RADHA GOVIND UNIVERSITY

RAMGARH, JHARKHAND

DEPARTMENT OF BIOTECHNOLOGY

COURSE CURRICULUM FOR UNDERGRADUATE COURSES

UNDER CHOICE BASE CREDIT SYSTEM

FACULTY OF SCIENCE

B. Sc. in Biotechnology

(Effective from Session 2025-28)

9/5/25
(Dr. Arun Kumar Singh Jha)

9/5/2025

09/05/25

Vision

To impart knowledge and envisages in learner for applying their minds to develop technologies, which will impact not only science but also for society in long run.

Mission

- To produce leadership in science and technology.
- Creating awareness about potential application in the field of Biotechnology and socio-ethical implications of the subject.
- To create a unique image of institution through large scale participation and contribution of students, expert faculties.
- To prepare responsible trained manpower in teaching and research.
- To publish high quality research papers in different fields
- The department will encourage young creative mind to enable them to tap their potential as emerging entrepreneurs in the field of Biotechnology.

Program Educational Objectives (PEO)

- Bachelor course in biotechnology offers the synergism of basic concepts of biology, biotechnology, molecular biology, genomics, Recombinant DNA technology, microbiology, biochemistry and bioinformatics with technological applications.
- The main objective of this degree course is to produce graduates with enhanced skills, knowledge and research aptitude to carry out higher studies, entrepreneurship or research and development in the various health, research and industrial areas.
- Develop proficiency in application of current aspects of biotechnology, molecular biology, Recombinant DNA technology, bioinformatics and genomics.
- Students will be able to use state of the art techniques relevant to academia and industry, generic skills and global competencies including knowledge and skills that enable the students to undertake further studies in the field of biotechnology, molecular biology, Recombinant DNA technology, genomics, microbiology, biochemistry or any other related field.

Programme Specific Outcome (PSO)

PSO-1: Critical Thinking- Students will demonstrate an understanding of major concepts in all disciplines of biology, biochemistry, biotechnology microbiology and bioinformatics. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.

PSO-2: Environment and Sustainability- Understand the issues of environmental contexts and sustainable development.

PSO-3: Self-directed and Lifelong learning- Students will be capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development. Follow the ethical principles and responsibilities to serve the society.

Program outcome

PO 1: Knowledge and Understanding of: Understand the need and apply knowledge of Biotechnology to solve problems in the areas of Medicine, Agriculture, Fermentation technology, Food processing and Environment, and develop entrepreneurial ideas.

PO 2: Intellectual skill: Demonstrate proficiency in basic laboratory skills like preparation of solutions and culture media, handling of equipment, aseptic techniques, micropipetting, maintaining scientific laboratory manuals.

PO 3: Practical skill: Perform, and analyze results of experiments using basic laboratory techniques in molecular biology and recombinant DNA technology, like agarose and polyacrylamide gel electrophoresis, restriction enzyme digestion, bacterial transformations and PCR, immunology and plant tissue culture.

PO 4: Transferable skill: Ability to present their project work through written, oral, and visual presentations.

PO 5: Scientific Knowledge: Get an exposure in current scientific literature, computer programs and web information pertaining to Biotechnology.

PO 6: Medical approach: understanding the concept of biotechnology, microbiology students will exhibit an ability to work independently and collaboratively.

PO 7: Design solution: Design and understand the solution for heal as well as environment problems by using the concepts in Biotechnology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology and molecular biology.

PO 8: Conduct investigation of complex problems: Demonstrate the laboratory skills in cell biology, basic and applied microbiology with an emphasis on technological aspects.

PO 9: Design solution: Competent to apply the knowledge and skills gained in the fields of Plant biotechnology, animal biotechnology and microbial technology in pharma, food, agriculture, beverages, herbal and nutraceutical industries.

PO 10: Environment and sustainability: Critically analyze the environmental issues and apply the knowledge gained in biotechnology for conserving the environment and resolving the problems.

PO 11: Modern usage tool: Demonstrate comprehensive innovations and skills in the field of biomolecules, cell biology molecular biology, bioprocess engineering and genetic engineering of plants, microbes, and animals with respect to applications for human welfare. Apply knowledge and skills of immunology, bioinformatics, computational modelling of proteins, drug design and simulations to test the models and aid in drug discovery.

PO 12: Ethics: Apply ethical principles and commit to environmental ethics and responsibility and norms of the environment and human welfare.

B.Sc. in Biotechnology

(Six Semester Course)

SEMESTER-I

COURSE	Code Of Papers	Name of Papers	Credit	Total Credit
(A) CORE Course	C-1	Biochemistry and Metabolism	04	12
	C-2	Cell biology	04	
	P-1	Practical based in C-1 & C-2	04	
(B) AECC Ability Enhancement Compulsory Course	AECC-1	Communication Skill	02	02
(C) Generic Elective	GE-1	Developmental Biology	04	06
		Practical-GE	02	
			Total credits	20

Semester II

COURSE	Code Of Papers	Name of Papers	Credit	Total Credit
Core Course	C-3	-	04	12
	C-4	Plant Anatomy and Physiology	04	
	P-2	Practical based on C-3 & C-4	04	
(B) AECC Ability Enhancement Compulsory Course	AECC-2	Communication Skill / Environmental Science	02	02
(C) Generic Elective	GE-2	IPR, Bioethics and Biosafety	04	06
		Practical-GE	02	
				20

Semester III

COURSE	Code Of Papers	Name of Papers	Credit	Total Credit
Core Course	C-5	Genetics	04	18
	C-6	General Microbiology	04	
	C-7	Chemistry-1	04	
	P-3	Practical based on C-5,C-6 & C-7	06	
(B) Skill Enhancement Course	SEC-1	Constitution of India and Human Rights	02	02
Generic Elective	GE-3	Biotechnology and Human Welfare	04(T)+02(P)	06
			Total	26

Semester -IV

COURSE	Code of Papers	Name of Papers	Credit	Total Credit
Core Course	C-8	Molecular Biology	04	18
	C-9	Immunology	04	
	C-10	Chemistry -II	04	
	P-4	Practical based on C-8,C-9& C-10	06	
(B) Skill Enhancement Course	SEC-2	Science and Life	02	02
Generic Elective	GE-4	Basics of Forensic Science	04(T)+02(P)	06
				26

SEMESTER V

COURSE	Code Of Papers	Name of Papers	Credit	Total Credit
Core Course	C-11	Bioprocess Technology	04	12
	C-12	Recombinant DNA Technology	04	
	P-5	Practical based on C-11& C-712	04	
Discipline specific Elective	DSE-1	Bioinformatics	04	12
	DSE-2	Plant Diversity	04	
	P-6	Practical based on DSE-1 & DSE-2	04	
			Total	24

SEMESTER VI

COURSE	Code Of Papers	Name of Papers	Credit	Total Credit
Core Course	C-13	Bio Analytical Tools	04	12
	C-14	Genomics and Proteomics	06	
	P-7	Practical based on C-13 & C-14	02	
Discipline specific Elective	DSE-3	Animal Biotechnology	04	12
	DSE-4	Medical Microbiology	04	
	P-8	Practical based on DSE-3 & DSE-4	04	
			Total	24

B.Sc. Biotechnology

Semester I

Core Course C-1

BIOCHEMISTRY AND METABOLISM

(Credit 4+2)

Course Objective:

- This course presents the chemical reactions or metabolic functions in the living system and their regulations.
- To make the student to understood the concept of biochemical regulations.
- To enriching the analytical and research knowledge in the biomolecules and life
- To make them learn the about the digestion, transport, catabolism and anabolism of lipids in the body.
- Make the students to learn the concept of metabolism and energy involved in metabolic pathways.
- Make them to understand the concepts of chemical interactions in biological system.

Course Outcome:

CO 1: To know the basics of bio-molecules, structure, complexity and properties.

CO 2: To understand the biochemical process of life.

CO 3: On successful completion of the subject the student should have understood: Basic biomolecules, *viz* protein fats, enzymes and their relevance to biological molecular stabilization.

CO 4: Understand the metabolic pathways and regulations of carbohydrates metabolism.

CO 5: Learn about the digestion, transport, anabolism and catabolism of lipids in the body.

CO 6: Understand and learn about the chemical interactions in biological systems.

THEORY **(Credit 4)**

UNIT I

Introduction to Biochemistry:

A historical prospective.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

UNIT II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

UNIT III

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, activation energy and transition state, enzyme activity. Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD^+, $NADP^+$, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12.

UNIT IV

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

PRACTICALS

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry**: (i)** Verification of Beer's law, estimation of protein.

   (ii) To study relation between absorbance and % transmission.

6. Preparation of buffers.

7. Separation of Amino acids by paper chromatography.

8. Qualitative tests for Carbohydrates, lipids and proteins

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	**BL**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	L1	3	1	1	3	3	1	3	3	1	1	2	2	3	2	2
CO2	L2	3	3	3	3	3	-	1	1	1	-	2	-	2	2	1
CO3	L2, L4	3	-	3	3	2	2	1	2	2	1	3	2	2	1	2
CO4	L1, L2, L3	2	1	1	3	2	1	2	3	-	1	3	1	3	1	2
CO5	L1, L2	2	2	2	2	3	2	1	2	-	-	2	-	3	2	2
CO6	L1, L2, L6	-	2	3	-	3	2	2	3	3	-	2	3	3	3	3

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.

3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

Core course II

Cell Biology

(Credit 4+2)

Course Objective:

- This course presents the types and structural details of the basic unit by which all the living things are made of (the cell).
- To make the student to understood the concept of cell cycle, regulation and checkpoints.
- This course presents the types and structural details of the basic unit by which all the living things are made of (the cell).
- To make the student to understood the concept of cell and their activities and molecular signalling.
- The students will be able to understand the theories given by scientist for the origin of cell along with different types of prokaryotic and eukaryotic cells.
- Understand them to learn the mechanism of signaling and receptors involved in signaling process.

Course Outcome:

CO 1: Understand concepts in Biotechnology and demonstrate knowledge acquired in interdisciplinary skills in cell biology and genetics

CO 2: Comprehend the structure of a cell with its organelles.

CO 3: Understand the chromatin structure and its location.

CO 4: Understand the basic principles of life, and how a cell divides.

CO 5: Explain the organization of genes and chromosomes, chromosome morphology and its aberrations.

CO6: Understand towards cell differentiation, malignancy and cell death. Compile the information on the structural aspect of cellular biology.

THEORY **(Credits 4)**

UNIT I

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

UNIT IV

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

PRACTICALS

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.

7. Cell division in onion root tip/ insect gonads.

8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	3	2	3	2	3	3	3	2	3	2	2	3	2	2	3
CO2	1,2	-	2	3	-	1	3	1	-	2	3	3	2	1	-	2
CO3	2,3	2	1	1	2	2	2	2	2	-	1	3	2	2	-	3
CO4	1,2	3	-	2	3	2	1	-	1	1	2	1	-	2	1	-
CO5	2,4	1	2	2	3	-	-	2	3	2	2	2	1	2	-	2
CO6	2,3	2	3	-	2	3	2	2	1	2	-	1	1	3	1	3

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Generic
Developmental Biology
(Credit 4+2)

Course Objective

- The objective of this course is to provide a comprehensive understanding of the concepts of early animal development.
- Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.
- Concepts of animal development will be elaborated in one model system or the other.
- The students will be made familiar with different approaches that have been used to study such concepts.

Course Outcome

CO 1: Explain the reproductive strategies in invertebrates and vertebrates and structural and functional features of human reproductive system.

CO 2: Describe process of fertilization, pregnancy, gestation, placentation, parturition and lactation in humans.

CO 3: Explain the scope of reproductive technologies in infertility management; prenatal diagnostic techniques and methods of fertility control.

CO 4: Understand the phases and theories of development, and classification of eggs.\

CO 5: Enumerate the types of cleavage, arrangement of blastomeres, germ layers and their derivatives, cell lineage in Planocera and different types of blastula.

CO 6: Illustrate the early developmental process of egg in Amphioxus, frog, chick and man.

THEORY

UNIT I: Gametogenesis and Fertilization

Definition, scope & historical perspective of development Biology, Gametogenesis Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers. Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

PRACTICALS

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs.
5. Study of different types of placenta.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2	2	2	3	2	3	2	1	2	3	2	3	1	3	1	1
CO2	1,3, 4	3	3	2	3	1	3	2	1	2	2	2	-	2	2	3
CO3	1,2, 3	3	2	3	-	1	1	3	3	1	1	3	-	3	2	3
CO4	1,2, 4	2	2	1	3	3	2	2	1	1	3	3	3	1	2	3
CO5	1,2, 3	2	1	2	2	2	2	-	2	2	3	1	2	2	3	2
CO6	1,2, 3	1	1	2	3	-	2	2	1	2	1	1	1	1	2	2

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.

3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

Semester II

CORE COURSE III

MAMMALIAN PHYSIOLOGY

(Credit 4+2)

Course objective

- Impart a comprehensive overview of the principles and basic concepts of mammalian physiology, especially human physiology.
- Provide an advanced understanding of skeleton-muscle physiology and digestive system functioning.
- Give an overview of renal physiology and electrolyte homeostasis and endocrine function.
- Provide a comprehensive idea about circulatory and respiratory biology and functioning of the heart.
- Provide a comprehensive idea about nervous coordination, nerve impulses and the central and peripheral nervous systems.
- familiarize students with laboratory techniques and equipment used in the acquisition of physiological data.

Course outcome

CO 1: Learn about anatomical and physiological aspects of animal body.

CO 2: Gain knowledge about functioning of systems of body.

CO3: Generate path for further research and innovation.

CO 4: Enhance new collaborative approaches with modern fields of biotechnology.

CO 5: Leads to enhance interest in research in advanced biotechnology.

CO 6: Exposure with other interdisciplinary subjects of biology.

THEORY **(Credits 4)**

UNIT I: Digestion and Respiration

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and fats. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT II Circulation

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood.

Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III Muscle physiology and osmoregulation

Structure of cardiac, smooth & skeletal muscle. Muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation

UNIT IV Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Mechanism of action of hormones (insulin and steroids)

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

PRACTICALS

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	3	3	3	2	3	2	3	2	3	3	2	2	2	2	2
CO2	2,3	1	2	1	1	2	2	-	1	2	2	3	2	1	3	1
CO3	1,3	2	3	3	3	1	1	1	3	1	2	1	-	3	2	2
CO4	2,3, 4	2	2	-	2	-	3	2	2	2	1	1	1	3	1	2
CO5	1,2, 4	-	2	1	1	1	2	3	2	-	3	2	3	2	2	3
CO6	1,2, 4	1	-	2	3	1	-	2	1	2	1	2	3	1	1	1

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

Core course IV

Plant Anatomy and Physiology

(Credit 4+2)

Course Objective

- Students will be introduced to plant physiology and biochemistry.
- This will give students an understanding of the essential physiological processes in plants.
- They will get a glimpse of the signalling pathways involved in these physiological processes.
- They will understand the concepts and theories of plant anatomy.
- In the practical module students will be familiarized with laboratory techniques and equipments used for study of plant physiology and biochemistry.
- In the practical module students will be made familiar with laboratory techniques and equipments used for study of plant anatomical experiments.

Course outcome

CO 1: Students able to develop knowledge of biochemical aspects of body.

CO 2: Students learn about important metabolic pathways and their regulation.

CO 3: Understand and Deals with pathways responsible for energy production.

CO 4: Study of various enzymatic reactions and their role in body.

CO 5: They have faith and develops collaborative and research approach.

CO 6: The contents of this course will help the students to relate crop physiological processes with water-plant interaction, mineral absorption, transportation & assimilation.

THEORY **(Credits 4)**

UNIT I: Anatomy

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth.

UNIT II: Plant water relations and micro & macro nutrients

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport.

UNIT III: Carbon and nitrogen metabolism

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV: Growth and development

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

PRACTICALS

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	3	2	3	3	2	2	2	3	2	2	1	2	2	3	2
CO2	2,3	2	-	2	-	3	2	3	2	2	3	2	3	3	2	2
CO3	1,3	2	2	2	2	-	1	2	1	3	2	2	2	3	2	1
CO4	2,3, 4	1	2	1	2	1	3	1	2	1	-	1	-	1	1	3
CO5	1,2, 4	3	2	1	1	2	-	2	2	3	2	2	2	2	2	3
CO6	1,2, 4	2	2	-	2	2	1	-	3	3	1	1	1	2	3	2

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.

2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.

3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.

4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.

5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.

6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.

7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.

8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

Generic
IPR, Bioethics and Biosafety
(Credit 4+2)

Course objective:

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development.
- To become familiar with India's IPR Policy.
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.
- To become familiar with ethical issues in biological research.
- This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

Course Outcome

CO 1: Students will gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas

CO 2: They will able to devise business strategies by taking account of IPRs.

CO 3: They will be able to assists in technology up-gradation and enhancing competitiveness.

CO 4: They will acquire adequate knowledge in the use of genetically modified organisms and its effect on human health

CO 5: They will gain more insights into the regulatory affairs.

CO 6: Recognize the importance of protection of new knowledge and innovations and its role in business

THEORY

Unit I - Introduction to Ethics & Bioethics Ethical issues in genetic engineering, patenting human genes, cloning; Biotechnology & social responsibility.

Unit II - Intellectual property Rights TRIPS; GATT; International Conventions; Patent-basic principle & requirements.

Unit III - Biosafety regulatory frame work for GMOs in India; Biosafety regulatory frame work for GMOs at International level.

Unit IV - Hazard assessment Use of genetically modified organisms & their release in environment; Biosafety in laboratory- Laboratory associated infections and other hazards.

Unit V- International dimensions in Biosafety- Bioterrorism & conventions on biological weapons.

PRACTICALS

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	3	2	2	3	2	2	3	2	2	3	3	2	2	1	3
CO2	1,2, 3	3	3	1	2	3	3	1	2	3	2	2	2	3	3	1
CO3	1,3, 4	2	1	3	2	1	3	2	1	3	1	2	1	3	2	3
CO4	1,2, 3,4	1	2	1	3	2	2	1	2	1	2	1	3	1	2	2
CO5	1,2	2	3	1	2	1	1	2	3	2	2	1	2	1	3	3
CO6	1,2, 4	2	2	1	1	2	2	3	3	1	3	2	1	3	3	2

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Semester III

CORE COURSE V

Genetics
(Credit 4+2)

Course Objective

- Impart a comprehensive understanding of the principles of genetics and the modes of inheritance including allelic and non-allelic interactions.
- Provide an overview of the basic structure and function of chromosomes.
- Provide a comprehensive idea about genetic linkage, crossing over and chromosome mapping
- Introduce students to DNA damage and mutation.
- Thereafter introduce students to various DNA damage repair pathways and their detailed mechanisms.
- Enable students use their knowledge of genetics to analyze pedigrees and predict genotypes and phenotypes.

Course outcome

CO 1: Understand the concept of classical genetics including Mendelian laws is easily grasped by students

CO 2: Understand the basic microbial genetics including prokaryotic gene expression and regulation.

CO3: Understand the concept of gene in terms of recon, muton and cistron including both classical and modern concept.

CO 4: Know various chemical and physical mutagens involved in causing mutation.

CO 5: Understand the concept of sex determination and populations genetics.

CO 6: Students use their knowledge of genetics to analyze pedigrees and predict genotypes and phenotypes.

THEORY **(Credits 4)**

UNIT I

Introduction & Inheritance Pattern –Mendelism & Chromosome Theory – Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Linkage & Crossing over.

UNIT II

Interaction of Genes: Allelic Variation & Gene function Multiple allele, Genetic interaction, Penetrance (complete & incomplete), Expressivity, Pleiotropism. Non-Mendelian inheritance Evidences for Cytoplasmic factors, cytoplasmic inheritance & extranuclear inheritance (mitochondrial, chloroplast)

UNIT III

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT IV

Chromsomes & abberrations: Chromosomal variation in Number & Structure Euploidy, Aneuploidy, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Deletion, Duplication, Inversion, Translocation, Chromosomal aberrations & evolution. Human karyotype, Banding techniques

PRACTICALS

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Karyotyping with the help of photographs
5. Pedigree charts of some common characters like blood group, colour blindness and PTC tasting.
6. Study of polyploidy in onion root tip by colchicine treatment.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	3	2	3	3	3	2	2	2	3	2	2	3	3	2	2
CO2	2,3, 4	1	2	2	1	2	-	3	2	1	2	2	3	3	3	2
CO3	1,2, 3	3	3	3	3	2	1	2	1	2	1	2	2	2	3	1
CO4	2,3	2	2	2	2	-	2	2	1	2	3	3	1	1	1	2
CO5	1,3	1	2	3	1	2	3	1	3	1	2	1	2	3	2	3
CO6	1,2, 3,4	3	1	2	2	1	2	-	2	3	1	2	2	3	2	2

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

Core course VI

General Microbiology

(Credit 4+2)

Course Objective

- In this paper, students will be introduced to microbes that form many of the basic models for research in Biotechnology, Molecular Biology and Medicine.
- Light will be thrown on the fundamental concepts in Microbiology and Microbial Taxonomy.
- The cultivation and nutritional requirements of microbes, their growth and reproductive strategies including sporulation, how to control microbial growth, and the importance of water and food as their natural niches and vehicles of disease transmission will be explained to the students.
- Students will also be given a brief introduction to Virology here. Uniqueness of viruses with respect to their obligate parasitism, structural & genomic organisation, replication cycle and classification will be explained.
- This Virology module will serve as a prelude to the Recombinant DNA Technology module (in Sem V) that includes viral vectors.
- In the practical module, students will be introduced to methods for staining microorganisms, for cultivation of microorganisms and isolation of bacteria from natural sources.

Course outcome

CO 1: Understand the microbiological techniques for the isolation and characterization of microbes.

CO 2: Understand the mechanism of different metabolic processes.

CO3: Know the physiology and survival mechanism of extremophilic bacteria.

CO 4: Know the concept of virus lytic and lysogenic cycle is quite clear to students.

CO 5: Understand the epidemiology and microbial pathogenesis.

CO 6: Apply the knowledge about the food preservation, food fermentation, food safety, quality control and validation.

THEORY **(Credits 4)**

UNIT I Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms e.g. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

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CO1	1,3	3	2	3	2	3	2	3	2	2	1	2	3	3	2	3
CO2	1,3, 4	2	3	2	3	2	2	-	2	3	-	2	3	3	2	1
CO3	2,3	2	1	-	1	2	3	2	1	3	3	1	2	2	1	2
CO4	1,2, 3	2	2	1	1	2	-	2	3	-	2	-	2	2	3	3
CO5	1,4	1	1	2	2	2	3	1	1	2	3	1	1	3	1	2
CO6	1,2, 4	3	1	2	3	3	2	2	1	-	1	3	-	1	2	1

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.

2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.

3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.

4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.

5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.

8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Core course VII

Chemistry-I

(Credit 4+2)

Course Objective

- Introduce students to basic chemistry.
- Introduce students to the application of basic chemistry to the biological system.
- Enable students understand stereochemistry and its applications.
- Provide knowledge about acid, base and buffer and their applications.
- Enable students to understand chemical bonding and its application.
- Enable students to qualitatively analyse solid organic compounds in the practical module.

Course outcome

CO 1: To understand the structure of atoms trough old approaches (Bohr's model) and new approaches (quantum mechanical model).

CO 2: To know and understand different type of chemical bonding in compounds and different approaches of covalent bonding in molecules.

CO3: To know and understand the various effect in organic chemistry.

CO 4: To know the spatial rearrangement of molecules and their applications in different fields.

CO 5: To know about the types of aliphatic hydrocarbons, properties and synthesis.

CO 6: Introduce students to the application of basic chemistry to the biological system.

THEORY **(Credits 4)**

Section A: Inorganic Chemistry-1

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

Section B: Organic Chemistry-1
Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans -addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

PRATICAL

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

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CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	3	2	3	3	3	2	1	2	-	2	3	2	2
CO2	2	3	3	3	2	3	3	3	-	-	-	1	2	3	2	2
CO3	3	3	3	-	1	3	3	3	1	2	3	2	2	3	1	2
CO4	3	3	3	3	2	3	2	3	2	2	-	1	3	3	2	2
CO5	2	3	3	3	2	3	3	3	-	2	-	2	2	3	1	2
CO6	3	3	3	3	1	3	1	3	2	2	1	2	2	3	2	2

Suggested reading:

- J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
- T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

SEC-1

Constitution of India and Human Rights

(Credit 2)

Generic

Biotechnology and Human Welfare

(Credit 4+2)

Course Objective:

- This paper will enable the students to learn the basics and lay strong foundation in understanding the biotechnological techniques in human welfare.
- To understand the use of living cells such as bacteria, yeast, algae or component of cells like enzymes, plants and animals to generate industrial products and processes.
- The Students will learn the fundamentals of transfer of pest resistance genes to plants, interaction between plants and microbes, qualitative improvement of livestock.

Course Outcome:

CO 1: Comprehend role of industrial biotechnology in improving microbial cells as factories

CO 2: Acquire the knowledge about the transfer of genes, plant microbe interactions.

CO 3: A good understanding of various recombinant DNA techniques and DNA finger printing.

CO 4: Develop transgenics resistant to biotic & abiotic stresses and quality characteristics and their role in crop improvement.

CO 5: Develop of non-toxic therapeutic agents, recombinant live vaccines, genetherapy, diagnostics and monoclonal technique, project on human genomeand techniques of DNA finger printing.

CO 6: Learn the techniques for genetic improvement of micro-organisms to improve yield of bioproducts.

THEORY **(Credits 4)**

UNIT I

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

UNIT IV

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	**BL**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1,2, 3	3	2	3	3	3	2	2	2	3	2	2	3	3	2	2
CO2	2,3, 4	1	2	2	1	2	-	3	2	1	2	2	3	3	3	2
CO3	1,2, 3	3	3	3	3	2	1	2	1	2	1	2	2	2	3	1
CO4	2,3	2	2	2	2	-	2	2	1	2	3	3	1	1	1	2
CO5	1,3	1	2	3	1	2	3	1	3	1	2	1	2	3	2	3
CO6	1,2, 3,4	3	1	2	2	1	2	-	2	3	1	2	2	3	2	2

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.

2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Semester IV

CORE COURSE VIII

MOLECULAR BIOLOGY
(Credit 4+2)

Course Objective:

- Students will be introduced to the major biological processes – replication, transcription and translation, in prokaryotic and eukaryotic systems.
- Students will also be made familiar with DNA damage and repair mechanisms.
- The course aims to impart knowledge about the mechanisms and regulation of prokaryotic transcription.
- The course aims to impart knowledge about the mechanisms and regulation of eukaryotic transcription.
- The course aims to impart knowledge about the mechanisms and regulation of prokaryotic and eukaryotic translation.
- Students would be made familiar with DNA structure and replication.

Course outcome

CO 1: Learn about the mechanism of replication of DNA in prokaryotes and eukaryotes.

CO 2: Learn and compare the mechanism of transcription in prokaryotes and eukaryotes.

CO3: Learn the various post-transcriptional processes in cell.

CO 4: Learn about the mechanism of protein synthesis in prokaryotes and eukaryotes.

CO 5: Understand about gene expression regulation and various mechanisms of gene silencing.

CO 6: On successful completion of the subject the student should have understood the molecular aspects of Molecular biology.

THEORY **(Credits 4)**

UNIT I

DNA structure and replication

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA

polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II

DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III

Transcription and RNA processing

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains

Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV: Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of t-RNA, aminoacyl t-RNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins.

PRACTICAL

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

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CO1	1,2	3	3	2	3	3	2	3	2	1	3	2	1	1	2	3
CO2	1,2, 3	2	3	-	2	2	2	1	2	-	2	3	2	2	3	1
CO3	1,3	2	1	2	3	2	3	2	1	3	2	-	2	2	1	2
CO4	1,2, 3,4	2	2	3	2	-	1	1	3	2	1	2	2	1	3	2
CO5	1,2, 4	1	2	1	3	1	2	-	1	2	3	1	1	3	2	3
CO6	1,3	2	-	2	1	3	2	2	1	3	2	-	3	3	2	3

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell.
VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular
Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

Core course IX

Immunology

(Credit 4+2)

Course Objective:

- Through this paper the students will be introduced to the very complex but intriguing vertebrate immune system.
- They will realise the significance of innate immunity and how it contributes to the activation of the adaptive branch.
- The enormous diversity in recognition of foreign antigens resulting from the very unique ‘gene segment rearrangement’ phenomenon will be dealt with at molecular level.
- The different immuno-techniques of wide-spread applications in different branches of biological research will be explained to the students.
- The students will realise the details of intricate cell-cell, as well as intracellular signalling in the context of the immune system.
- In the practical module, students would learn about immunological techniques like Western blot, ELISA and immunofluorescence.

Course outcome

CO 1: Understand and explain the phylogeny of immune system, types of immunity, immune response.

CO 2: Describe the concept of clonal selection theory, humoral and cell mediated immunity.

CO3: Understand and explain the structure and functions of the organs and cells of the immune system.

CO 4: Understand the mechanism of antigen-antibody interaction.

CO 5: Describe the structure of antibodies, their types and functions in immunity.

CO 6: Able to explain the basic principles of immunology relating to host resistance.

THEORY **(Credit 4)**

UNIT I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors.

UNIT II

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, antibody diversity.

UNIT III

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing.

Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization.

Introduction to immunodiagnostics – RIA, ELISA.

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. ELISA.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	2	3	2	2	2	1	3	2	-	3	3	2	3	3	2
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CO3	2,3	3	2	1	1	3	2	3	1	2	1	3	-	2	2	3
CO4	1,4	1	1	2	2	3	2	-	2	3	3	1	2	1	2	2
CO5	2,3, 4	2	3	3	2	2	1	3	2	1	-	2	1	2	3	3
CO6	2,3	2	3	2	3	1	3	2	-	1	2	1	2	2	3	2

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.

3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.

5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Core course X

Chemistry-II

(Credit 4+2)

Course Objective

- Enable students understand the principles and applications of thermodynamics.
- Provide further information about Chemical Bonding (which was started in Sem III).
- Enable students understand bonding features in organic molecules and its application.
- Introduce students to elementary quantum mechanics
- Introduce students to chemical kinetics.
- Perform qualitative inorganic analysis of mixtures in the practical module.

Course outcome

CO 1: Understand the basic terms and laws of thermodynamics, variation of various thermodynamic parameter with temperature, pressure etc.

CO 2: Able to know the equilibria in chemical reactions, Le Chatelier's principal of equilibria..

CO 3: Able to develop the concept of ionic equilibria, types of electrolytes, buffer solution..

CO 4: Able to know the preparation of aromatic compounds, reaction mechanism, different types of reactions.

CO 5: Able to understand the preparation of aliphatic and aromatic alcohols.

CO 6: Able to develop the critical thinking and skill developments to solve the problem.

THEORY **(Credit 4)**

Section A: Physical Chemistry-1

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynaomic derivation of the law of chemical equilibrium. Distinction between G and G Le Chatelier'sprinciple. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B: Organic Chemistry-2 (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides

Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Alcohols and Phenols Upto 5 Carbons)

Alcohols: Preparation: Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.

KMnO4, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben– Hoesch Condensation, Schotten Baumann Reaction.

Practicals

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations:

   Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

a) Bromination of Phenol/Aniline
b) Benzoylation of amines/phenols
c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	3	2	3	3	3	2	1	2		2	3	2	2
CO2	2	3	3	3	2	3	3	3					2	3	2	2
CO3	3	3	3	3	1	3	3	3	1	2	3	2	2	3	1	2
CO4	3	3	3	3	2	3	2	3	2	2		1	3	3	2	2
CO5	2	3	3	3	2	3	3	3				2	2	3	1	2
CO6	3	3	3	3	1	3	1	3	2	2	1	2	2	3	2	2

Reference Books:

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage LeningIndia Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

SEC-2

Science and Life (Credit 02)

Generic

Basics of Forensic Science

(Credit 4+2)

Course Objective

- To develop laboratory skills for examining evidence at crime scenes and to prepare students for employment in state and central organizations.
- Recognize the steps in securing a crime scene and the various types of evidence that may be collected in order to solve a crime.

Course Outcome

CO 1: Understand the basic concept of crime, criminology, victimology and forensic science.

CO 2: Understand and interpret the criminal behaviour and its linkage to different crime scenario

CO 3: Interpret various principles of forensic science and its connection to different crime scenario.

CO 4: Analyze various crime scenario and apply it into a case study.

CO 5: Classify and evaluate crime and its connections with victim and perpetrator.

CO 6: Choose various types of evidence collection methods for effective and proper packing.

THEORY **(Credits 4)**

Unit I

Introduction & Basics: Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science.

Unit II

Crime & Crime Scene: Causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit III

Fingerprints & Toxicology: Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal Identification, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine.

Unit V

Investigation Tools: Discovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

PRACTICALS

1. Case studies to depict different types of injuries and death.
2. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
3. Investigate method for developing fingerprints by Iodine crystals.
4. PCR amplification on target DNA and DNA profiling,
5. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	**BL**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1,3	2	3	2	2	2	1	3	2	-	3	3	2	3	3	2
CO2	1,2, 3,4	2	3	1	3	1	-	2	1	2	2	2	3	1	2	1
CO3	2,3	3	2	1	1	3	2	3	1	2	1	3	-	2	2	3
CO4	1,4	1	1	2	2	3	2	-	2	3	3	1	2	1	2	2
CO5	2,3, 4	2	3	3	2	2	1	3	2	1	-	2	1	2	3	3
CO6	2,3	2	3	2	3	1	3	2	-	1	2	1	2	2	3	2

SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).

Semester V

CORE COURSE XI

BIOPROCESS TECHNOLOGY

(Credits 4+2)

Course Objective

- Acquaint the students with an overall idea of the techniques and methodologies that industries employ for the large-scale fermentative production of beneficial products, using microbes.
- Provide students with information about bioreactors and the usage of microbes in industry.
- Outline the basic principles of water treatment.
- Introduce the principles of fermentation and techniques for microbial production of enzymes, proteins etc.
- Provide the students the hands-on essence of a bioprocess technique by means of a visit to any industrial plant.
- Provide students with hands-on-experience of relevant techniques e.g. isolation of industrially important microorganism and microbial analysis of drinking water supplies relevant in bioprocess technology in the practical module.

Course outcome

CO 1: Develop an understanding of the various aspects of bioprocess technology and their basic principles.

CO 2: Develop skills associated with controlling of various parameters of bioprocess monitoring.

CO3: Understand principles underlying design of fermentor, fermentation Process and downstream processing.

CO 4: Get knowledge of industrial productions of various primary and secondary metabolites.

CO 5: Know the advantages of biochemical processes and its conventions.

CO 6: Gain understanding of production of secondary metabolites and antibiotics.

THEORY **(Credits 4)**

UNIT I

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

PRACTICALS

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	2	3	1	3	3	2	1	2	3	3	-	3	3	2	2
CO2	1,2	2	3	2	2	-	2	3	2	-	2	3	2	2	3	1
CO3	1,2, 3,4	3	1	3	1	2	1	2	3	2	3	2	2	2	2	3
CO4	3,4	1	3	1	1	2	3		-	3	1	2	1	2	3	2
CO5	1,3	1	2	3	2	3	1	3	2	1	2	1	2	3	3	2
CO6	1,3, 4	2	1	3	2	2	2	1	1	2	-	2	3	2	1	2

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Core course XII

RECOMBINANT DNA TECHNOLOGY

(Credits 4+2)

Course Objective

- Students will be introduced to the basics and applications of recombinant DNA technology.
- They will learn various aspects about generating clones and gene expression using modern and relevant techniques.
- Students will be provided with an overview of the application of molecular tools and Polymerase chain reaction (PCR).
- Students will be provided with further knowledge about viral vectors (in continuation of the knowledge imparted in General Microbiology Module (Semester III).
- In practical module the students will be given hands on training of some of the techniques discussed in theory classes.
- The module seeks to make students well versed with the technological aspects of the knowledge about recombinant DNA technology.

Course outcome

CO 1: Learn the procedure of DNA isolation from bacteria, plant and animal cell and its purification and modification.

CO 2: Know various methods of introducing DNA into living cells.

CO3: Learn the technique of gene cloning, tools used in it and different vectors used for transforming host cells.

CO 4: Know the procedure of producing proteins from cloned genes, its uses in medicines with examples and gene therapy.

CO 5: Learn the theoretical aspects of DNA amplification using PCR and analysis of DNA by various molecular markers.

CO 6: Learn genomic sequences analysis by using different techniques.

THEORY **(Credit 4)**

UNIT I

Introduction: History, scope & guidelines of Genetic Engineering, Gene Cloning & Patenting, Restriction Enzymes, their types and mode of action, Plasmids, Cosmids, Phasmids, BAC, YAC, Bacteriophage, *Agrobacterium tumefaciens* & *Agrobacterium rhizogenes*, Plant and Animal viruses.

UNIT II

Selection & Screening: Isolation and purification of DNA (Bacteria & Plants), Introduction of Recombinant DNA into living cells, Selection & Screening of recombinant clones.

UNIT III

PCR & DNA Sequencing: Introduction, Types, Application, DNA sequencing methods, Southern, Northern and Western hybridization, *In situ* hybridization.

UNIT VI

Applications of Genetic Engineering: Genetic engineering in animals: Production of transgenic mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines, transgenic animals.

PRACTICALS

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
6. Demonstration of PCR

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2	2	3	2	3	2	2	1	3	3	1	2	3	3	2	2
CO2	1,3	1	2	2	1	3	2	2	2	2	2	3	2	1	2	3
CO3	1,2, 4	2	2	3	1	3	3	3	1	2	3	1	-	1	2	1
CO4	1,3, 4	2	1	3	3	1	-	3	2	3	3	1	2	2	3	3
CO5	1,2, 3	1	3	2	3	1	3	1	2	-	1	2	1	3	3	1
CO6	1,2, 3,4	3	1	-	2	1	3	2	3	2	2	2	2	2	2	3

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

DSE-1

Bioinformatics
(Credits 4+2)

Course Objective

- Students will be introduced to the principles of Bioinformatics.
- Students will be provided with an essence of the different tools and aspects of Bioinformatics.
- Students will learn about structure-function relationship in functioning of enzymes, enzyme regulation and enzyme immobilization technique for commercial application of enzymes.
- An overview of protein information sources, protein tertiary structure prediction, biological databases, searching of databases and information retrieval would be provided.
- Students would be introduced to data generating techniques and bioinformatics problems.
- Students would be familiarized with techniques in bioinformatics by means of project/ computer based practicals.

Course Outcome

CO 1: Understand and explain the structural organization and characteristics of computers and its parts.

CO 2: Describe the concept of use of internet in bioinformatics.

CO 3: Explain the concept and organization of biological databases

CO 4: Understand and explain the structure and functions of the phylogenetic analytic tools.

CO 5: Predict the phylogenetic tree and evolutionary relationship.

CO 6: Understand about nucleotide and protein sequence retrieval, submission through NCBI database.

THEORY **(Credit 4)**

UNIT I

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST,

FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2	3	2	3	2	3	2	1	3	2	1	2	2	1	3	3
CO2	1,2, 3,4	1	2	1	2	1	3	2	2	3	2	3	2	3	1	1
CO3	2,4	3	3	1	3	2	1	2	1	3	2	1	2	2		3
CO4	1,2, 4	2	2	2	2	2	2	3	1	2	3	2	3	3	3	2
CO5	2,3	1	2	1	3	3	2	1	3	2	3	3	1	2	1	3
CO6	3,4	1	3	2	1	1	2	3	2	1	2	3	1	1	2	2

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.

3.Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

DSE-2

Plant Diversity
(Credits 4+2)

Course Objective

- Introduce students to plant groups and their overall morphological and anatomical structures.
- Provide knowledge about complexity of plant groups and their evolutionary relationship.
- Provide an overview of angiosperm morphology and embryology in plants.
- Provide an overview of plant kingdom and comparative anatomy of plants.
- Compare and contrast the life processes in different plants
- Familiarize the students with diverse aspects of Plant biology and enable them to develop an understanding of the plant kingdom.

Course Outcome

CO 1: The students to trace the evolutionary history, diversity of gymnosperms & develop an understanding of fossils, fossilization & geological time scale and its significance in the evolution of angiosperms.

CO 2: The students will develop an understanding of the basis, guiding principles & salient features of the various classification systems of angiosperms.

CO 3: Know the economic importance of the angiosperm plants.

CO 4: Systematic position, distinguishing characters and economic importance of some important families like Rutaceae, Cucurbitaceae,Rosaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Lamiaceae, Euphorbiaceae, and Poaceae.

CO 5: The students will develop an understanding of the characteristics, life cycles & interrelationships among different forms of gymnosperm.

CO 6: The students will have a good overview of the general morphology, diversity, distribution, sexual reproduction, diversity of bryophytes, the significance of bryophytes as pioneer plants on land and their role in the origin of pteridophytes.

THEORY **(Credit 4)**

UNIT I

Algae:

General character, classification and economic importance. Life histories of algae belonging to various classes:

Chlorophyceae – *Volvox, Oedogonium*

Xantho phyceae –*Vaucheria*

Phaeophyceae – *Ectocarpus*

Rhodophyceae-*Polysiphonia*

UNIT II

Fungi:

General characters, classification & economic importance.

Life histories of Fungi:

Mastigomycontina- *Phytophthora*

Zygomycotina-*Mucor*

Ascomycotina- *Saccharomyces*

Basidomycotina-*Agaricus*

Deutromycotina-*Colletotrichum*

UNIT III

Lichens :

Classification, general structure, reproduction and economic importance. Plant diseases:

Casual organism, symptoms and control of following plant diseases.

Rust & Smut of Wheat.

White rust of Crucifers.

Late blight of Potato.

Red rot of Sugarcane.

Citrus Canker.

UNIT IV

Bryophytes:

General characters, classification & economic impotance.

Life histories of following:

Marchantia.

Funaria.

PRACTICALS

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of *Marchantia* and *Funaria*
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	**BL**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1,2, 3	3	3	2	2	3	2	1	2	3	2	2	3	1	3	3
CO2	1,2, 4	2	3	1	1	2	3	2	3	1	2	3	3	2	3	2
CO3	2,3	2	2	2	-	2	1	2	3	2	3	1	2	1	2	2
CO4	2,4	3	3	3	2	3	2	3	1	2	1	2	1	2	3	1
CO5	1,2, 3	2	2	3	2	2	-	1	3	3	2	3	2	2	3	1
CO6	2,4	3	1	2	3	1	1	3	2	1	2	3	1	1	3	3

SUGGESTED READING

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4th edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.

7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.

8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.

9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3rd edition, Cambridge University Press, Cambridge.

11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

Semester VI

CORE COURSE XIII

BIO ANALYTICAL TOOLS
(Credits 4+2)

Course Objective

- Provide an overview of various technical methods and bio-analytical tools which have useful applications in biotechnology.
- Introduce students to microscopy, centrifugation and cell fractionation techniques.
- Introduce students to electrophoresis and its applications.
- Enable students understand the principles of chromatography.
- Introduce students to the principles of spectroscopy.
- Provide students with a hands-on-experience of several bio-analytical techniques in the practical module.

Course outcome

CO 1: Understand the principle and instrumentation of Colorimetry, spectrophotometry (visible, UV, infra-red), centrifugation, etc.

CO 2: Understand principle instrumentation of chromatographic techniques and their types.

CO3: Principle and applications of electrophoresis I.e., PAGE, Immunoelectrophoresis etc.

CO 4: Understand radioisotope tracer techniques and application.

CO 5: Develop broad knowledge base, deep theoretical understanding of instruments and their practical implementation in the laboratory.

CO 6: Learn about various spectroscopic techniques and X –ray crystallography.

THEORY (Credit 4)

UNIT I

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV

Introduction to electrophoresis. Polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and their applications.

PRACTICAL

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of protoplasts from leaves.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.
6. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2	3	3	2	2	2	2	3	2	3	2	3	2	3	3	11
CO2	1,3	2	2	-	2	3	1	1	2	2	3	3	1		2	2
CO3	1,2, 4	1	3	3	1	2	2	2	3	-	1	1	3	3		1
CO4	1,3, 4	2	1	2	3	2	2	-	3	1	2	1	3	1	2	3
CO5	1,2, 3	2	3	-	1	1	1	3	1	2	2	2	1	2	1	3
CO6	1,2, 3,4	1	2	3	2	1	2	3	-	1	3	2	3	1	2	2

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Semester VI

CORE COURSE XIV

Genomics and Proteomics

(Credits 4+2)

Course Objective:

- Impart theoretical knowledge and information about computational tools of genomics.
- Impart theoretical knowledge and provide information about computational tools of proteomics.
- Introduce students to structural and functional genomics and DNA sequencing methods.
- Introduce students to proteomics and techniques for analysis of proteomes.
- To provide knowledge about computational tools for high throughput handling of gene and protein sequences.
- Provide students with information about web based servers and softwares for genome analysis by means of projects/ tutorials.

Course outcome

CO 1: Gain understanding of basic structure of protein and its separation by using various techniques.

CO 2: Get insight of modeling and in silico protein structure building.

CO3: Get understanding of study of protein – protein interaction using various methods.

CO 4: Develop knowledge of fundamental techniques in proteomics.

CO 5: Learn various modules of MALDI TOF for analysis of proteins.

CO 6: Understand Genome anatomy, gene expression and Post translational modification.

THEORY **(Credit 4)**

UNIT I

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms'Genomes and Databases.

UNIT III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures –Edman degradation.

UNIT IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

PRACTICALS

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Native PAGE
7. SDS-PAGE

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	3	2	2	3	2	2	3	2	2	3	3	2	2	1	3
CO2	1,2, 3	3	3	1	2	3	3	1	2	3	2	2	2	3	3	1
CO3	1,3, 4	2	1	3	2	1	3	2	1	3	1	2	1	3	2	3
CO4	1,2, 3,4	1	2	1	3	2	2	1	2	1	2	1	3	1	2	2
CO5	1,2	2	3	1	2	1	1	2	3	2	2	1	2	1	3	3
CO6	1,2, 4	2	2	1	1	2	2	3	3	1	3	2	1	3	3	2

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.

2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.

5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.

6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.

7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

8. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

9. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

10. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

DSE-3

ANIMAL BIOTECHNOLOGY
(Credit 4+2)

Course Objective

- Animal Biotechnology deals with the understanding of basic principles of animal cell culture and gene manipulation techniques.
- It also finds an application in the production of livestock with improved traits and transgenic animals with desirable characteristics.
- Familiarize the students with the application of animal biotechnology in therapeutics.
- Make the students to learn and apply the basics of cell culture technique for identifying and maintenance of cell line.
- Make the students to learn gene manipulation methods in tissue engineering.
- Understand and apply the ideas of various biotechnological techniques foe improvement of livestocks.

Course Outcome

CO 1: Understand theory of animal cell culture, culture media, methods to develop cell lines. and their maintenance for commercial applications.

CO 2: Understand scale up production of monoclonal antibodies and hybridoma technology.

CO 3: Understand the structure and function of variety of hormones and growth factors.

CO 4: Understand the technology and concept behind in-vitro fertilization and embryo transfer, and development of superior live stocks.

CO 5: Understand the concept of ethical value regarding the use of animal biotechnology.

CO 6: Understand analyse, apply and evaluate the significance of different molecular markers, stem cells and its production of transgenic animal with desirable traits.

THEORY **(Credit 4)**

UNIT I

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis.

UNIT III

Animal propagation – Artificial insemination, Animal Clones.

Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

PRACTICALS

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Quantification of isolated DNA.
6. Resolving DNA on Agarose Gel.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2,3	3	3	2	3	2	2	3	2	2	1	3	3	3	2	3
CO2	1,2, 3,4	2	3	1	-	1	3	2	3	3	2	1	1	1	2	2
CO3	3,4	2	1	3	2	3	-	1	3	2	3	2	3	1	2	1
CO4	2,4	1	3	2	1	-	3	1	2	1	3	1	2	3	2	3
CO5	1,2, 3,4	2	3	1	3	2	2	2	1	2	1	2	1	3	2	2
CO6	1,4	3	2	1	2	3	1	3	-	3	2	3	2	1	3	1

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.

2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.

4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.

5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

DSE-4

MEDICAL MICROBIOLOGY
(Credit 4+2)

Course Objective

- Develops concepts in pathogenesis of various pathogens.
- Underling mechanisms along with molecular interactions, leading to development of disease in the host.
- Develops principles of pathogen, host and environment in terms of its varied existence and interactions.
- To make students to understand epidemiological events

Curse Outcome

CO 1: Define basics in Medical Microbiology and understand types of infectious diseases with respect to Pathogenesis of Bacterial Diseases ,Viral , Protozoan and Fungal diseases.

CO 2: Explain the various pathological events during the progression of an infectious disease.

CO 3: Apply the principle of epidemiological sciences in studying the underlying mechanisms of spread of disease and controls required thereof to combat the spread of pathogens.

CO 4: Analyse and breakdown cellular and molecular basis of immune responsiveness.

CO 5: Categorize, classify and compare various types of vaccines.

CO 6: Articulate in detail study of host parasite relationship of different infections including Etiology, Transmission, Pathogenesis, Laboratory diagnosis.

THEORY (Credit 4)

UNIT I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae.*

UNIT II

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.*

UNIT III

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides)* and opportunistic fungal infections (*Candidiasis, Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

PRACTICALS

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of *Aspergillus* and *Candida* by appropriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	3	2	3	2	1	3	2	2	3	2	2	2	2	2	3
CO2	1,2, 4	3	2	2	-	2	2	3	3	2	2	3	3	3	1	2
CO3	2,4	2	2	1	3	2	2	1	1	-	3	1	3	3	3	2
CO4	1,4	1	3	3	2	1	2	1	2	2	1	3	1	1	2	2
CO5	1,2, 4	1	2	2	2	1	3	2	1	3	2	2	3	3	2	3
CO6	1,3	3	1	2	1	1	3	2	2	3	2	1	2	1	3	2

SUGGESTED READINGS

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .

3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

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