micale, J. Pelczar Jr., E.C.S. Chan., Noel R. Kraig., 2002. Pelczar Microbiology. 5th Edition. McGraw Education, New York, USA.

3. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.

4. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.

5. R.C. Dubey, 2014. Advanced Biotechnology. S. Chand Publishers, New Delhi, India.

6. Colin Ratledge, Bjorn, Kristiansen, 2008. Basic Biotechnology. 3 Edition. Cambridge Publishers.

7. U. Sathyanarayana, 2005. Biotechnology. 1st Edition. Books and Allied Publishers pvt. ltd., Kolkata.

8. Upadhyay, Upadhyay and Nath. 2016. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.

9. Arthur M. Lesk. Introduction to Bioinformatics. 5th Edition. Oxford publishers.

10. AP Kulkarni, 2020. Basics of Biostatistics. 2nd Edition. CBS publishers.

ACTIVITIES

1. Identification of given organism as harmful or beneficial.
2. Observation of microorganisms from house dust under microscope.
3. Finding microorganism from pond water.
4. Visit to a microbiology industry or biotech company.
5. Visit to a waste water treatment plant.
6. Retrieving a DNA or protein sequence of a gene'
7. Performing a BLAST analysis for DNA and protein.
8. Problems on biostatistics.
9. Field trip and awareness programs on environmental pollution by different types of wastes and hazardous materials.
10. Demonstration on basic biotechnology lab equipment.
11. Preparation of 3D models of genetic engineering techniques.
12. Preparation of 3D models of transgenic plants and animals.

[***NOTE***: In the colleges where there is availabilityof faculty for microbiology and biotechnology, those chapters need to be handled by microbiologyand biotechnology faculty. In other colleges, the above topics shall be dealt by Botany and Zoologyfaculty]

SEMESTER-II

COURSE 3: BIOMOLECULES AND ANALYTICAL TECHNIQUES

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

On successful completion of the course, the students will be able to

1. Learn about classification, structure and properties of Carbohydrates, Proteins and Lipids.

2. Learn about structure and function of DNA, RNA, Vitamins and Bioenergetics.

3. Learn about basic principles of Centrifugation, Chromatography and Electrophoresis.

4. Learn about principles of Spectroscopy, Microscopy and Techniques.

5. Learn about basics of Biostatistics.

II. Syllabus

Unit-I-Carbohydrates, Protein and Lipids

1. Classification, structure, properties of carbohydrates, amino acids, peptide bond and peptides.
2. Classification, structure (primary, secondary, tertiary, quaternary) and functions of proteins. Denaturation and renaturation of proteins.
3. Classification structure and properties of saturated and unsaturated fatty acids.

Unit-II- Nucleic acid, Vitamins, and Bioenergetics

1. Structure and functions of DNA and RNA.
2. Source, structure, biological role, and deficiency manifestation of vitamin A, B, C, D, E, and K. Free energy, entropy, enthalpy, and redox potential.
3. High energy compounds, Electron-Transport System and Oxidative Phosphorylation.

Unit-III-Centrifugation, Chromatography, and Electrophoresis

1. Basic principles of sedimentation and types of centrifugations.
2. Principle, instrumentation, and application of partition, absorption, paper, TLC, ion exchange, gel permeation, and affinity chromatography.
3. Basic principles and types of electrophoresis, factors affecting electrophoretic migration. PAGE (Native, SDS-PAGE). Introduction to 2D & Isoelectric Focusing.

Unit - IV-Spectroscopy, Microscopy and Laser Techniques

Beer-Lambert law, light absorption and transmission. Extinction coefficient, Design and application of photoelectric calorimeter and UV-visible spectrophotometer. Introduction to crystallography and application.

2. Types and design of microscopes - compound, phase contrast, fluorescent electron microscopy (TEM, SEM).
3. Introduction to radioisotopes, measurement of radioactivity (scintillation counter and autoradiography

Unit –V- Biostatistics

1. Mean, median, mode, standard deviation,
2. One-way ANOVA, Two-way Anova
3. t-test, F-test and chi-square.

III . Skills Outcome

On Successful Completion of this Course, Student shall be able to

1. learn about basic instruments and their operation
2. learn about Qualitative and Quantitaive analysis of carbohydrates
3. Learn about estimations nucleic acids and protein by various methods
4. learn about the separation of molecules by chromatography and electrophoresis
5. Learn about problems on mean median mode

SEMESTER-II

COURSE 3: BIOMOLECULES AND ANALYTICAL TECHNIQUES

Practical Credits: 1 2 hrs/week

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 hydrolyze by salivary amylase
10. Preparation of standard buffer and pH determination
11. Separation of amino acids by paper chromatography
12. Separation of lipids of TLC
13. Agarose gel electrophoresis
14. Calculation of mean, median and mode

V. REFERENCES

1. Outlines of Biochemistry, 5th Edition, (2009), Erice Conn & Paul Stumpf; John Wiley and Sons, USA
2. Principles of Biochemistry, 4th edition, (1997), Jeffory Zubey; McGraw-Hill College, USA
3. Principles of Biochemistry, 5th Edition (2008), Lehninger, David Nelson & Michael Cox; W.H. Freeman and Company, NY
4. Fundamentals of Biochemistry, 3rd Edition (2008), Donald Voet & Judith Voet; John Wiley and Sons, Inc. USA
5. Biochemistry, 7th Edition, (2012), Jeremy Berg & Lubert Stryer; W.H.Freeman and Company, An NY
6. Introduction to Practical Biochemistry, 3rd Edition, (2001), David Plummer; Tata McGraw Hill Edu. Pvt.Ltd. New Delhi, India
7. Biochemical Methods,1st Edition, (1995), S.Sadashivam, A.Manickam; New Age International Publishers, India
8. Textbook of Biochemistry with Clinical Correlations, 7th Edition, (2010), Thomas M. Devlin; John Wiley and Sons, USA
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10. Biochemical Calculations, 2nd Ed., (1997), Segel Irvin H; John Wiley and Sons, NY
11. Biophysical Chemistry Principles & Techniques Handbook, (2003), A. Upadhyay, K. Upadhyay, and N. Nath

12. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001), Palmer Trevor, Publisher: Horwood Pub. Co., England.
13. Analytical Biochemistry, 3rd edition, (1998), David Holmes, H.Peck, Prentice-Hall, UK
14. Introductory Biostatistics, 1st edition, (2003), Chap T. Le; John Wiley, USA.
15. Methods in Biostatistics, (2002), B. K. Mahajan –Jaypee Brothers.
16. Statistical methods in biology, (1995), Bailey, N. T.; Cambridge university press

VI. CO-Curricular Activities

a) ***Suggested C0-Curricular Activities***

1. Assignments
2. Seminars, Group Discussions on related topics
3. Charts preparation on vitamins

SEMESTER-II

COURSE 4: MICROBIOLOGY, CELL BIOLOGY

Theory Credits: 3 3 hrs/week

I. LEARNING OUTCOMES

On successful completion of the course, the students will be able to

1. Learn about Scope and Techniques of Microbiology.

2. Learn about concept of Microbial species and strains,

3. Learn about cell structure and function.

4. Learn about cell signaling and control mechanisms.

5. Learn about genome organization of prokaryotic and eukaryotic organisms

II. Syllabus

Unit-I- Scope and Techniques of Microbiology

1. History and contribution of Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming.
2. Ultrastructure of bacteria and growth curve. Pure culture techniques.
3. Sterilization techniques, principles and application of physical methods (autoclave, hot air oven, incineration), chemical methods and radiation methods. Simple, gram and acid-fast staining.

Unit-II-Microbial Taxonomy and Metabolism

1. Concepts of microbial species and strains. Classification of bacteria based on morphology, nutrition and environment. General characteristics, transmission and cultivation of viruses. Structure and properties of plant (tobacco mosaic virus, TMV), animal (Newcastle disease virus, NDV), human (Human immunodeficiency virus, HIV) and bacterial viruses (T4 phage). Emerging and reemerging viruses (dengue) and zoonotic viruses (rabies, SARS-CoV-2).
2. Microbial production of penicillin. Bacterial toxins, tuberculosis, typhoid. Introduction to fungi, algae and mycoplasm.

Unit-III- Cell Structure and Functions

1. Structure, properties and functions of cellular organelles (E.R, Golgibodies, Mitochondria, Ribosomes lysosomes , nucleus) of eukaryotic cells.
2. Cell cycle and its regulation
3. cell division (mitosis and meiosis).

Unit-IV- CELL SIGNALLING

1. Chemical composition and dynamic nature of the membrane,
2. Cell Surface Receptors
3. cell signaling and communication(GPCR .- cAMP,cGMP,IP3-DAG)

Unit – V - Central Dogma of Molecular Biology

1. Genome organization of prokaryotic and eukaryotic organisms
2. Enzymes involved in Replication, Transcription, and Translation
3. DNA repair Mechanism

III . Skills Outcome

On Successful Completion of this Course, Student shall be able to

1. Learn about preparation of media for culturing of various microorganisms
2. Learn about isolation of microrganisms from different sources
3. Learn about staining techniques and biochemical identification of bacteria
4. Learn about different stages of cell division

SEMESTER-II

COURSE 4: MICROBIOLOGY, CELL BIOLOGY

Practical Credits: 1 2 hrs/week

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

14 Extraction and isolation of DNA from bacteria

V. REFERENCES

1. Microbiology–6th Edition, (2006), Pelczar M.J., Chan E.C.S., Krieg N.R.; The McGrawHill Companies Inc. NY
2. Prescott's Microbiology, 8th edition, (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton; McGrawHill Science Engineering, USA
3. Textbook of Microbiology, Anantnarayan and Paniker (2017)
4. Brock biology of microorganisms, 2003, Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J.; Upper Saddle River (NJ): Prentice-Hall, 2003.
5. Genes XI, 11th edition, (2012), Benjamin Lewin; Publisher - Jones and Barlett Inc. USA
6. Molecular Biology of the Gene, 6th Edition, (2008), James D. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R.; Cold Spring Harbour Lab. Press, Pearson Pub.
7. Molecular Biology, 5th Edition, (2011), Weaver R.; McGraw Hill Science. USA
8. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi; Oxford University Press.
9. Molecular Biology: Genes to Proteins, 4th edition (2011), Burton E Tropp Jones& Bartlett Learning, USA.
10. Cell and Molecular Biology: Concepts and Experiments, 6th Edition, Karp, G. 2010.; John Wiley & Sons. Inc.

VI. CO-Curricular Activities

a) ***Suggested Co-Curricular Activities***

1. Assignments
2. Seminars, Group Discussions on related topics
3. Charts on Replication, cell cycle , cell signalling