SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

Programme: MSC (CBCS)
Syllabus with effective from: JUNE-2017

MICROBIOLOGY

M. Sc. Microbiology				
Semester	**I**	**II**	**III**	**IV**
Core I (4 Credits)	Molecular Biology (PS01CMIC21)	Bioprocess and Biochemical Engineering (PS02CMIC21)	Microbial Biotechnology (PS03CMIC21)	R-DNA Technology (PS04CMIC21)
Core II (4 Credits)	Bioinstrumentation (PS01CMIC22)	Microbial Genetics (PS02CMIC22)	Environmental Microbiology (PS03CMIC22)	Environmental Biotechnology (PS04CMIC22)
Core III (4 Credits)	Cell Biology (PS01CMIC23)	Fundamentals of Immunology (PS02CMIC23)	Enzymology (PS03CMIC23)	Lab I (PS04CMIC23) Practicals based on PS04CMIC21 and PS04CMIC22
Core IV (4 Credits)	Lab I (PS01CMIC24) Practicals based on PS01CMIC21 and PS01CMIC22	Lab I (PS02CMIC24) Practicals based on PS02CMIC21 and PS02CMIC22	Lab I (PS03CMIC24) Practicals based on PS03CMIC21 and PS03CMIC22	
Core V (4 Credits)	Lab II (PS01CMIC25) Practicals based on PS01CMIC23 and PS01EMIC2X	Lab II (PS02CMIC25) Practicals based on PS02CMIC23 and PS02EMIC2X	Lab II (PS03CMIC25) Practicals based on PS03CMIC23 and PS03EMIC2X	
Elective I (4 Credits)	Biochemistry (PS01EMIC21)	Biostatistics (PS02EMIC21)	Advanced Immunology (PS03EMIC21)	Lab II (PS04EMIC21) Practicals based on PS04CMIC2X and PS04EMIC2X
Elective II (4 Credits)	Biomolecules and Bioenergetics (PS01EMIC22)	Medical Microbiology (PS02EMIC22)	Bioinformatics (PS03EMIC22)	Dissertation (PS04EMIC22) (12 Credits)
Elective III (4 Credits)	Phytoresource Utilization and Conservation (PS01EMIC23)	Microtechniques (PS02EMIC23)	Omics and Computational Biology (PS03EMIC23)	Microbial Physiology (PS04EMIC23)
Elective IV (4 Credits)	Human Physiology (PS01EMIC24)	Toxicology (PS02EMIC24)	Plant Biochemistry (PS03EMIC24)	Food and Dairy Microbiology (PS04EMIC24)
Elective V (4 Credits)				IPR and Biosafety (PS04EMIC25)
Elective VI (4 Credits)				Plant Biotechnology (PS04EMIC26)

PS01CMIC21: Molecular Biology

Unit I: DNA structure

DNA structure: Chemistry of DNA, DNA structure, Different conformations of DNA (B, A and Z), Denaturation and Renaturation (Cot curves) of DNA.

DNA topology: Supercoiling, Biology of Supercoiled DNA, DNA topoisomerases and their mechanism of action.

DNA- protein interactions: General features, Sequence specific DNA binding protein motifs, ss DNA binding proteins.

Unit II: Organization of genome and its replication

Organization of DNA into chromosomes: Packaging of DNA and organization of chromosome in bacterial cells; Packaging of DNA in eukaryotic nucleosome and chromatin condensation, assembly of nucleosomes upon replication, chromatin modification.

DNA replication: Mechanism of DNA polymerase catalyzed synthesis of DNA, Types of DNA polymerases in bacteria, Initiation of DNA replication and its regulation in prokaryotes, assembly of replisome and progress of replication fork, termination of replication. DNA replication in eukaryotes and archaea. Inhibitors of DNA replication.

Unit III: Gene expression in prokaryotes and eukaryotes

Transcription: RNA polymerases, features of prokaryotic and eukaryotic promoters, assembly of transcription initiation complex in prokaryotes and eukaryotes, and its regulation; synthesis and processing of prokaryotic and eukaryotic transcripts.

Translation: structure and role of t-RNA in protein synthesis, ribosome structure, basic features of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes).

Unit IV: Regulation of gene expression

Regulation of gene expression in prokaryotes: Operon concept, positive and negative regulation. Examples of lac (including mutational analysis), ara, and trp operon regulation; global regulatory responses.

Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

References:

- Genes X: Lewin
- Molecular Biology of the Gene: Watson et al
- Molecular Genetic of Bacteria: Snyder and Champness
- Molecular Biology, 4th Edition: Burton E Tropp
- Principles of Genetics: Snustad and Simmons

PS01CMIC22: Bioinstrumentation

Unit I

Visualization techniques:

Principle of working and applications of bright field microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy. Principle and applications of cytophotometry and flow cytometry.

Unit II

Separation techniques:

Basic principle and application of Differential, density and ultracentrifugation

Principle and applications of Native-PAGE, SDS-PAGE, Agarose and 2D gel electrophoresis. Capillary electrophoresis and its applications.

Principle, methodology and applications of gel – filtration, ion –exchange and affinity chromatography; Thin layer and High Performance Thin Layer Chromatography. Gas chromatography, High performance liquid chromatography and FPLC.

Unit III

Spectropscopy

Principle, instrumentation and applications of UV, Visible, IR (including FTIR and ATR), AAS, NMR, fluorescence and CD spectroscopy.

Unit IV

Principle and applications of tracer technique in biology:

Radioactive Isotopes and half-life of isotopes; Effect of radiation on biological system; autoradiography; cerenkov radiation; radiation dosimetry; ionization and scintillation based detection and quantification of radioactivity.

Biosensors: Principle, types and applications.

Principle of biophysical methods used for analysis of biopolymer structure: X ray diffraction and mass spectrometry.

References:

1. Instrumental method of chemical analysis: Sharma B K
2. Instrumental methods of analysis: D A Skoog
3. An introduction to practical Biochemistry: Plummer
4. Instrumentation: Chatwal and Anand
5. Modern experimental Biology: Boyer

PS01CMIC23: Cell Biology

Unit I

- Evolution of cell: Cell as a unit of living organism, evolution and structure of prokaryotic cell, evolution of eukaryotic cell.
- Structure of Plasma membrane, Transport across plasma membrane.
- Endocytosis (Phagocytosis, Receptor mediated endocytosis)
- Cell walls and extracellular matrix
- Cell-Cell interactions (Cell adhesion protein, Tight junctions, gap junctions, plant cell adhesion and plasmodesmata).

Unit II

- Nucleus, Nuclear pore complex and transport across nuclear envelope.
- Structure and functions of Endoplasmic reticulum, Golgi complex and lysosomes (Protein sorting and transport, Types of vesicular transport and their functions).
- Structure and function of Mitochondria, Chloroplasts and Peroxisomes.

Unit III

- Cytoskeleton and cell movement (Structure and organization of actin filaments; Actin, myosin and cell movement; Intermediate filaments; Microtubules and microtubule motors and movements); cilia and flagella: structure and function.
- Cell signalling: Signalling molecules and their receptors, Functions of cell surface receptors, pathways of intracellular signal transduction, signal transduction and cytoskeleton, signalling in development and differentiation.

Unit IV

- Cell division cycle (phases of CDC; Regulation by cell growth and extracellular signals; cell cycle check points; regulators of cell cycle progression-MPF, cyclins and CDKs, Inhibitors of cell cycle progression; M-phase and cytokinesis.
- Programmed Cell Death: Difference between necrosis, apoptosis and necroptosis, Caspases, Central regulators of apoptosis (Bcl-2 family), signalling pathways that regulate apoptosis.
- Cancer: Types of cancer, development and causes of cancer, properties of transformed cells, oncogenes and tumor suppressor genes.

References:

- The cell: A molecular approach-Geoffrey M Cooper and Robert E. Hausman
- Cell Biology-Karp
- Molecular Biology of the cell- Alberts
- Molecular Cell Biology-Lodish et al.

PS01CMIC24: Lab I Practicals based on PS01CMIC21 and PS01CMIC22

PS01CMIC25: Lab II Practicals based on PS01CMIC23 and PS01EMIC2X

PS01EMIC21: Biochemistry

Unit I

- Chemical and physical foundations of biomolecules.
- Water, acid, base and buffers
- Carbohydrate metabolism: Glycolysis and alternate pathways of glucose utilization, TCA cycle, glyoxylate cycle, Gluconeogenesis, Glycogen synthesis and utilization.

Unit II

- Principles of Thermodynamics; Bioenergetics and energy metabolism in cells.
- Oxidative phosphorylation and Electron transport chain: Electron carriers, iron sulphur proteins, cytochromes, PMF, ATP synthetase complex. Uncouplers and inhibitors of energy transfer.

Unit III

- Lipids: Structure and properties of lipids, fatty acids, phospholipids, and other derived lipids; functions of lipoproteins, cholesterol, steroids and prostaglandins, membrane lipids.
- Lipid metabolism: synthesis and oxidation of fatty acids (α, β and ω oxidation of fatty acids).
- Ketone bodies: Formation and degradation
- Vitamins: structure and function.

Unit IV

- Protein structure: primary, secondary, tertiary and quaternary structure of proteins. Determination of protein structure and its analysis, Ramachandran plot, Hydropathy plot.
- Structure, properties and classification of amino acids, aminoacid metabolism , urea cycle and nitrogen balance. Disorders associated with amino acid metabolism
- Nucleotides: Structure and functions, Nucleotide metabolism.

References:

- Lehninger's Principles of Biochemistry: D L Nelson and M M Cox, Macmillan, Worth Pub. Inc., NY.
- Biochemistry : Lubert Stryer
- Harper's Biochemistry: R. K. Murray and others, Appleton and Lange, Stanford.
- Microbial Physiology: Moat, Foster and Spector.

PS01EMIC22- Biomolecules and Bioenergetics

Unit I

Carbohydrates and glycobiology : Monosaccharide - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates, Industrial importance of carbohydrate.

Unit II

Amino acids: Structure and classification, physical, chemical and optical properties of amino acids, Classification of amino acids, Protein sequencing and alignment

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes, Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids.Lipids as signals, cofactors and pigments

Nucleic acids: Structure of major species of RNA - mRNA, tRNA and rRNA.
Nucleic acid chemistry – UV absorption, effect of acid and alkali on DNA.

Unit III

Acid-Base Equilibrium & Henderson and Hassebach equation, Buffers and their importance, pKa of amino acid and their relevance, Importance of discontinuous buffer system used in SDS PAGE.

Common reaction mechanism in biological reaction: Peptide bond formation, oligonucleotide and oligosaccharide synthesis, disulphide bond, group-specific chemical modification for amino acid

Unit IV

Bioenergetics: The laws of thermodynamics, concept of entropy and free energy; ATP synthesis and hydrolysis, Biological oxidations-–oxygenases ,hydrolases ,dehydrogenases, free energy changes and redox potentials, Gibbs energy,

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization (**Animals, Plants, and Bacteria**), ATP- synthetase complex, Chemiosmotic theory of Energy Coupling, Inhibitors of ETC, Regulation of body temperature

References:

- Chemistry of Biomolecules by S. P. Bhutani, Ane Books Pvt. Ltd. CRC Press
- Lehninger's Principles of Biochemistry: D. L. Nelson and M. M. Cox, Macmillan, Worth Pub. Inc., NY.
- Biochemistry: Lubert Stryer WH Freeman & Co., NY.
- Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford.
- Text book of Biochemistry with clinical correlations by Delvin.

PS01EMIC23: Phytoresource Utilization and Conservation

Unit - I

Plant Biodiversity : Concept, status in India, utilization and concerns.

Origin, evolution, botany, cultivation and uses of (i) Food, forage and fodder crops, (ii) fibre crops (iii) medicinal and aromatic plants, and (iv) vegetable oil – yielding crops

Plants as sources of drugs, pharmaceauticals and pharmaceutical aids.

Unit -II

Ethnomedicobotany: Basic approaches to study traditional knowledge on herbal medicine; Scope and potential applications.

Collection methods of ethnomedicobotanical data: Field methods and scrutiny of Herbarium specimens and folklore; verification of data; collection of materials for voucher specimen and for phytochemical screening; application of ethnomedicobotany.

Creating indigenous knowledge base of traditional medicines of plant origin.

Unit -III

Forest products**:**

Important timber yielding planting.

Timber types, identification diagnostic features, structure & quality

Important fire wood plants

Non Timber forest products bamboos, rattans, fibers pulp; gums, resins, tanins, lotex, fruits & tubers.

Innovations for meeting world food demands.

Plants used as avenue trees for shade, pollution control and aesthetics.

Unit –IV

Principles of conservation; extincitons; environmental status of plants based on International Union for Conservation of Nature.

Strategies for conservation – *in situ* conservation : International efforts and Indian initiatives; protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity.

Ex situ conservation **:** Principles and practices; botanical gardens, fields gene banks, seed banks, *in vitro* repositories, cryobanks; general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific & Industrial Research (CSIR), and the Department of Biotechnology (DBT) for conservation, non-formal conservation efforts.

References:

- Anonymous. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
- Arora, R. K. and Nayar, E. R. Wild Relatives of Crop Plants in India. NBPGR Science Monograph.
- Baker, H. G. Plants and Civilization. C. A. Wadsworth, Belmont.
- Bole, P. V. and Vaghani, Y. Field Guide to Common Indian Trees. Oxford University Press, Mumbai.
- Chandel, K. P. S., Shukla, G. and Sharma, N. Biodiversity in Medicinal and Aromatic Plants in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.

- Cristi, B. R. CRC Handbook of Plant Sciences and Agriculture. Vol. I. In-situ conservation. CRC Press, Boca Raton, Florida, USA
- Council of Scientific & Industrial Research. The Useful Plants of India. Publications and Information Directorate, CSIR, New Delhi.
- Plant Wealth of India. Special Issue of Proceedings India National Science Academcy B – 63
- Rodgers, N. A. and Panwar, H. S. Planning a Wildlife Protected Area Network in India. Vol. 1. The Report Wildlife Institute of India, Dehradun.
- Sahni, K. C. The Book of India Trees, Oxford University Press, Mumbai.
- Sharma, O. P. Hill's Economic Botany. Tata McGraw Hill Co. Ltd., New Delhi.
- Swaminathan, M. S. and Kocchar, S. L. Plants and Society. Macmillan Publication Ltd., London.
- Thakur, R. S., Puri, H. S. and Husain, A Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow. S.K. Jain: A Manual of Ethnobotany
- S.K. Jain: Glimpses of Indian Ethnobotany
- S.K.Jain, B.K. Sinha and R.C.Gupta: Notable plants in Ethnomedicine of India
- J.K. Maheswari: Dictionary of Indian Folk medicine and Ethnobotany
- S.K. Jain: Useful plants of India
- Wiley Chichester, CIBA Foundation Symposium 185: Ethnobotany and the search for new drugs

PS01EMIC24: Human physiology

Unit I

Homeostasis and the organization of body fluids, Control of Homeostasis, Positive and negative Feedback systems, Homeostatic Imbalances.

An overview of human circulatory system. Anatomy of heart, cardiac cycle, cardiac output, blood pressure and regulation, ECG. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Blood-components and functional significance. Blood buffer systems, Blood coagulation and factors involved in coagulation. Laboratory tests to measure coagulation and thrombolysis. Hemopoiesis and blood groups, Disorders of circulatory system: coagulation disorders, hypertension, thalassaemias and anemias.

Unit II

Digestive system – Composition, functions and regulation of saliva, gastric, pancreatic intestinal and bile secretions – digestion and absorption of carbohydrates, lipids, proteins nucleic acids, minerals and vitamins.

The Muscular System – Types of muscles and their functions. Physiology of muscle contraction in striated and non-striated muscle.

Unit III

Excretory system – structure of nephron formulation of urine, glomerular filteration, GFR, tubular reabsorption of glucose. renal and pulmonary control of blood pH, renal clearance.

Unit IV

Nervous System- Structure of neuron, function and organization of nervous system, Blood-brain barrier, Neurotransmitters, Nerve impulse transmission.

Reproductive physiology – secretion and function of reproductive hormones, pregnancy and lactation. Hormonal disturbances.

References:

Text book of Medical Physiology by A. C. Guyton and J. E. Harcourt.
Text book of Medical Physiology by Ganong.
Principles of anatomy and physiology by Gerard Tortora and Bryan Derrickson, 12th edition