Mahajana Education Society (R)
Education to Excel
SBRR Mahajana First Grade College (Autonomous)
Post Graduate Wing
Pooja Bhagavat Memorial Mahajana Education Center
KRS Road, Metagalli, Mysuru

SCHOOL OF LIFE SCIENCES

M.Sc. MICROBIOLOGY PROGRAMME
[Choice Based Credit System (CBCS)]

MINIMUM CREDITS TO BE REGISTERED BY A STUDENT IN A NORMAL PHASE TO SUCCESSFULLY COMPLETE M.SC. MICROBIOLOGY DEGREE IN FOUR SEMESTERS

Semesters	**Hardcore**		**Softcore**		**Open elective**		**Total**	
	Numbers	**Credits**	**Numbers**	**Credits**	**Numbers**	**Credits**	**Numbers**	**Credits**
I semester	05	16	02	06	-	-	06	22
II semester	04	12	01	03	1	04	07	19
III semester	05	16	02	06	-	-	07	22
IV semester	1	07	02	06	-	-	02	13
Total	**15**	**51**	**07**	**21**	**1**	**04**	**23**	**76**

Minimum Credits for Hard Core	42
Minimum Credits for Soft Core	16
Minimum Credits for Open Elective	04
Minimum Total Credits	76

I Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Bacteriology	HC	3	1	0	4
2		Virology	HC	3	1	0	4
3		Techniques in Biology	FCHC	3	1	0	4
4		**Practical IA** (Techniques in Biology & Bacteriology & Virology)		0	0	2	2
		Practical IB (Molecular Cell Biology & Environmental Microbiology)		0	0	2	2
		Soft Core (Any two)					
5		Environmental Microbiology	SC	3	0	0	3
6		Molecular Cell Biology	FCSC	3	0	0	3
7		Fundamentals of Biochemistry	FCSC	3	0	0	3
TOTAL CREDITS **5 Hard Core (3 theory + 2 practicals) :16 credits** **2 Softcore: 06 credits**							**22 CREDITS**

***Note: For students those who wish to have more than one softcore, Bridge course/Add-on course (theory) will be provided.**

II Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Molecular Biology	FCHC	3	1	0	4
3		Genetic Engineering	FCHC	3	1	0	4
4		**Practical IIA**: (Molecular Biology & Genetic Engineering)		0	0	2	2
5		**Practical IIB:** (Microbial Physiology)		0	0	2	2
		Soft Core (Any one)					
6		Microbial Physiology	SC	3	0	0	3
7		Molecular Diagnostics	FCSC	3	0	0	3
8		Microbial Diversity	OE	3	1	0	4
TOTAL CREDITS **4 Hard Core (2 theory + 2 practicals) :12 credits** **1 Softcore: 03 credits** **1 Open elective :04 credits**							**15+4=19 CREDITS**

III Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Medical Microbiology	HC	3	1	0	4
2		Immunology	FCHC	3	1	0	4
3		Food Microbiology	HC	3	1	0	4
4		**Practical-IIIA:** Immunology & Medical Microbiology & Food Microbiology (Research Paper Presentation)		0	0	2	2
5		**Practical-IIIB** Genetics & Mycology		0	0	2	2
		Soft Core (Any Two)					
6		Genetics	HC	3	0	0	3
7		Mycology	SC	3	0	0	3
8		Genomics and Proteomics	SC	3	0	0	3
TOTAL CREDITS 5 Hard Core (3 theory + 2 practical) :16 credits 2 Softcore: 06 credits							**22 CREDITS**

IV Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Project Work	HC	0	1	6	7
2		Agricultural Microbiology	SC	3	0	0	3
3		Industrial Microbiology	SC	3	0	0	3
TOTAL CREDITS 1 Hard Core (PW) : 07 credits 2 Softcore: 06 credits							**13 CREDITS**

Grand Total Credits: 76

SCHOOL OF LIFE SCIENCE

I SEMESTER

HARD CORE: BACTERIOLOGY

Total Credit: 04 **Total Hours: 48 hours**

Module-I **12hrs**

Learning Objectives: Students should study this paper to know –

1. The structure of bacteria and its identification
2. The different agents to inhibit bacteria

Introduction: Important events in development of bacteriology, Scope and relevance of bacteriology. Economic importance of bacteria.

Cell Structure: An overview of bacterial size, shape and arrangement, structure, chemical composition of cell wall of Archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria, cell wall deficient organisms including L-form structure, composition and function of cell membrane, capsule, flagella, pili, Inclusion bodies, ribosomes, mesosomes, reserve food materials , magnetosomes and phycobilisomes, endospores, bacterial nucleic acids – chromosome, plasmid, transposons, integrons and antibiotic resistance cassettes.

Microscopy: Working Principles of bright field microscope, fluorescent microscope, dark field microscope, phase contrast microscope, stereo microscope, confocal microscopy and electron microscope. Preparation of sample for electron microscopic studies. Application and importance of above microscopes. Measurement of microscopic objects.

Module-II **12hrs**

Bactericidal and bacteriostatic agents - Factors affecting static and cidal activity, phenols and phenolic compounds, alcohols, halogens, heavy metals, dyes, detergents, aldehydes Non-medical uses of antibiotics. Assay methods of antimicrobial agents – Phenol coefficient, qualitative assay of drugs (drug sensitivity testing), quantitative assays – liquid tube assay (MIC), agar tube assay. Agar plate assay

Module-III **12hrs**

Growth, Cultivation and control of Bacteria: Nutrient requirements, nutritional types of bacteria, culture media, classification of media. Growth:

Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Methods for measurement of microbial growth – direct microscopy, viable count estimates, turbidometry, and biomass. Aerobic, anaerobic, batch, continuous and synchronous cultures. Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Preservation and Maintenance of Microbial cultures: Repeated subculturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, lyophilization. Advantages and disadvantages of each method. Control of microorganisms: Antimicrobial agents, physical and chemical methods. Principles, functioning and types of Biosafety cabinets.

Module-IV **12hrs**

Characteristics and Salient features of major groups of Bacteria: Archaebacteria: general **c**haracteristics and classification; extremophiles, halophiles, thermophiles and barophiles; General characteristics, classification, diversity and distribution, economic importance of .**Actinomycetes, Cyanobacteria**. **Bioluminescent bacteria;** characteristics and examples, mechanism of bioluminescence. General characteristics, life cycle, growth, multiplication and significance of Mycoplasma, Rickettsiae and Chlamydia

Learning Outcomes: After studying this paper the students will know –

1. The concept and working principles of micorscopes
2. Claasification and salient features of different groups of bacteria

REFERENCES:

1. Black, J.G. 2012. Microbiology: Principles and Explorations (8th ed.). Wiley
2. Brown, A. 2011. Benson's Microbiological Applications Short Version (Brown, Microbioligical Applications) (12th ed.). McGraw-Hill Science/Engineering/Math
3. Hogg, S. 2013. Essential Microbiology (2nd ed.). Wiley-Blackwell
4. Leboffe, M.J., Pierce, B.E., and Ferguson, D. 2012. Microbiology Laboratory Theory & Application, Brief (2nd ed.). Morton Publishing Company

5. Madigan, M.T., D.P. Clark, Stahl, D., and Martinko, M.J. 2012. Brock Biology of Microorganisms (13th ed.). Benjamin Cummings
6. Mara, P., Duncan, and Horan, N.J. 2003. Handbook of Water and Wastewater Microbiology, Academic Press
7. Perry, J.J., Staley, J., and Lory, S. 2002. Microbial Life, Sinauer Associates.
8. Pommerville, J.C. 2010. Alcamo's Fundamentals of Microbiology (9th Revised ed.). Jones and Bartlett Publishers, Inc
9. Sherwood, A. and Willey, W. 2007. Prescott, Harley, and Klein's Microbiology (7th Int. ed.). McGraw-Hill

HARD CORE: VIROLOGY

Total Credit: 04 **Total Hours: 48 hours**

Module- I **12hrs**

Learning Objectives: Students should study this paper to know –

1. Structure and functioning of viruses
2. Infectious cycle and replication pattern

A) The science of virology: Concept and scope of virology. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and other contents. Classification and nomenclature of viruses. Evolutionary importance of viruses.

B) Working with viruses: Visualization and enumeration of virus particles, Biological activity of viruses, Physical and chemical manipulation of the structural components of viruses, Characterization of viral product expressed in the infected cells. Isolation and purification of viruses, Detection of viruses: physical, biological, immunological and molecular methods.

Module-II **12hrs**

A) Virus Infectious Cycle: Adsorption/attachment, Entry, Disassembly/uncoating, Nucleic acid and Protein synthesis, Intracellular trafficking, Assembly, Maturation and Release.

B) Replication patterns of specific viruses: Viruses with RNA genomes; DNA genomes. Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpes virus, Poliovirus, Influenza virus, coronavirus, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, Retroviruses.

Module-III **12hrs**

A) Virus-Host Interactions: Types of infections: Acute (RSV, influenza, viral encephalitis), Persistent (Hepatitis B, C, HIV), Latent (HSV), Slow (scrapie). Maternal-fetal transmission, Transformation and oncogenesis resulting from virus infections (warts, lymphoma, hepato- cellular carcinoma). Vector-borne and emerging diseases (sources and causes).

B) Host-responses to viruses: Innate (cytokines, interferons, NK cells) and adaptive immunity to viruses (antibody and cell-mediated immunity)

C) Prevention and control of viral diseases: Vaccines: History (smallpox, rabies, polio, measles, mumps, HPV, hepatitis B). Live-attenuated and killed-virus vaccines, subunit vaccines, nucleic acid based, & viral-vector-based vaccines. Pre- and post-exposure prophylaxis. **Antiviral drugs:** Nucleoside analogs, reverse transcriptase inhibitors, fusion inhibitors, maturation/protease inhibitors.

Module-IV **12hrs**

A) Propagation, purification, characterization and identification and genomics of plant viruses: General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis techniques, methods employed in identification of plant viruses.

B) Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

C) Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses.

D) Viruses as tools: Study of gene expression and regulation in host cells, use as gene delivery vehicles to treat genetic disorders or as vaccines.

Learning Outcomes: After studying this paper the students will know –

1. Viruses as tool for vaccination
2. Host and virus specific responses

REFERENCES:

1. Cann, A.J. 2011. Principles of Molecular Virology (5th ed.). Elsevier

2. Carter, J., and Saunders, V.A. 2007. Virology: Principles and Applications, John Wiley & Sons, west Susscex , England.
3. Clokie, H., Martha, R.J., and Andrew, K. 2009. Bacteriophages, Methods and Protocols, Volume 1: Isolation, Characterization, and Interactions, Humana Press
4. Dimmock, N., Easton, A., and Leppard, K. 2009. Introduction to Modern Virology (6^{th} ed.). Wiley-Blackwell
5. Flint, J.S., Enquist, L.W., and Shalka, A.M. 2004. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, American Society for Microbiology
6. Fujita, H.F.R., Entwistle, P.F., Evans, H.F. and Crook, N.E. 1998. Insect Viruses and Pest Management. John Wiley & Sons Ltd.

7. Lobocka, J., Malgorzata, K., and Szybalski, W.T. 2012. Bacteriophages (2^{nd} ed.). Academic Press

8. Matthews, Ford, R.E., and Hull, R. 2002. Matthews' Plant Virology (4th ed.). Gulf Professional Publishing.
9. van Regenmortel, M.H.V., and Mahy, B.W.J. 2009. Desk Encyclopedia of General Virology (1st ed.). Academic Press.

10. Wagner, E.K., Hewlett, M.J., Bloom, D.C., and Camerini, D. 2007. Basic Virology (3rd ed.). John Wiley & Sons.

TECHNIQUES IN BIOLOGY (FCHC)

Total Credit: 04 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

a. This paper is designed to give a brief introduction to most of the techniques used in the field of biological analyses
b. Nevertheless the topics in this paper are to be taught compendiously.

Module I: Biological samples: Types and preparation 12 hours

Study Models: *In vivo* and *in vitro* models; Microbial, Animal, Plants; choice of models;types of studies, auxotrophs. Routes of exposure of test chemicals in animals. Culture: microbes, animal and plant cells in laboratory.

Cell fractionation techniques: Tissue homogenization, Cell lysis techniques, extraction of cellcellularcontents. Protein purification techniques: salting in, salting out, dialysis and ultrafiltration.

Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium.

Ultra centrifugation: Differential and density gradient centrifugation, centrifugal elutriation, isolation of cell organelles (e.g. Mitochondria) from biological tissue samples.

Module II:Spectroscopicanalysis 12 hours

Principles and applications of colorimeter, spectrophotometer, fluorimeter, multiwell plate reader. Beer-Lambert's Law and its limitations. Extinction coefficient, chromogenic and fluorescent probes, their applications. Principle of flame photometry, and X-ray crystallography, IR, ESR,NMR& Raman's spectroscopy.

Module III: Chromatographic and electrophoretic techniques: 12 hours

Chromatography: Principles, working and applications of paper chromatography (radial, ascending, descending and 2-D), Thin layer chromatography,Brief introduction, application of Adsorption, Ion exchange, Gel

filtration, Affinity, Gas chromatography. Chromatofocusing, HPLC, UPLC and FPLC.

Protein electrophoresis: Polyacrylamide gel electrophoresis, SDS-PAGE, IEF & 2DEF.Visualizing proteins using CBB, silver stain;glycoproteinsand lipoproteins staining,Brief introduction to Zymogram and reverse zymogram;

Nucleic acid electrophoresis: Agarose gel electrophoresis, Visualizing nucleic acids in using Ethidium bromide and UV. Fluorescence probes: SYBR green and Eeva green, Taq man, PFGE and capillary electrophoresis.

Module IV: Radiochemistry and Mass spectroscopy 12 hours

Isotopes: Heavy isotopes and radio isotopes, half-life, decay constant, detection and quantitation; Principle and working of GM counter and scintillation counter (solid/liquid).

Mass spectroscopy Principle and construction of mass spectrometer. m/e, tof, MALDI and ESI. LC-MS, LC-MS-MS.

Applications of radioactivity: Radio isotopes in biology 3H, 14C, 32P, 131I, 35S; Labeling of proteins and nucleic acids, autoradiography, pulse chase method, carbon dating.

Learning Outcomes: After studying this paper the students will know –

1. Techniques in Biology
2. The fundamental principles in cell homogenization
3. Importance of bioanalytical techniques

REFERENCES:

1. Bryce, C., and Balasubramanian, D. 2004. Concepts in Biotechnology, Universities Press.
2. Crueger, W., and Crueger, A. 2006. Biotechnology: A Textbook of Industrial Microbiology, Science publishers Ltd., England.
3. Halford, N.G. 2003. Plant Biotechnology: The Genetic Manipulation of Plants: Adrian Slater, Nigel Scott, Mark Fowler; Oxford University Press, Oxford, New York.

4. Marshall, A.G. 1978. Biophysical Chemistry: Principles, Techniques, and Applications: Wiley New York.
5. Micklos, D.A., and Freyer, G.A. 1990. DNA Science; A First Course in Recombinant DNA Technology: Cold Spring Harbor Laboratory Press.
6. Purohit, S., and Mathur, S. 1999. Drugs in Biotechnology Fundamentals and Applications. Purohit SS. Maximillan Publishers, India.
7. Walker, M., and Rapley, R. 2009. Route Maps in Gene Technology, John Wiley & Sons.
8. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.

SOFTCORE: ENVIRONMENTAL MICROBIOLOGY

Total Credit: 03 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

1. The evolution of life, microorganisms and soil interaction
2. Adaptation of microorganisms

Module- I **12hrs**

Introduction to Microbial Ecology: Evolution of Life on Earth; History and scope of ecology, Concept of autecology, synecology, population, community, biome. Ecological succession. Microorganism in aquatic Environment: major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes. Biofilms, Production in lakes, rivers, estuaries and wetlands. Nutrient dynamics in lakes, rivers, estuaries and wetland, Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.

Module-II **12hrs**

Soil Microbiology: Characteristics and classification of soil. Interactions between microorganisms: Mutualism, commensalism, ammensalism synergism, parasitism, predation, competition. Rhizosphere, rhizosphere microflora and its beneficial activity. Role of microorganism in nitrogen, phosphorous and sulphur cycles. Detrimental effects of diverted biogeochemical cycles. Biological nitrogen fixation in detail: Symbiotic, asymbiotic and associated nitrogen fixation. Structure, function and gentic regulation of nitrogenases. Viable but nonculturable bacteria. Impact of crop residues burning on soil fertility and agriculturally important microbes

A) Module-III **12hrs**

Microbes in extreme environment: Microbes of extreme environments, Thermophiles, acidophiles, alkaliphiles, halophiles. barophiles and their survival mechanisms.

B) Space microbiology: Historical development of space microbiology, Life detection methods a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic and heterotrophic).

Module-IV **12hrs**

Microbes in the degradation of wastes: Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides, Xenobiotics, degradation of lignin,

cellulose and pectin. Bioremediation. Geomicrobiology: Microbes in metal extraction, mineral leaching and mining, copper extraction by leaching and microbes in petroleum product formation. Global Environmental Problems: Global Warming, Acid rain, Ozone depletion. Biodeterioration of wood and metals.

Learning Outcomes: After studying this paper the students will know –

1. The ecological succession of microorganisms and its adaptation
2. Bioremediation concept of microorganisms

REFERENCES:

1. Alexander, M. 1999. Biodegradation and Bioremediation. Academic Press, U.S.A.
2. Das, S. 2014. Microbial Biodegradation and Bioremediation (1st ed.). Elsevier academic Press, U.K.
3. Frederic, P.M., Agnes, F.V., and McBrewster, J. 2010. Bioleaching. VDM Publishing house, Mauritius.
4. Gabriel, B. 2005. Waste Water Microbiology. John Wiley & Sons publishers, U.K.
5. Nicholas, P., and Cheremisinof. 2002. Handbook of Water and Wastewater Treatment Technologies. Butterworth Heinemann Publishers, U.S.A.
6. Paulsen, Ian T., Holmes, and Andrew, J. 2014. Environmental Microbiology (2nd ed.). Springer-Verlag Berlin Heidelberg, Germany.
7. Pradipta, K., and Mohapatra. 2008. Textbook of Environmental Microbiology. I K International Publishing House Pvt. Ltd, New Delhi.
8. Raina, M.M., and Ian, L.P. 2009. Environmental Microbiology (2nd ed.). Academic Press, U.S.A.
9. Singh, Ajay, Ward, and Owen, P. 2004. Biodegradation and Bioremediation, Springer-Verlag Berlin Heidelberg, Germany.
10. Singh, S.N. 2011. Microbial Degradation of Xenobiotics. Springer Heidelberg Dordrecht, London, U.K.

SOFTCORE: MOLECULAR CELL BIOLOGY(FCHC)

Total Credit: 03 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

1. The Cellular organization.
2. Study of phytochemicals in cancer biology.
3. Signaling transduction in cells.

Module- I **12hrs**

Organization of the cell

Universal features of cells,Ultra-structure of prokaryotic and eukaryotic cells (Plants and animals), Structure of plant cell wall, Structure of cell membrane and models, functions of cell membrane, Intracellular organelles: Structure and functions of Ribosomes, Golgi apparatus; Mitochondria, Chloroplast, Lysosomes, Centrosome, Endoplasmicreticulum, Nucleus-Internal organization, Chromatin- structure and function, cellular cytoskeleton.

Module - II **12 hrs**

Cellular processes

Cell cycle and its regulation, Cell cycle check points, Molecular dynamics of cell division, interphase, Mitosis and meiosis, Cyclins and CDKs, Cell differentiation: Stem cells, Differentiation of stem cells into different cell types and organization into specialized tissues, apoptosis, necrosis & autophagyMolecular mechanisms of membrane transport active, passive and facilitated, Receptor mediated endocytosis.

Module - III **12 hrs**

Cancer Biology

Introduction,Historical account, classification, Characteristics of cancer cells, hallmark features of cancer cells,Carcinogenesis, Exogenous and endogenous carcinogens, cancer initiation, promotion and progression, Cancer cell cycle, Viruses and cancer, Oncogenes, Tumor suppressor genes with examples, cancer

therapy present and future, Role of p53 in cancer. Role of phytochemicals in cancer treatment, cancer stem cells.

Module – IV **12 hrs**

Basics of Signal Transduction

Extra-cellular matrix components, Cell junctions, Cell adhesion molecules, Hormones and their receptors, Cell surface receptors as reception of extra-cellular signals, Types of cell signalling, Growth factors- EGFR, VEGF, PDGF and theirSignalling, signalling through G-protein coupled receptors; Second messengers in signal transduction pathways: cAMP and calcium ions (Ca2+), signalling through Receptor tyrosine kinases ,MAP kinase pathway,P13K -Akt pathway.

Learning Outcomes: After studying this paper the students will know –

1. Structure and function of cell.
2. Phytochemical role in cellular process and cancer biology
3. Importance of growth factors and cellular signalling.

REFERENCES:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. 2008. Molecular Biology of the Cell (5th ed.). New York: Garland Science.
2. Lodish, H.F. 2016. Molecular Cell Biology (8th ed.). New York: W.H. Freeman.
3. Cooper, G.M., and Hausman, R.E. 2013. The Cell: a Molecular Approach. (6th ed.). Washington: ASM; Sunderland.
4. Hardin, J., Bertoni, G., Kleinsmith, L.J., and Becker, W.M. 2012. Becker's World of the Cell. Boston (8th ed.). Benjamin Cummings.
5. Kleinsmith, L.J., and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd ed.). Harper Collins College Publishers, New York, USA.
6. E-books

- https://cdn.preterhuman.net/texts/science_and_technology/nature_and_biology/Cell_and_Molecular_Biology/Molecular%20Cell%20Biology%205th%20ed%20-%20Lodish%20et%20al.pdf
- http://standring.weebly.com/uploads/2/3/3/5/23356120/8_-_unit_30c.pdf

- file:///C:/Users/Dr.%20Divya/Downloads/Cancer%20Biology%204th%20ed%20-%20R.%20Ruddon%20(%20PDFDrive%20).pdf

SOFTCORE: **FUNDAMENTALS OF BIOCHEMISTRY(FCHC)**

Total Credit: 03 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

1. The basics of biochemistry.
2. Lipids and metabolism

Module I: Basics of Chemical Bonding and Carbohydrates 18hrs

Bonding: Covalent bond; coordinate bond; coordinate bond formation in transition metals. Bonding of iron in hemologlobin and cytochromes, cobalt in Vit B_{12}, magnesium in chlorophyll. Special properties of water; Structure and bonding, non-covalent interactions, reactions of carbohydrates.

Carbohydrates: Structure and classification of carbohydrates, monosaccharides (pentoses, hexoses), disaccharides (lactose, sucrose, maltose) and polysaccharides (starch, cellulose, glycogen and bacterial cell wall polysaccharides) explanations.

Module II: Basics of Amino Acids and Proteins 10hrs

Aminoacids: Nomenclature, classification and buffering properties, zwitterionic structure,reactions of Aminoacids.

Proteins: Primary, secondary, tertiary and quaternary structures, protein sequencing.

Factors responsible for protein folding: Anfinsen's experiment. Non-covalent interactions and S-S bridges in stabilizing the proteins, Denaturation and renaturation of proteins, molten globule, chaperones.

Module III: Basics of Lipids& Enzymology 08hrs

Lipids: Classification & reaction of lipids; oils, fats, and waxes. Occurrence and properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. Role in cell membrane.

Enzymology:Classification, enzyme activity, Michaelis-Menten kinetics, LB plot, inhibition - competitive, uncompetitive, non-competitive, determination of Ki, active site, allosterism - ATCase, isoenzymes- LDH, catalytic strategies, co-enzymes and cofactors, multienzyme complexes-PDC.

Module IV: Basics of Nucleic Acids **12hrs**

Nucleic Acids: DNA as genetic material ,Griffith ,Avery & Macleod experiments , isolation of DNA & RNA from biological sources,secondary structure of DNA, Watson and Crick model,Chargaff's rule; B and Z DNA. Features of mitochondrial, chloroplast DNA and plasmids. Secondary structure of tRNA and clover leaf model. Physiochemical properties of nucleic acids, melting of DNA, T_m; factors affecting T_m, $C_o t$ curve, classification of DNA based on $C_o t$ curve.

Learning Outcomes: After studying this paper the students will know –

1. Importance of biochemistry.
2. Application of biochemistry knowledge in the society.

REFERENCES:

1. Bahl, A. 2010. Advanced Organic Chemistry; S. Chand & Company Limited.
2. Berg, J.M., Tymoczko, J.L., and Stryer, L. 2006. Biochemistry: International Edition: WH Freeman & Company Limited
3. Mathews, P. 2002. Advanced chemistry, Cambridge low price editions. Cambridge University Press, UK.
4. Morrison, R., and Boyd, R. 1992. Organic Chemistry (6^{th} ed.). Englewood Cliffs, NJ: Prentice Hall.
5. Nelson, D.L., Lehninger, A.L., and Cox, M.M. 2008. Lehninger Principles of Biochemistry: Macmillan J
6. Voet, D., and Voet, J.G. 2010. Biochemistry (4^{th} ed.). New York: J. Wiley & Sons.

1. Videos for the concept:

- www.khanacademy.org – Chemical Bonding, Chemistry of Biomolecules
- www.yourgenome.org – Structure of DNA

PRACTICAL IA: (Techniques in Biology & Bacteriology & Virology)

Total Credit: 02 Total hours : 32

1. Laboratory safety rules
2. Isolation and enumeration of bacteria from soil and water
3. Staining techniques – simple (positive and negative), differential (Grams and acid fast), structural (endospore and capsule)
4. Motility test (hanging drop method and soft agar method)
5. Biochemical tests for the identification of bacteria – catalase, IMViC, Urease, TSIA.
6. TLC of amino acids.
7. Bacterial growth curve.
8. Diauxic growth curve in *E.coli*
9. Isolation of coliphages from sewage
10. Study of morphological changes due to viral infection in plants
11. Ascending chromatography
12. Descending chromatography
13. Circular paper chromatography
14. Wavelength scan of proteins and Nucleic acids

PRACTICAL IB: (Molecular Cell Biology & Environmental Microbiology)

Total Credit: 02 Total hours : 32

1. Microscopic examination of prokaryotic and eukaryotic cells using staining techniques.
2. Measurement of cell dimension by micrometery.
3. Cell Counting and viability by tryphan blue exclusion method.
4. Study of mitosis in onion root tips.
5. Study of meiosis in onion flower buds.
6. Polytene chromosomes.
7. Determination of BOD of pollution water.
8. Determination of COD of polluted water.
9. Degradation of cellulose by *Chaetomium globosum*.
10. Bacterial examination of drinking water by membrane filters technique.
11. Identification and study of soil associated Mycorrhiza.
12. Study of important microbes in the degradation of wastes.

II SEMESTER

HARDCORE: **MOLECULAR BIOLOGY(FCHC)**

Total Credit: 04 **Total Hours: 48 hours**

Learning Outcomes: After studying this paper the students will know –

a. *To understand biological activities and metabolism at DNA and protein level*
b. *The course gives an in-depth insight into the molecular aspects of life - the central dogma.*
c. *It explains molecular aspects of genes and its regulation- genome- gene expressions heredity- recombination- protein synthesis- molecular basis of diseases- mutationsgenetic analysis etc.*

Module I: **08 Hours**

1. **Genome organization:** Prokaryotic and eukaryotic genome organization, central dogma, structural organization of chromosome, structure and functions of DNA & RNA, Biochemical evidences for DNA as genetic material.

2. **DNA**: Chemistry of DNA, Forces stabilizing DNA structure, Physical Properties of Ds DNA (UV absorption spectra Denaturation and renaturation), chemical that react with DNA, Interaction with small ions, DNA binding motifs: Zinc finger, leucine zipper, helix-turn- helix others motifs, DNA binding and kinks.

Module II: **12 Hours**

1. **DNA topology:**Supercoiled form of DNA, Biology of supercoiled DNA, DNA topoisomerases, effect of supercoiling on structure of DNA and role of supercoiling in gene expression and DNA replication.

2. **DNA Replication:** Characteristics and functions of bacterial DNA polymerases I, Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication,Eukaryotic DNA polymerases and mechanism of replication. Replication of viral DNA, DNA replication in telomeric regions,Telomerases,mechanisms of action of topoisomerase I and II ,Models of DNA replication, Inhibitors of replication.

Module III: **14 Hours**

1. **Transcription:** Characteristics and function of bacterial RNA polymerases Eukaryotic RNA polymerases, mechanism of transcription and regulation.

transcription factors, Stringent response. Post transcriptional modifications of mRNA mechanism of splicing,Processing of tRNA and rRNA. Inhibitors of transcription. Mechanism of action of ribozymes ,

2. **Translation:** Structure and role of tRNA in protein synthesis, ribosome structure, basic feature of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes), Post translational processing,Control of translation in eukaryotes (Antisense RNA, Heme and interferon).

Module IV: **14 Hours**

1. **Regulation of Gene expression in prokaryotes and eukaryotes:** Positive and negative regulation. lac-, ara-, his- and trp- operon regulation; antitermination,global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

2. **Protein localization&Gene Silencing**: Export of secretory proteins- signal hypothesis, transport and targeting of proteins to mitochondria, chloroplast, peroxisomes, Gene Silencing: Definition, types, RNAi pathway, shRNA & CRISPR-CAS.

3. **Non coding RNA**: coding and non coding RNA,types of ncRNA : Short ncRNA(mi RNA,Sn RNA,Pi RNA,t-RNA & its fragments,SnoRNA)long ncRNA ,functional significance of ncRNA

Learning Outcomes: After studying this paper the students will know –

a. *The student will get an idea about the principles behind molecular biology*
b. *Makes students to understand the basic molecular tools and its application in basic research and applied research in various fields of life sciences.*

REFERENCES:

1. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K., and Watson, J.D. 1994. Molecular Biology of the Cell (4th ed.). Oxford Press
2. Cooper, G.M. 1997. The Cell: A molecular approach (5th ed.). ASM Press, USA

3. Darnell, J., Lodish, H., and Baltimore, D. 1990. Molecular Cell Biology(3rd ed.). Scientific American Books Inc. press NY.
4. Elliott, W.H., and Elliott, D.C. 2006. Biochemistry and Molecular Biology (3rd Indian ed.). Pub. Oxford Press.
5. Garrett, R.H., and Gresham, C.M . 1995. Molecular aspects of Cell Biology(4t ed.).International edition, Saunders College Pub press.
6. Karp, G. 1996. Cell and Molecular Biology concepts and experiments(3rd ed). John Wiley and Sons Inc. press. NY.
7. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., and Darnell, J. 2004. Molecular Cell Biology (4th ed.).Scientific American Books Inc. press. NY.
8. Mathews and Ahern, V.H. 2000. Biochemistry. (3rd ed.). Pub Pearson education press.
9. Nelson, D.L., and Cox, M.M.2005. Lehninger- Principles of Biochemistry,4th edition Pub WH Freeman Co.
10. Old, R.W., and Primrose,S.B. 1993. Principles of gene manipulation .An introduction to genetic engineering Blackwell Scientific Publications.

1. Weblinks :
    i. https://www.slideshare.net/ShobhaSurbhaiyya/gene-silencing-69645867.
    ii. https://www.slideshare.net/lalvarezmex/dna-topology.
2. Research article:
    i. Karakar, D and Ozpolat, B. 2021. The role of Lnc RNAs in Translation . Non coding RNA . 23: 7-16.
    ii. Anderson, P and Ivanov P . 2014. t RNA fragments in health and disease ,FEBS letters 588 :4297-4304.
    iii. Mleczko, A.M ., Celichowski ,P., and Żywicka K.B, 2014. Ex-translational function of tRNAs and their fragments in cancer,61(2): 211-216.
    iv. Afonso A.P and Micro L .G. 2021. RNAs in the TFh regulation : Small molecules with big impact ,European Journal of Immunology 51:292-295.

HARDCORE: **GENETIC ENGINEERING (FCHC)**

Total Credit: 04 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

a. The basics of Genetic engineering.

b. Basic principles of gene cloning and gene products.

c. Applied aspects of Genetic engineering

Module-I **12 hours**

Cloning and Expression vectors: Plasmids, lambda vectors, M13 Phage, cosmids,phagemids, Artificial chromosome vectors-YACs, PACs and BACs, plant and animal viruses as vectors, Transposons, Expression vectors-prokaryotic (pRSET, pET), eukaryotic (pcDNA3, pCEP), Baculovirus and Pichia vector system, plant based vectors- Ti and Ri, binary and shuttle vectors,Gene cloning: genomic cloning, c-DNAcloning,

Module- II **12 hours**

Gene manipulation Restriction enzymes, restriction mapping, cloning in plasmid, Phage and cosmid vectors, insertion of foreign DNA into host cells-transformation, electroporation, Transfection transient and stable, screening methods for transformants, downstream processing of recombinant proteins, affinity tags- His-tag, GST-tag, MBP-tag, Fc-tag. Construction and screening of genomic and cDNA libraries, chromosome walking, Chromosome Jumping, BAC libraries and assembly of BACs into contigs.

Module- III **14 hours**

Gene analysis techniques

Hybridization techniques- Southern, Northern, South-western, Far-western, Colony hybridization, fluorescence *in situ* hybridization, molecular probes-preparation, labelling, amplification, applications, Polymerase chain reaction-Principle, primer designing, Types- RT-PCR, Realtime PCR, colony PCR, Multiplex PCR, Hot-start PCR, asymmetric PCR, Sequencing methods- chemical sequencing of DNA (Maxam and Gilberts methods andSangers dideoxy method), automated DNA sequencing, sequencing by DE-MALDI- TOFMS,microarray.

ChIP and Chip-on-chip techniques Chromogenic *in situ* hybridization, qPCR, next generation sequencing .

Module- IV **10 hours**

Gene therapy, transgenics and Genome editing

Ex vivo and *in vivo* gene therapy, Vectors and other delivery systems for gene therapy, Invitro gene therapy, gene therapy of genetic diseases: eg.Neurologocal, metabolic disorders and cystic fibrosis, viruses for gene therapy- lentivirus, adenovirus. Gene targeting, knockout mice, genome editing by CRISPR-CAS

Learning Outcomes: After studying this paper the students will know –

a. Importance of Recombinant DNA Technology.
b. The fundamental cloning vectors.
c. Preparation of probes and its application in scientific fields.

REFERENCES:

1. Alexander, N., Glazer and Nikaido , H. 2007. Microbial Biotechnology Fundamentals of Applied Microbiology (2nd ed.) Cambridge University Press.
2. Brown, T.A. 2010. Gene Cloning and DNA Analysis-An Introduction (6thed.). Blackwell Science Press.
3. Brown, T.A. 2011. Introduction to Genetics: A Molecular Approach (1st ed.). Blackwell Science Press.
4. Desmond, S. T., and Nicholl. 2002. An Introduction to Genetic Engineering (2nd ed.). Cambridge University Press.
5. Gupta P.K. 2008. Molecular Biology and Genetic Engineering (2nd ed.). Deep and Deep Publications. India.
6. Gupta,V.K., MSchmoll., M. M, Tuohy.,M. Mazutti., M. A.2013 Applications of Microbial Engineering(4th ed.). CRC Press.
7. Lodish, H., Berk, A., Chris, A., and Krieger .K K. 2007. Molecular Cell Biology (6th ed.) W.H. Freeman and Company, New York.
8. Maheshwari, D.K., Dubey, R.C., and Kang, S.C. 2006. Biotechnological Applications of Microorganisms(3rd ed.). I.K. International Publishing House. New Delhi.

9. Rehm H.J., and Reed, G. 2008. Biotechnology: Genetic Fundamentals and Genetic Engineering(3rd ed.). Cambridge University Press.
10. Setlow and Jane, K. 2004. Genetic Engineering: Principles and Methods (3rd ed.) Springer Publication.

SOFTCORE: MICROBIAL PHYSIOLOGY

Total Credit: 03 **Total Hours: 48 hours**

Learning Outcomes: After studying this paper the students will know –

a. This course deals with characteristics, properties and biological significance of the biomolecules of life.

***b.** In depth knowledge of the energetic and regulation of different metabolic processes in microorganisms.*

Module-I **12 Hours**

1. **Microbial Physiology**: Microbial Physiology: Role of ATP in metabolism. Microbial enzymes: Structure and Classification, Mechanism of Enzyme actions: Lock and Key model, induced fit Theory, Factors affecting rates of enzyme mediated reactions (pH, temperature and substrate and enzyme concentration), Enzyme Inhibition and Enzyme regulation- types of enzymes

Module-II **12 Hours**

A) **Metabolism of Carbohydrate**: Metabolism of Carbohydrate: Glycolysis, Citric acid Cycle and different types of Phosphorylation, Homo and Hetero Lactic Fermentation, Utilization of sugars other than glucose: Lactose, Galactose, Maltose, Mannitol. Degradation of cellulose, Starch and Glycogen (bioenergetics).

Module-III **12 Hours**

Metabolism of other Substrates: Movement of Molecules: Facilitated transport, Channels, Carrier Proteins, Primary Active Transport, ABC Transporters, Siderophores, Group Translocation. **Lipid metabolism:** β-oxidation, Biosynthesis of fatty acids, degradation of fatty acids. **Nitrogen metabolism**: Nitrogen metabolism, Biological nitrogen fixation process, symbiotic and non symbiotic nitrogen fixation. Ureolytic bacteria and its fertility, degradation and biosynthesis of essential and non-essential amino acids. **Nucleic acid metabolism:** Biosynthesis and degradation of purines and pyrimidines.

Module-IV **12 Hours**

A) Microbial Photosynthesis: Photosynthetic Pigments and apparatus in bacteria. Oxygenic andAnoxygenic. Photosynthesis. Autotropic CO2 fixation and mechanism of Photosythesis. Utilization of light energy by Halobacteria.

B) Autotrophic Mechanisms in bacteria: Hydrogen bacteria, Nitrifying bacteria, Purple sulphur bacteria,Non-sulfur bacteria, Green sulfur bacteria, Iron bacteria, Methylotrophs.

C) Microbial Stress Responses: Oxidative stress, Thermal stress, Starvation stress, Aerobic to anaerobictransitions. Biofilm and quorum sensing

Learning Outcomes: After studying this paper the students will know –

a. *The student develops understanding of the laws of thermodynamics, concepts of entropy, enthalpy and free energy changes and their application to biological systems and various biochemical studies and reactions.*
b. *Conceptual knowledge of aerobic and anaerobic respiration and various intermediary mechanisms involved, oxidative phosphorylation.*
c. *Overview of major biomolecules: Classification, structure, function of carbohydrates, lipids, proteins, aminoacids, nucleic acids.*
d. *Discuss the biosynthesis and the degradation pathways involved in the physiology of microbes.*
e. *Conceptual knowledge of properties, structure, function of enzymes, enzyme kinetics and their regulation, enzyme engineering, Application of enzymes in large scale*

REFERENCES:

1. Albert, G., Moat,Michael, P., and Foster, S.J.W. 2009. Microbial Physiology(3rd ed.) BWSTM Press.
2. Caldwell, D.R. 1999. Microbial Physiology and metabolism(2nd ed). Star Pub Co press.
3. Frederick, C., and Neidhardt, John, L. I., and Schaechter, M.1990. Physiology of the Bacterial Cell: A Molecular Approach (2nd ed.). Sinauer Associates Inc press.
4. Kim , B H., Gadd , G.M. 2008. Bacterial Physiology and Metabolism(2nd ed.) Cambridge University Press.
5. Poole R.K. 2014. Advances in Microbial Systems Biology(2nd ed.). Academic Press
6. Rose and Anthony, H. 2000. Advances in Microbial Physiology(3rd ed.). Elsevier Science & Technology Book publisher.
7. Rose and Anthony, H. 1976. Chemical Microbiology- An Introduction to Microbial Physiology(2nd ed.).). Elsevier Science & Technology Book publisher.
8. White,D. Drummond , J. and Fuqua, C. 2011. The Physiology and Biochemistry of Prokaryotes(3rd ed.). Oxford University Press.

SOFTCORE: **MOLECULAR DIAGNOSTICS (FCSC)**

Total Credit: 03 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. *The course focuses on learning and understanding how the various molecular techniques that were studied can be developed and utilized in diagnosis.*
b. *The course explains common analytical techniques and molecular techniques related to the development and use of diagnostics.*
c. *Students learn about the clinical applications of molecular diagnostic in patients with infectious disease.*

Module-I **08hrs**

Introduction and History of diagnostics:

1. Introduction and History of diagnostics of diseases, mode of infection, types of infectious diseases, philosophy and general approach to clinical specimens. genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, inborn errors of metabolism.

2. Traditional disease diagnosis methods: Diagnosis of infectious diseases caused by bacteria, fungi, viruses, protozoa and Helminthes, Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host - Parasite relationships.

Module- II **14hrs**

Molecular techniques for diagnosis

1. Basics and Implication of Molecular techniques in Genome resolution, detection and analysis of pathogen causing disease : PCR,Real-time; Multiplex; FISH; RFLP; DGGE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; MALDITOF-MS; Metabolite profile for biomarker detection the tissues in various disorders by making using LCMS & NMR technological platforms.

2. Biochemical tests & Immunoassays: Detection and quantification of biochemical parameters

Types: RIA,ELISA,Chemiluminescent IA, FIA and specific applications; Immunohistochemistry – principle and techniques. Different Levels of Biosafety, Containment.

Module-III **12hrs**

Major Metabolic & Genetic disorders:

1. Traditional methods for the diagnosis of metabolic errors(Diabetes Type 1 & Type 2, hyperthyrodis&Hypothyrodism). Disease due to genetic disorders(Sickle cell anemia& Cystic fibrosis).Identifying human disease genes., Methods available for the diagnosis of genetic diseases and metabolic disorders.Blood (formation, composition, function and pathology of blood disorders (haemoglobinopathies,hemophilia), Muscle disorders (Duchene muscular dystrophy-DMD, Becker's muscular dystrophy-BMD, spinal muscular atrophy-SMA), Bone disorders
2. (Osteogenesis imperfecta, Rheumatoid arthritis), Skin disorder (Muir-Torre *syndrome*), Eye disorder (Retinitis pigmentosa).
3. Neonatal and Prenatal disease diagnostics. Gender identification using amelogenin gene locus. Amplification of Y chromosome specific Short Tandem Repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance,Karyotyping& characteristics of Karyotyping.. Molecular diagnosis for early detection of cerebral palsy, Down syndrome etc.

Module-IV **14hrs**

Cancer diagnosis:

1. Molecular Oncology Tests, Analysis of the Expression of Multiple Genes and Cancer Prognosis, Analysis of Lymph Nodes to Detect Metastasis of Breast Cancer, Screening for Colorectal Cancer: Stool-Based DNA Screening, Leukemias and Lymphomas, DNA Methylation Tests and Cancer, Predicting Risk of Developing Cancer.
2. Personalized Medicine: Pharmacogenomics and Companion Diagnostics, Cytochrome P450 and Drug Metabolism, Targeted Cancer Therapies and Companion Diagnostics Tests, Testing for HER2/neu Overexpression in Breast Cancer, Testing for Epidermal Growth Factor Receptor (EGFR), UGT1A1 Genetic Variants, Pharmacogenetics and Response to Antiretroviral Therapy, Thiopurine Methyltransferase and Metabolism of Thiopurine Drugs

Learning Outcomes: After studying this paper the students will know –

a. *The student will get an idea about the concept of molecular diagnosis and underpinning the successful application of gene therapy or biologic response modifiers as well they can find their future focus in biotechnology companies developing and marketing Diagnostic kits.*

REFERENCES:

1. Bruns, D.E., Ashwood,E.R., and Burtis.C.A.2007. Fundamentals of Molecular Diagnostics. (2nd ed.) Cambridge University Press.
2. Buckingham, L and Flaws, M.L. 2007. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (3rd ed.). Humana Press
3. Carl, A., Burtis, Edward, R., Ashwood and David E. Bruns, D.E.2007. Textbook of Clinical Chemistry and Molecular Diagnosis (5nded.) .Elsevier Publisher.
4. Coleman, W. B., and Tsongalis, G. J. 2006. Molecular diagnostics: for the clinical laboratorian. Springer Science & Business Media. (5nd ed.) .Elsevier Publisher
5. Coleman, W.B.2006. Molecular Diagnostics for the Clinical Laboratorian (2nd ed.) Humana Press
6. Greenwood, D., Slack, R and Peutherer, J, 1997. Medical Microbiology (5th ed). Sinauer Associates Inc press.
7. Henry. 2007. Clinical Diagnosis And Management By Laboratory Methods (2nded). .Mcpherson publisher.
8. Leonard, D. G., Bagg, A., Caliendo, A. M., Deerlin, V. M., and Kaul, K. L. 2007. Molecular pathology in clinical practice (2nd ed.). Springer Publisher.
9. McPherson, R. A., and Pincus, M. R. 2017. Henry's Clinical Diagnosis and Management by Laboratory Methods(1st ed.). Elsevier Health Sciences Publishing house.

1. Weblinks :

i. https://www.slideshare.net/Dentist_abdurrahman/genetic-disorders-47095869

ii. https://www.ihrp.uic.edu/files/4%20Screening%20and%20Diagnosis.ppt

2. Research articles:

i. Dermime, S. 2013. Cancer Diagnosis, Treatment and Therapy.M J CarcinogeneMutagene 14: 1-3.

ii. Egger, G., *et al.*, 2004. Epigenetics in human disease and prospects for epigenetic therapy. Nature, 429: 457-463.

PRACTICALS IIA: (Molecular Biology & Genetic Engineering)

Total Credit: 02

Total hours: 32

1. Estimation of DNA by diphenyl amine method.
2. Estimation of RNA by orcinol method.
3. Isolation of Genomic DNA from yeast cell
4. Determination of purity and concentration of isolated DNA using spectrophotometer and agarose gel electrophoresis.
5. Determination of RNAse &DNA seactivity

6. Restriction digestion of plasmid and analysis
7. DNA ligation
8. Isolation of plasmids from bacteria by agarose gel electrophoresis.
9. Preparation of competent *E. coli* cells for Bacterial transformation.
10. Induction of gene expression and purification of the induced protein from the host.
11. Amplification, Purification and separation of PCR product.
12. Determination of Proteinase activity on proteins

PRACTICALS IIB: (Microbial Physiology)

1. Population growth of yeast – *S. cerevisiae*.
2. Population growth of bacteria – *E coli*.
3. Sugar fermentation tests.
4. Catalase activity.
5. Hydrolytic rancidity.
6. Casein hydrolysis.
7. Carbohydrate catabolism by microbes
8. Study of acid and pH stress tolerance by microbes.
9. Effect of molecular oxygen on microbial growth.
10. Effect of osmotic pressure on microbial growth.
11. Effect of relative humidity on microbial growth.
12. Effect of different wavelengths of light on microbial growth

OPEN ELECTIVE: MICROBIAL DIVERSITY

Total Credit: 04 **Total Hours: 48 hours**

Learning Outcomes: After studying this paper the students will know –

a. *Describe common groups of bacteria and archaea in different ecosystems, and their role in biogeochemical key processes in these environments.*
b. *Describe for cultivation-independent methods for studies of the composition of microbial communities and for the function and occurrence of individual groups.*
c. *Describe genomic-based methods to study microbial diversity in nature and for the mechanisms behind it.*
d. *Describe important interactions within microbial communities and between microorganisms and plants and animals.*
e. *Evaluate, synthesise and present scientific studies of genetic and functional microbial diversity in different ecosystems.*
f. *Use bioinformatic tools and databases that are used to study microbial diversity.*

Module I **8 hours**

A) Viral Diversity: Morphology, ultra structure, chemical composition of virus, classification of viruses, Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – Hepatitis virus. **Sub-viral particles**: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

Module II **8 hours**

A)Bacterial Diversity: Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists. Classification based on Bergey's manual (Determinative & Systematic).

Module III **8 hours**

A)Fungal Diversity: Classification, Distribution, Importance, Structure, reproduction and general characteristics of the fungal divisions: Zygomycota (*Rhizopus*), Ascomycota (*Neurospora*), Basidiomycota (*Agaricus*), Deuteromycota (*Penicillium*), Chytridiomycota (*Allomyces*) , Myxomycota and Yeast.

Module IV **8 hours**

A) Importance and Conservation of Microbial Diversity: Importance of microbial diversity in agriculture, forestry, environment, industrial & food

biotechnology, animal & human health. Metagenomics. Importance of conservation. *In situ* conservation and *Ex situ* conservation. Role of culture collection centers in conservation.

Learning Outcomes: After studying this paper the students will know –

a. *Microbial ecology – concepts of Niche, habitat, ecosystem etc.*
b. *Concept related to extremophilic microbes and archea*
c. *Significance of microbes in biodegradation and biodeterioration*
d. *Application of biofertilizers and their significance Anoxygenic photosynthetic microbes, Oxygenic photosynthetic microbes and the Role of blue green algae (BGA) in agriculture*
e. *Methanogenic Archeobacteria, General characteristics. Bioluminescent and*
f. *Magnetotactic bacteria Microorganisms in prospecting of oils Extremophiles*

REFERENCES:

1. Alexopoulos, C. J. and Mims, C. W. 1979. Introductory Mycology.(3rd ed.) Wiley Eastern Publisher. New Delhi.
2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Vorology(5th ed.) Blackwell publishing, USA.
3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management (2nd ed.) Aph Publishing Corp. Calcutta.
4. Landecker, E. M. 1972. Fundamentals of Fungi (2nd ed.) Prentice-Hall, Angelwood Cliff, New Jersey.
5. Madigan, M.T., Martinko, M. J. and Parker, J. 2003. Brock Biology of microorganisms (3rd ed.). Pearson education., New Jercy.
6. Pelczar, M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology (4th ed.).McGraw Hill publisher. New York
7. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity ((4th ed.). Wesley Longman publisher. New York.
8. Presscott, L. M., Harley, J. P. and Klein, D. A. 1999. Microbiology (4th ed.). WCB Mc Graw- Hill publisher. New Delhi.
9. Satyanarayana, T. and Johri, B. N. 2005. Microbial Diversity – Current Perspectives and Potential Applications (3rd ed.). I K Int. Pvt. Ltd. New Delhi.
10. Stainer, R. Y., Ingraha, J, L., Wheelis, M. L. and Painter, P. K. 1986. General Microbiology (3rd ed.). Mc Millan Edun. Ltd. London.
11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life (3rd ed.) John Wiley Sons Inc.Publication. New York.
12. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology(4th ed.).Blackwell Science. Inc.Publisher.

III SEMESTER

HARDCORE: MEDICAL MICROBIOLOGY

Total Credit: 04 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

1. Basis of microbial infection
2. Mode of action of drugs on microbes
3. Diagnosis of microbial infectious diseases

Module I **10 hours**

A) Introduction to Medical Microbiology: History, Development and scope of Medical Microbiology. Concept of Disease, disorder, syndrome, Communicable diseases- Microbial infections and diseases. Factors responsible for microbial pathogenicity.

B) Microbial infections**:** Types of infections, modes of transmission, portal of entry: Urinary tract infection, sexually transmissible infection, Infection of the central nervous system, Infections of circulatory system, Oral cavity and respiratory infection, gastrointestinal infection.

Module II **14 hours**

A) **Nosocomial infection:** Incidence of nosocomial infections, types of nosocomical infections, emergence of antibiotic resistant microorganisms, hospital infection control programmes, preventing nosomical infections and surveillance, General concepts for specimen collection and handing of specimen, specimen processing and biosafety.

B) Chemotherapeutic agents-antibiotics (Classification based on chemical structure, mode of action and range of effectiveness). Recent trends-Drug resistance and its consequences, antibiotic policy, NCCLS (CLSI) guidelines and standards, WHO guidelines.

C) G protein signaling-Establishment, spreading, tissue damage and anti-phagocytic factors; Evasion of host defense, non-specific host defense, toxigenesis-bacterial toxins and its types, Significance of quorum sensing in Gram positive and Gram negative.

Module III **12 hours**

A) Epidemiology, Pathogenesis, Spectrum of disease, Laboratory diagnosis and Prevention**:** Diseases caused by Viruses: Chicken pox, Rabies virus, hepatitis, encephalitis, AIDS, Herpes simplex infections, Influenza, Dengue

B) Diseases caused by Bacteria: Tuberculosis, Leprosy, cholera, Typhoid, Botulism, Shigellosis, Helicobacter pylori infection, Salmonellosis, Tetanus. Diseases caused by Fungi: Candidiasis, Histoplasmosis, Blastomycosis, Coccidiomycosis, Dermatomycosis, Aspergillosis and Cryptococcosis, Anthrax

Module IV **12 hours**

a. Diseases caused by Mycoplasma: *Mycoplasma pneumoniae, M. urealyticum, M.homonis*.

b. Diseases caused by Protozoa: Giardiasis, Trichomoniasis, Celebral Malaria, Toxoplasmosis, Cryptosporidium.

c. Disease caused by Chlamydiae: Psittacosis, Lymphogranuloma Venereum, Trachoma and Inclusion conjunctivitis.

d. Emergent Diseases: Hemorrhagic fever, Swine flu, SARS, Chikun gunya, Ebola, Hanta, Leptospoirosis, Marburg virus disease

Learning Outcomes: After studying this paper the students will know –

1. Expertise in diagnosing different diseases caused by microbes using different techniques
2. Understanding noscomial infectious diseases

REFERENCES:

1. Bauman, RW. 2011. Microbiology with Diseases by Body System (3rd
2. Cowan, K. 2012. Microbiology Fundamentals: A Clinical Approach; McGraw- Hill Science/Engineering/Math
3. Geo, BF., Karen, CC., Janet, BS. 2012. JawetzMelnick & Adelbergs Medical Microbiology ; McGraw-Hill Medical Publishing Division
4. Inglis, TJJ. 2013. Clinical Microbiology and Infectious Diseases; Point of Care Publications
5. Jawetz. 2010. Medical Microbiology, 25th Edition; Tata McGraw - Hill Education Edition);Benjamin Cummings
6. Mahon, CR., Lehman, DC., Manuselis, GJR. 2010. Textbook of Diagnostic Microbiology ; Saunders
7. Murray, PR., Ken,S., Michael, RA., Pfaller MD. 2012. Medical Microbiology; Saunders
8. Paniker, A. 2009.Textbook of Microbiology , 8th Edition; University Press
9. Ryan, KC., Ray,G., Ahmad, N., Lawrence, WD., Lagunoff,M., Pottinger,PL., Reller, BCR., Sterling. 2014. Sherris Medical Microbiology, Sixth Edition; McGraw-Hill Medical
10. Tille, P. 2013. Bailey & Scott's Diagnostic Microbiology; Mosby Marjorie

Semester III: FCHC

IMMUNOLOGY (FCHC)

Total Credits: 04…..Total Marks: Theory 80+20 (100M) ..... Total Hours:48 hours

Learning Objectives: Students should study this paper to know –

1. Role of immune system in maintaining health
2. Cellular and molecular basis of immune responses
3. How immune responses are triggered and regulated

Module-I **14 Hrs.**

a) **Over view and Types of immunity:**
Innate immunity: anatomic barriers, physiologic barriers, phagocytic barriers, microbial antagonism, acute phase reactants, anti-microbial peptides, interferons, inflammation, Pattern Recognition Receptors (PRRs), Pathogen Associated Molecular Patterns (PAMPs) and Damage Associated Molecular Patterns (PAMPs). Complement system: components, pathways of activation and biological consequences.

Acquired immunity: Active **(**Naturally acquired and artificially acquired), Passive (Naturally acquired and artificially acquired), Adoptive immunity, Humoral and Cell mediated immune response

b) **Tissues of immune system:** Structural organization and functions of Lymphatic system, Primary lymphoid organs (Bone marrow, Thymus) Secondary lymphoid organs and tissues (Spleen, Lymph node, Tonsils, Adenoids, Peyer's patches, Lamina propria, Mucosa-associated lymphoid tissue, Gut-associated lymphoid tissue).
c) **Cells of the immune system:** Hematopoiesis, Biology, Development and Functions of PMNLs, NK cells, Macrophages, T-Lymphocytes, B-Lymphocytes, Dendritic cells

Module-II **12 Hrs**

a) **Antigens, and Antibodies:** Antigens, Immunogens and Haptens, Factors influencing immunogenicity, adjuvants, epitopes, Structure and functions of immunoglobulins, Synthesis of immunoglobulins, Genetic basis of immunoglobulin diversity.
b) **MHC molecules:** Types, structure, diversity and functions
c) **Antigen recognition:** Thymus dependent and independent Antigens, Clonal selection and immunological memory of B and T cells, Antigen processing and presentation (Endogenous pathway, Exogenous pathway, Cross presentation), Superantigens.
d) **Monoclonal Antibodies:** Hybridoma technology and production of mAbs, types, and applications. Advantages and disadvantages of mAbs in therapy.

Module-III **12 Hrs**

a) **Immune System in Health and Disease:** Immunological Tolerance and Autoimmunity, Autoimmune Diseases (Organ specific autoimmune diseases-Graves' disease, Myasthenia Gravis, Systemic autoimmune diseases-Multiple Sclerosis, Rheumatoid Arthritis, Systemic Lupus Erythematosus), Immunosuppression, Hypersensitivity (Type I, II, III & IV).

b) **Vaccines and Vaccination:** Principles of vaccination, Immune response to vaccines (Primary and Secondary response), Whole-Organism vaccines, Purified macromolecules as vaccines, Recombinant vaccines, DNA vaccines, Multivalent subunit vaccines and Edible vaccines, Vaccine safety, Reverse vaccinology. Overview of COVID-19 vaccines.

c) **Primary & Secondary Immuno-Deficiency Disorders:**

Primary: Wiscott-Aldrich syndrome, Severe combined immunodeficiency disease (SCID), DiGeorge syndrome, Ataxia-telangectasia, Leucocyte adhesion defects, Chronic granulomatous disease, X-linked agammaglobulinemia, Complement deficiencies. Gammopathies (Multiple myeloma).

Secondary: AIDS, Malnutrition, Drug regimen, Diabetes, Chronic infection.

Module-IV **10 Hrs.**

a) **Clinical Immunology**: **Transplantation of tissues and organs:** Nomenclature of transplantations, Transplantation reactions, HvG and GvH. Exception from rejections, Major and minor blood groups, Blood transfusion, tissue typing, Kidney and bone marrow transplantations. Immunosuppressive drugs. **Tumor immunology**: Neoplasms, tumor-associated antigens, immune response to tumor antigens, immunologic factors favoring tumor growth, immune surveillance,Tumor necrosis factor α and β.Metastatic processes, Immunodiagnosis, Antitumour drugs, Immunotherapy.

b) **Immunological Techniques:**. *In vitro* antigen-antibody reactions, serotyping, agglutination, complement fixation, immunoprecipitation, Immunodiffusion, ELISA, RIA, IHC, Immunoelectrophoresis.

Learning Outcomes: After studying this paper the students will know –

a. Organs, tissues, cells and molecules of the immune system
b. The immunological methods used to detect the disease
c. How the knowledge of immunology can be transferred into clinical decision-making through case studies presented in class.

REFERENCES:

1. Abbas A.K., Lichtman A.H. and Pillai S. (2014). Cellular and Molecular Immunology (10th Edition). Online Access: Elsevier Health Sciences.
2. Abbas, AK., Andrew,H., Lichtman, H., Pillai, S. 2012.Basic Immunology: Functions and Disorders of the Immune System, ; Saunders
3. Abul, K.A., Andrew, H. L. and Shiv, P. 2019. Basic Immunology: Functions and Disorders of the Immune System. Elsevier India.

4. Ajoy, P. 2015. Textbook of Immunology: including Immunotechnology & Immunotherapy. Books & Allied Press.
5. Ashim, K. C. 2006. Immunology and Immunotechnology (1st ed.). Oxford University Press.
6. Berg J.M., Tymoczko J.L. and Stryer L. (2002). Biochemistry (5th Edition). International edition: WH Freeman & Company Limited
7. Brostoff, J., Seaddin, J. K., Male, D. and Roitt, I. M. 2002. Clinical Immunology. London: Gower Medical Pub.
8. Chapel,H., Haeney,M., Misbah,S., Snowden, N. 2014. Essentials of Clinical Immunology; Wiley-Blackwell
9. Coico, R. and Sunshine, G. 2015. Immunology – A Short Course (7th ed.). Wiley.
10. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M. (2011) Roitt's essential immunology: John Wiley & Sons.
11. Hawley,L., Clarke, B., Ziegler, RJ. 2013. Microbiology and Immunology; LWW
12. Madhavee Latha, P. 2012. A Textbook of Immunology. S. Chand Press.
13. Murphy, K., Travers, P., Walport, M. and Janeway, C. 2012. Janeway's Immunobiology. Taylor & Francis.
14. Nelson D.L., Lehninger A.L. and Cox M.M. (2008). Principles of Biochemistry (12th Edition). Macmillan.
15. Owen J.A., Punt J., Stranford S.A. and Jones P.P. (2013) Kuby immunology: WH Freeman New York.
16. Parham, P. 2005. The Immune System. New York: Garland Science.
17. Paul, W. E. 2012. Fundamental Immunology. Raven Press.
18. Peter,DJ., Seamus, MJ., Dennis, BR. 2011. Roitt's Essential Immunology; Wiley & Sons, Incorporated, John
19. Pinchuk, G. 2001. Schaum's Outline of Immunology; McGraw-Hill
20. Ramesh, S. R. 2016. Immunology. Mc Graw Hill Education India Pvt. Ltd.
21. Richard C. and Geoffrey S. (2003). Immunology: A short course (6th Edition). Willey Blackwell.
22. Voet D. and Voet J.G. (2010). Text book of Biochemistry (4thEdition). New York: J. Wiley & Sons.

Videos on Immunology: **www.imm.ox.ac.uk - from University of Oxford**

PRACTICAL III:

Total hours: 32
Total credits: 04

1. Purification of IgG.
2. Slide agglutination test/ Blood grouping.
3. Immunoprecipitation test- Ouchterlony double diffusion.
4. Purification of IgY.
5. Immunofluorescence for localization of an antigen.
6. ELISA for quantification of an antigen.
7. Western blotting and detection.
8. Complement fixation
9. Clinical laboratory visits

HARDCORE: FOOD MICROBIOLOGY

Total Credit: 04 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

1. Basis of food borne microbes
2. Nutritive value of foods/ Nutraceuticals
3. Food bore pathogen detection

Module I **12 hours**

A) Introduction to food microbiology: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. Principles of food preservation-Chemical preservatives and Food additives Asepsis-Removal of microorganisms.

B) Contamination and food spoilage: fruits/ Vegetables, meat and meat products, Fish and sea foods spoilage of canned foods

Module II **12 hours**

A) Dairy Microbiology: Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Cream and butter bacteriology.

B) Probiotics: definition, types, properties, microbial group. Prebiotics: synbiotics and neutraceuticals, Taxonomy of Lactobacilli and Bifidobacteria, The Microecology of Lactobacilli in the Gastrointestinal Tract, Exopolysaccharide Production by Intestinal Lactobacilli

Module III **12 hours**

A) Food poisoning and intoxication: Significance of food borne diseases, Staphylo Food poisoning and intoxication: Significance of food borne diseases, Staphylococcal, Gasteroenteritis and enterotoxins: Types and incidence, Prevention of Staphylococcal and other food poisoning syndromes, *Clostridium perfringens* food poisoning and Botulism, *Bacillus cereus* food poisoning, Food borne Listeriosis by *Listeria monocytogenes*, Food borne Gastroenteritis by *Salmonella* and *Shigella, Vibrio, Campylobacter* and *Yersinia*, fungal spoilage and Mycotoxins.

B) Food produced by Microbes: Microbial cells as food (single cell proteins) – mushroom cultivation. Bioconversions- production of alcohol-fermented beverages-beer and wine. Genetically modified foods. **Application of fungal pigments in food industry**

Module IV **12 hours**

A) Detection of food-borne microorganisms: Culture, Microscopic and Sampling methods.. Chemical: Thermostable nuclease *Limulus* Lysate for Endotoxins, Nucleic Acid (DNA) probes, DNA Amplification (PCR), Adenosine- Triphosphate Measurement, Radiometry, Fluoro-and Chromogenic substrates. Immunologic Methods: Fluorescent Antibody, Enrichment Serology, Salmonella 1-2. Test, Radioimmunoassay, ELISA.

B) Microbial indicators of food safety and quality control: Principles of quality control and microbiological criteria, Indicators of product quality and microbiological safety of foods, Food safety laws and standards, international – HACCP, ISO 9000 Series, GMP and LP, India – PFAA, FSSAI, FPO, MPO, CSO, the Agmark Standards, bureau of Indian Standard (BIS). Food testing laboratories in India SRI, FRAC.

Learning Outcomes: After studying this paper the students will know –

1. Expertise in detecting food poisoning
2. Interaction of microbes with different food commoditiy

REFERENCES:

1. Adams, M R and Moss MO. 2007. Food Microbiology 3rd Edition. Royal Society of Chemistry. UK.
2. Ahmed, EY and Carlstrom, C. 2003. Food Microbiology: A Laboratory Manual, John Wiley and Sons, Inc. New Jeresy.
3. Blackburn, C. 2006. Food Spoilage Microorganisms. Woodhead Publishing.
4. Forsythe, SJ. 2010. The Microbiology of Safe Food, 2nd Edition. Wiley-Blackwell.
5. Fratamico, PM., Bhunia,AK., Smith, JL. 2008. Foodborne Pathogens: Microbiology and Molecular Biology. Caister Academic Press.
6. Frazier, WC and Westhoff, C.D. 2008 Food Microbiology. Tata Mc Graw Hill Publishing Company Limited, New Delhi. Indian Edition.
7. James JM., Martin,LJ., David, GA. 2004.Modern Food Microbiology. 7th ed. Springer
8. John, PI and Ailsa, HD. 2009. Fungi and Food Spoilage 3rd Edition. Springer.
9. Liu, D. 2009. Molecular Detection of Foodborne Pathogens. CRC Press.
10. Marth,EH and Steele, J. 2001. Applied Dairy Microbiology, Second Edition. CRC Press.
11. Ray, B., and Bhunia, A. 2013. Fundamental Food Microbiology, Fifth Edition. CRC Press
12. Richard, M.L. (Ed.) 2007. Food Safety. Springer.
    a. [illegible]

SOFTCORE: **GENETICS (FCSC)**

Total Credit: 03 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

1. The basics of genetic transmission
2. Study on microbial genetic factors and mutation.
3. Study ongenetic basis of sex determination and transposable elements

Module- I **14 Hours**

History and developments of genetics. Principle of Genetic Transmission: Mendel's' Experiments, Symbols and terminology, Principle of dominance and segregation, Principle of independent assortment, Mendelian inheritance and probability (Multiplication and Addition rites). Extensions of Mendelian Principles:co-dominance, incomplete dominance, gene interactions, multiple alleles, lethal alleles, pleiotropy, penetrance and expressivity, polygenic inheritance, linkage and crossing over, sex linked inheritance, sex limited and influenced traits, genome imprinting, extra nuclear inheritance.

Module-II **12 Hours**

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination and Mapping. **Bacterial Genetics:** Bacterial Transformation- Types of transformation mechanisms found in prokaryotes, Bacterial Conjugation- properties of the F plasmid, F^+ x F^- mating, F' x F^- conjugation, Hfr conjugation. **Fungal Genetics:***Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora*. **Algal Genetics:** *Chlamydomonas* - unordered tetrad analysis - Recombination and Mapping.Floral meristems and floral development in *Arabidopsis,* ABC model.

Module- III **12 Hours**

Mutation and mutagenesis: Nature, type and effects of mutations. Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms and *Drosophila* . Site directed mutagenesis and its applications.

Recombination: Homologous and non-homologous recombination, Holliday model, site-specific recombination.

DNA Repair: Mechanism of genetic repair- direct repair, photoreactivation, excision repair, mismatch repair, post-replicative recombination repair, Repair of double-strand breaks, SOS repair.

Module- IV **10 Hours**

Sex Determination-Sex chromosomes, Chromosomal and genetic basis of sex determination. Sex determination in *C.elegans*,*Drosophila*, human and Plant(*Melandrium*). Dosage compensation-Genic balance, Gene dose, Molecular basis of dosage compensation in Drosophila and man.

Transposable elements- discovery in maize and bacteria, transposal elements in bacteria and bacteriophage, types and functions; Transposable elements in eukaryotes- Plants, *Drosophila* and Humans, mechanisms of transpositions.

Learning Outcomes: After studying this paper the students will know –

1. Mendel's Experiments and extra nuclear inheritance.
2. The fundamental of recombination and mapping
3. Importance of chromosomal sex determination and transposition mechanism

REFERENCES:

1. Alberts, B., Bray, D., Lewis, J , Raff, M., Roberts, K and Watson, JD. 1999 . Molecular biology of the cell. Publisher: Garland Publisherlishing, Inc., New York.
2. Alberts, B., Johnson, A., Lewis, J., Rafi, M., Roberts, K., Walter, P. 2008. Molecular biology of the cell, 5th ed., Garland science, Publisher: Taylor & Francis Group, LLC, 270 Madison Avenue, NewYork NY f 0016, USA.
3. Atherly, AG., Girton, JR., Donald, JR. 1999. The Science of Genetics. Publisher: Saunders College Publisherlishers, Fort Worth, Texas.
4. Berk, LHA., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology, 4th edn. Publisher: W.H. Freeman and Co. New York, USA.

5. Brooker. RJ. 2005. Genetics –analysis and principles. Publisher: Addison Wesley Longman Inc., California.
6. Brown, TA. 2000. Genetics a molecular approach. Publisher: Van Nostrand Reinhold (intn) Co., Ltd., London.
7. Buchanan, BB., Gruissem, W., Jones, RL. 2010. Biochemistry and Molecular Biology of Plants. ed. Publisher: ASPP Press.USA.
8. Fairbanks, DJ and Anderson, WR. 1999. Genetics the continuity of Life. Publisher: Brooks's/Cole Publisherlishing Company, California.
9. Griffith, AJF., Gelbart, WM., Muller, JH., Lewintin, RC. 1999. Modern Genetic Analysis. Publisher: W.H. Freeman and Co. New York.
10. Hartl, D. 1991. Basic Genetics. 2edn., Publisher: Jones and Barlett Publisherlishers Inc., Boston.
11. Kleinsmith, LJ and Kish, VM. 1995 .Principles of Cell and Molecular Biology 2nd edn. Publisher: Harper Collins College Publisherlishers, New York, USA.
12. Randhawa.SS. 2017. Textbook Of Genetics Ist Edition.Publisher :S Vikas and Company, Jalandhar.
13. Snustad, DP., Simmons, M.J., Jenkins, JR. 1997. Principles of Genetics. Publisher: Hohn Wiley & son's inc. New York.
14. Strickberger, MW. 2000. Evolution. 3rd Edn. Publisher: Jones & Bartlett Publisherlishers, Inc. 40 Tall PineDrive Sudbury, MA 01776, USA.
15. Tamarin, RH. 2009. Principles of Genetics. Seventh Edition Publisher:Tata-McGraw Hill, New Delhi.
16. Watson, JD., Baker, TA., Bell SP., Gann A., Levine M., Losick R. 2004. Molecular Biology of the Gene. 5th Edition. Publisher:Pearson Education Pte. Ltd., New Delhi, India.
17. Winchester, AM. 1969. Genetics. 3rd edn. Publisher: Oxford and IBH, New Delhi.

1. Video links

- https://www.youtube.com/watch?v=L42IwtPC7eM
- https://www.youtube.com/watch?v=3VrGkCm4sT4

- https://www.youtube.com/watch?v=l-9iUpFGbxE
- https://www.youtube.com/watch?v=pdEgBMXJdeg
- https://www.youtube.com/watch?v=VIS_4G3Ysyk
- https://www.youtube.com/watch?v=TfBnfxm0Xyc
- https://www.youtube.com/watch?v=he260FUU5_M
- https://www.youtube.com/watch?v=BlnUNmfGn7I
- https://www.youtube.com/watch?v=o4yJF90OR9M
- https://www.youtube.com/watch?v=_cJfsWYR42M

SOFTCORE: MYCOLOGY

Total Credit: 03 Total Hours: 48 hours

Learning Objectives: Students should study this paper to know –

1. Basis of fungal taxanomy
2. Fungal characteristics' and its economic importance

Module I 12 hours

A) Introduction: History and Development of Mycology, scope of mycology. Recent developments inMycology.

B) Fungal taxonomy: Taxonomic problems associated with variation in fungi, Classification of fungi(Alexopoulos and Mims).

Module II 12 hours

A) General characteristics of fungi and reproduction: Morphology and somatic structures: The thallus,organization, fungal cell, nuclear components, specialized somatic structures; Aggregation of hyphae, tissues, mycangia, General aspects of fungal nutrition and reproduction (Asexual, Sexual reproduction, Heterothalism and Parasexuality)

B) Growth in Fungi and hyphal tropism: Mechanism of apical growth,**Hyphal tropisms: Spore tropisms,Phototropisms, Sexual tropisms**

Module III 12 hours

A) **Human diseases:** Ringworm, athlete's foot, onychomycosis Infection. Animal Diseases: *Aspergillosis, Mucormycosis, candidiasis*

B) **Plant diseases:** Chytridiomycota, Zygomycota, Basidiomycota, Ascomycota,Deuteromycota, Oomycota,. Symbiotic fungi- Lichens.

Module IV 12 hours

A) Economic importance of fungi: Fungi as biocontrol agent, Economic importance of Fungi inAgriculture, Industry and medicine. Fungi as SCP, Fungi as parasites of human and plants. Role of fungi in bio deterioration of wood and paper. Mycorrhiza – ectomycorrhiza, endomycorrhiza, vesicular arbuscular mycorrhiza. Fungi as insect symbiont.

Learning Outcomes: After studying this paper the students will know –

1. Expertise in detecting fungal identification
2. Interaction of fungus with different commoditiy
3. Importance of fungi as proteins supplements

REFERENCES:

1. Alexopoulas, C.J., and Mims, C.W. 1979. Introductory Mycology (3rd ed.). Wiley Eastern, New Delhi.
2. Carlile, M.J., Sarah, C., Watkinson, G.W., and Gooday. 2007. The fungi. Academic Press. London, U. K
3. Deacon, J.W. 1997. Modern Mycology (3rd ed.). Blackwell Science Publishers, London.
4. Kavanagh, K. 2011. Fungi: Biology and Applications. John Wiley & Sons, Sussex, U.K.
5. Mehrotra, R.S., and Aneja, K.R. 1998. An Introduction to Mycology. New Age International Pvt. Ltd. New Delhi.
6. Mercedes, S.F., and Gerald, F.B. 2011. Biodiversity of Fungi: Inventory and Monitoring Methods. Academic Press
7. Moore, D., Robson, GD., Anthony, P.J., and Trinci. 2011. 21st Century Guidebook to Fungi, Cambridge University Press.
8. Odum, E.P. 1971. Fundamentals of Ecology (3rd ed.). Toppan Co. Ltd. Tokyo, Japan.

SOFTCORE*:* GENOMICS AND PROTEOMICS

Total Credit: 03 **Total Hours: 48 hours**

Module-I **10 hours**

A) Genome - Overview Of Genome; Sequence Of Genome Acqusition And Analysis - Homologies - Snps -Genetic Analysis, Linkage Mapping,

B) High Resolution Chromosome Mapping And Analysis - Physical Mapping, Yac, Hybrid Mapping, Strategies, Sequence Specific Tags (Sst), Sequence Tagged Sites(Sts), Ish, Fish, Rflp, Rapd.

Module-II **12 hours**

A) DNA Sequencing - Methods, Maxam And Gilbert Method, Ladder, Fluorescent, Shot Gun, Mass Spectrometry, Automation Sequencing – Find Gene Mutations, Implications of DNA – Sequencing And Sequencing Genomes.

B) Genome Data Bank, Metabolic Pathway Data - Construction And Screening Of cDNA, Libraries And Microarrays - Application Of DNA Arrays - PCR - Variations In PCR - Gene Disruptions – Sage And Sade Pharmacogenomics

Module- III **12 hours**

A) Protein Sequence Analysis - Introduction - Sequence Data Banks - Wbrf – Pir - Swissport - Databases, Data Mining - Algorithms Of Proteomics And Its Applications - Protein Expression

B) Profiling - Protein - Protein Interaction - Protein Modifications. Automation - Nucleic Acid Data Bank – EMBL Nucleotide Sequence Data Bank - Aids Virus Sequence Data Bank - RNA Data Bank.

Module-IV **14hours**

A) Tools For Data Bank - Pairwise Alignment - Needleman And Wusch Algorighm – Smith Waterman - Multiple Alignment - Clustral - Pras - Blast - Fast, Algorithms To Analyse Sequence Data - Pdb, Cambridge Structure Data Base (Lsd), 2d Electrophoresis, IEF, HPLC, Protein Digestion Technique, Mass Spectrometry, MALDI-TOF, Peptides, Mass Finger, Printing, Protein.

REFERENCES:

1. Akay, M. 2007. Genomics and Proteomics Engineering in Medicine and Biology. WileyPublications. UK.
2. Campbell, LJ., Heyer. 2003. Discovering genomics, proteomics and bioinformatics.Benjamin Cummings publications.
3. Dassanayake, R. S., Silva, YN., Gunawardene. 2011. Genomic and Proteomic Techniques: In PostGenomics Era. Narosa Book Distributors.
4. Ferenc, D., András, G., Dormán, G 2013. Chemical Genomics and Proteomics 2nd edition
5. Ganapathy, S and Nawin, M. 2012. Science of Proteomics: Historical Perspectives and Possible Role in Human Healthcare. Wiley Publications. UK

6. Jorde, L., Little, P., Mike,D., Shankar, S. 2014. Encyclopedia of Genetics, Genomics, Proteomics and Bioinformatics. Wiley Publication. UK
7. Nawin, M.2010. Applications of Proteomics I: Proteomics, Human Disease, and Medicine.Wiley publication. UK
8. Ruchi, S. 2014. Bioinformatics: genomics and proteomics. Vikas Publications.Newdelhi.
9. Saraswathy, N and Ramalingam, P. 2011. Concepts and Techniques in Genomics and Proteomics. Woodhead Publishing groups.
10. Suhai, S. 2002. Genomics and Proteomics. Springer publications.
11. Thangadurai, D and Sangeetha, J. 2015. Genomics and Proteomics Principles,Technologies, and Applications. Apple Academic Press.

PRACTICALS IIIB : (Immunology & Medical Microbiology & Food Microbiology)

Total Credit: 02
Total hours: 32

1. Purification of IgG.
2. Slide agglutination test/ Blood grouping.
3. Immunoprecipitation test- Ouchterlony double diffusion.
4. Purification of IgY.
5. Immunofluorescence for localization of an antigen.
6. ELISA for quantification of an antigen.
7. Western blotting and detection.
8. Complement fixation
9. Clinical laboratory visits
10. WIDAL Test,VDRL Test (RPR), HCG test (Agglutination inhibition test). CRP test, ASO Test (Anti streptolysin 'O' Test).
11. Detection and quantification of Aflatoxin B1.
12. Detection of food-borne bacteria by immunoassays.
13. Detection and enumeration of Microorganisms present in Utensils and canned food.
14. Enumeration of bacteria in raw and pasteurized milk by SPC method.
15. Determination of quality of a milk sample by MBRT.
16. Detection of number of bacteria in milk by breed-count method
17. Litmus milk test.
18. Microbiological examination of Ice-cream and Dairy products
19. Pathogenic fungi of the skin (Dermatophytes).
20. Microbial flora of mouth – teeth crevices, Microbial flora of saliva.
21. Microorganisms of respiratory tract-examination of sputum/ AFB acid – fast bacteria.
22. Estimation of bacteria in urine by calibrated loop direct streak method.
23. Antimicrobial assay – sensitivity test (MIC) for pathogenic bacteria.

PRACTICALS IIIB : (Genetics & Mycology**)**

Total Credit: 02
Total hours: 32

1. Replica plating technique for transfer of bacterial colonies.
2. Ultra-violet killing curve and determination of mutant types in *Saccharomyces cerevisiae.*
3. Induction of mutation
4. Isolation of streptomycin resistant strain of *E .coli* by gradient plate method.
5. Ames test
6. Study of special chromosomes- B chromosomes, and sex chromosomes.

7. Determination of chiasma frequency in onion.
8. To solve genetic problems on linkage, ordered and unordered tetrads
9. Study of Mutations in *Drosophila*
10. Study of Autosomal and sexlinked gene inheritance in *Drosophila*
11. Isolation of slime molds.
12. Isolation of aquatic fungi.
13. Isolation of soil fungi.
14. Isolation of fungi from air.
15. Isolation of fungi from cereals and cereal based products.
16. Study of the following representative genera: *Aspergillus, Penicillium, Fusarium, Neurospora, Saccharomyces, Erysiphae, Polyporus, Agaricus, Puccinia, Ustilago, Alternaria, Drechslera, Saprolegnia, Rhizopus, Trichoderma* and symbiotic fungi-Lichens.
17. Measurement of concentration of fungal conidia by Haemocytometer.
18. Measurement of fungal cells by Micrometer.

IV SEMESTER

SOFTCORE: AGRICULTURAL MICROBIOLOGY

Total Credit: 03 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

a. *This paper of microbiology and biochemistry of soil is designed with the objective to provide general introduction of soil and in depth information on soil microbial diversity and the role of microorganisms in biogeochemical cycling of elements like C,N,P and trace elements and soil fertility*

Module I **12 hours**

A) Introduction to Agricultural Microbiology:, Introduction to agricultural microbiology, concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution. Plant Pathology: Concept of disease, History of Plant Pathology, Significance of plant diseases, Symptoms and types of plant diseases, Koch rules

B) Transgenic Resistance: Gene-to-gene resistance (horizontal and vertical), functions of plant resistance genes, Resistance to viruses, fungi, bacteria and insects.

Module II **12 hours**

A) Parasitism and Disease Development Parasitism and pathogenecity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Pathogens Attack Plants – Mechanical forces, Microbial enzymes and toxins, Growth regulators. Effect on physiology of Host – Photosynthesis, Translocation and transpiration, Respiration, Permeability, Transcription and translation. Environment and Plant Disease– Effect of Temperature, Moisture, Wind, Light, Soil, pH and structure, Nutrition and Herbicides.

B) Defense Mechanisms of Plant: Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses. Microbe mediated strategies for abiotic stress management.

Module III **10 hours**

A)Plant Disease & their management: Tobacco Mosaic Disease, Sandal Spike Disease, Bacterial blight of Paddy, Citrus canker, Angular leaf spot of cotton, Late Blight of Potato, Downy Mildew of Bajra, Blast of paddy, Tikka disease of ground nut, Rust of coffee, Grain and Head smut of Sorghum. Powdery mildew of Cucurbits, Wilt of Tomato, and Root Knot of Mulberry. Bunchy top of Banana.

Module IV **14 hours**

A) Microbes and Plant interaction-Mycorrhizae-Biology and their applications, Biofertilizers - microbial inoculants. Production and application of *Rhizobium, Azospirillum, Azotobacter,* phosphor bacteria and

Cyanobacteria. PGPR's plant growth promoting *Rhizobacteria* and their uses.

B)Biological nitrogen fixation(BNF): Nitrification, denitrification; symbiotic nitrogen fixation (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum); Nitrogenase enzyme, nif genes and molecular mechanism of nitrogen fixation. Role of nodulin genes in nodule development and symbiosis. Genetic engineering of BNF

Learning Outcomes: After studying this paper the students will know –

- ***b.*** *The importance of physical, chemical and biological properties of soil.*
- ***c.*** *Role of microorganisms in biogeochemical cycling.*
- ***d.*** *Microbiology and physiology of degradation of native and organic matter and Nitrogen fixation.*
- ***e.*** *The mechanism of plant growth promotion. Production, application and use of microbes as biofertilizers*

REFERENCES:

1. Agrios, G.N. 2005 ,Plant pathology(5th ed.). Elsevier academic press, U.K.
2. Ainsworth, G.C. 1981. Introduction to the History of Plant Pathology(1st ed). Cambridge university press, U.K.
3. Bagyaraj, D.G. and Rangaswami. G. 2005. Agricultural Microbiology(2nd ed.) Prentice-Hall of India. New Delhi.
4. Hull, R. 2013.Plant virology1st ed.). Elsevier academic press. U.K.
5. Kannaiyan, S. 2002. Biotechnology of Biofertilizers (1st ed.).Alpha science international
6. Mehrotra. R.S. and Aggarwal , A. 2002. Plant pathology (2nd ed.). Tata MC Graw-Hill publishers, Delhi.
7. Oerke, E.C. Dehne, H.C., Schönbeck, F., and Weber, A. 1999. Crop Production and Crop Protection(5th ed.) Elsevier academic press, U.K.
8. Prell, H.H., Day,P.R. 2001. Plant-Fungal Pathogen Interaction: A Classical and Molecular View(1st ed). Springer-Verlag Berlin Heidelberg, Germany.
9. Rajvaidya, N and Markandey, D.K. 2006. Agricultural Applications of Microbiology(2nd ed). Nangia S.B. and A.P.H. publishing corporation, New Delhi.
10. Vidhyasekaran, P. 2007. Fungal Pathogenesis in Plants and Crops: Molecular Biology and Host Defense Mechanisms(2nd ed) APS press, U.S.A.

SOFTCORE: INDUSTRIAL MICROBIOLOGY

Total Credit: 03 **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know –

a. *Industrial microbiology & fermentation contains improved biochemical or physiological fermentation are mainly carried out by fungi and bacteria on large scale to produce commercial products.*
b. *The main objective of industrial fermentation is to produce highest quality and quantity of particles produce by combining.*

Module I **12 hours**

A) Introduction: Fermenter design and types of fermenters, achievement and maintenance of aseptic conditions, Types of fermentation processes (Surface, submerged, Batch, Continuous, solid-substrate, Dual, Fed batch fermentation and its applications),

B) Industrial Microorganisms: Screening, Isolation. Identification and characterization o**f** industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centres**.**

Module II 12 **hours**

A) Media for Industrial Fermentations: Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents and others, Sterilization: Sterilization of bioreactor, media, air and exhaust air and filter sterilization

B) Downstream processing and fermentation economics: Steps in recovery and purification Methods of cell separation – filtration and centrifugation, cell disruption, liquid liquid extraction, chromatography, membrane processes. Fermentation economics- expenses for industrial organisms, strain improvement, media sterilization, heating, cooling, aeration and agitation. Cost of Plant and equipments, batch process cycle time, continuous culture, recovery and effluent treatment, cast recovery due to waste usages and recycling.

Module III 12 **hours**

A) Industrial production of energy fuels: Industrial alcohol production: Biosynthesis, methods of production, recovery and applications of ethanol, acetone – butanol and glycerol through microbial process.

B) Industrial production of Organic acids and Enzymes: biosynthesis, media, production process, product recovery and application of citric acid and lactic acid, Enzymes: Fungal and Bacterial Amylase; Bacterial proteases.

Module IV **12 hours**

A) Industrial production of food additives: amino acid production, methods of production, product recovery of L-Glutamic acid and L-lysine (scaling downstream technique). Commercial uses of Amino acids Vitamins: Commercial production of Vitamin B12, and Riboflavin. Alcoholic beverages (Beer, Wine)

B) Industrial production of health care product: Penicillin and Streptomycin: Biosynthesis, production and recovery.

C) I P R: Patent Laws: Patent regulations of processes, products and microorganisms.

Learning Outcomes: After studying this paper the students will know –

a. Microbes involved in fermentation.
b. The basics of fermentation technology.
c. design of fermenter, media and the process of fermentation. Optimization of fermentation process.
d. Use of microbes for production of important industrial products.
e. The basic knowledge of intellectual property rights specially patents.

REFERENCES:

1. Anuradha, N.M. 2007. Industrial Microbiology A Laboratory Manual(1st ed). I.K. International Publishing House. New Delhi.
2. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology(3rd ed.). Taylor and Francis, New York.
3. Bonnett , R. 2010 Wine Microbiology and Biotechnology(2nd ed.). CRC press
4. Casida, L.E. 1997. Industrial Microbiology(2nd ed.). New Age International Publishers.
5. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology(3rd ed.). Panima Publishing corporation.
6. Davies , J.E. and Demain, A.L. 2009. Manual of Industrial Microbiology and Biotechnology(2nd ed). ASM Publisher
7. Demain, A. L. 2001. Industrial Microbiology and Biotechnology(2nd Ed.) ASM Press, Washington.
8. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology (2nd Edition). ASM Press, Washington.

9. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology(2nd ed.). Taylor and Francis Group.
10. Horton, H.R., Moran, L. A., Scrimgeour, K.G., Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry(4th ed). Pearson Education International, London.
11. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms(2nd ed.) I.K. International Publishing House. New Delhi.
12. Mansi, E., Mansi, C. F. A and Bryce. 2007. Fermentation microbiology and biotechnology(2nd ed). CRC Press.
13. Okafor, N. 2010. Modern Industrial Microbiology and Biotechnology (2nd ed.).ASM Publisher.
14. Patel, A. H. 1999. Industrial Microbiology(2nd ed.). Mc Millan India Limited, India.
15. Patel, A. H. 2008. Industrial Microbiology (2nd ed). PB Books Publisher , New Delhi.
16. Peppler, H.J. and Perlman, D. 1979. Microbial Technology. (1st ed.). Academic Press, New York.
17. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology (2nd ed.). Elsevier India Private Limited.
18. Puri, R.S. and Viswanathan, A. 2009. Practical Approach to Intellectual Property Rights. (2nd ed). I.K. International Publishing House. New Delhi.
19. Reed, G. 1999. Prescott and Dunn's Industrial Microbiology((2nd ed.) CBS Publishers and Distributors.
20. Waites ,M.J., Morgan , N.L., Rockey , J.S. and Higton, G. 2009. Industrial Microbiology(2nd ed). I.K. International Publishing House. New Delhi.

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School of Life Sciences

M.Sc. EXAMINATION
(Scheme: CBCS)
MICROBIOLOGY

Time: 3 hours **Max. Marks: 70**

I. Answer ALL TEN of the following(MCQ) **10X1=10**

1. ..
2. ..
3. ..
4. ..
5. ..
6. ..
7. ..
8. ..
9. ..
10. ..

II. Answer any SIX of the following **6 X 5=30**

11. ..
12. ..
13. ..
14. ..
15. ..
16. ..
17. ..
18. …

III. Answer any THREE of the following **3X10=30**

19. …
20. …
21. …
22. …
23. ….

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Affiliated to University of Mysore

School of Life Sciences
Question Paper Pattern (Practical) for M.Sc. Microbiology
Course/Paper: ……

Course/Paper Code……

Time: 3 Hours **Max Marks: 70**

Q I. Conducting Experiment/Micro-preparation /Plant identification	15
Q II. Minor experiment/ Demonstrations/ Procedure Writing	10
Q III. Critically comments /Identification	25
Q IV.Viva-voce examination	10
Q V.Class Records/ Submissions.	10