Dept. of Microbiology RVR

New CBCS.

HCT 5 units
SCT 17 Questio
OE - 3 units
12 questio

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DEPARTMENT OF MICROBIOLOGY
M.Sc. DEGREE (SEMESTER) COURSE UNDER CBCS SCHEME
SCHEME OF TEACHING AND EXAMINATION
(Effective from the academic year 2023-24 and onwards)

PAPER	Teaching Hours/week	Examination Hours	Marks	IA	Credits
I SEMESTER:					
1.1 HC Fundamentals of Microbiology	4	3	75	25	4
1.2 HC Cell Biology and Biochemistry	4	3	75	25	4
1.3 HC Bacteriology	4	3	75	25	4
1.4 SC Virology and Mycology	4	3	75	25	4
1.5 Practical Based on paper 1.1	4	3	35	15	2
1.6 Practical Based on paper 1.2	4	3	35	15	2
1.7 Practical Based on paper 1.3	4	3	35	15	2
1.8 Practical Based on paper 1.4	4	3	35	15	2
II SEMESTER:					
2.1 HC Microbial Physiology and Metabolism	4	3	75	25	4
2.2 HC Microbial Genetics and Molecular Biology	4	3	75	25	4
2.3 SCT Environmental Microbiology (A)	4	3	75	25	4
2.3 SCT Biophysics, Biostatistics and Bioinformatics (B)	4	3	75	25	4
2.4 OE Microbes in Human Welfare	2	2	35	15	2
2.5 Practical Based on paper 2.1	4	3	35	15	2
2.6 Practical Based on paper 2.2	4	3	35	15	2
2.7 Practical Based on paper 2.3 (A)	4	3	35	15	2
2.8 Practical Based on paper 2.3 (B)	4	3	35	15	2
III SEMESTER:					
3.1 HC Recombinant DNA Technology	4	3	75	25	4
3.2 HC Immunology and Immunotechnology	4	3	75	25	4
3.3 SCT Food and Dairy Microbiology (A)	4	3	75	25	4
3.3 SCT Microbial Enzymology (B)	4	3	75	25	4
3.4 OE Microbes and Environment	2	2	35	15	2
3.5 Practical Based on paper 3.1	4	3	35	15	2
3.6 Practical Based on paper 3.2	4	3	35	15	2
3.7 Practical Based on paper 3.3 (A)	4	3	35	15	2
3.8 Practical Based on paper 3.3 (B)	4	3	35	15	2
IV SEMESTER:					
4.1 HC Fermentation Technology and Bioprocess Engineering	4	3	75	25	4
4.2 HC Medical Microbiology and Diagnostics	4	3	75	25	4
4.3 HC Industrial Internship/Project – Dissertation	4	3	75	25	4
4.4 SC Agricultural Microbiology	4	3	75	25	4
4.5 Practical Based on paper 4.1	4	3	35	35	2
4.6 Practical Based on paper 4.2	4	3	35	35	2
4.7 Project colloquium and Viva	4	3	35	35	2
4.8 Practical Based on paper 4.4	4	3	35	35	2
TOTAL MARKS (I TO IV SEMESTERS)					

HC – Hard core, SC – Soft core, OE – Open Elective

(Gulappagouda R)

Department: **Microbiology** Course: **M.Sc Microbiology**

Paper Code	Paper and Title	Credits	No of Hours/ week Theory/ Practical	Duration of Exam (SEE)	Marks		Total
					Internal 25	SEE 75	
HCT 1.1	Fundamentals of Microbiology	4	4	3	25	75	100
HCT 1.2	Cell Biology and Biochemistry	4	4	3	25	75	100
HCT 1.3	Bacteriology	4	4	3	25	75	100
SCT 1.4	Virology and Mycology	4	4	3	25	75	100
	Practical Based on paper 1.1	2	4	3	15	35	50
	Practical Based on paper 1.2	2	4	3	15	35	50
	Practical Based on paper 1.3	2	4	3	15	35	50
	Practical Based on paper 1.4	2	4	3	15	35	50
MICHCT21	Microbial Physiology and Metabolism	4	4	3	25	75	100
MICHCT32	Microbial Genetics and Molecular Biology	4	4	3	25	75	100
MICSCT21	Environmental Microbiology (A)	4	4	3	25	75	100
	Biophysics, Biostatistics and Bioinformatics (B)	4	4	3	25	75	100
MICOET21	Microbes in Human Welfare	2	2	2	15	35	50
	Practical Based on paper 2.1	2	4	3	15	35	50
	Practical Based on paper 2.2	2	4	3	15	35	50
	Practical Based on paper 2.3	2	4	3	15	35	50
MICHCT31	Recombinant DNA Technology	4	4	3	25	75	100
MICHCT32	Immunology and Immuno-technology	4	4	3	25	75	100
MICSCT33	Food and Dairy Microbiology (A)	4	4	3	25	75	100
	Microbial Enzymology (B)	4	4	3	25	75	100
MICOET31	Microbes and Environment	2	2	2	15	35	50
	Practical Based on paper 3.1	2	4	3	15	35	50
	Practical Based on paper 3.2	2	4	3	15	35	50
	Practical Based on paper 3.3	2	4	3	15	35	50
MICHCT4.1	Fermentation Technology and Bioprocess Engineering	4	4	3	25	75	100
MICHCT4.2	Medical Microbiology and Diagnostics	4	4	3	25	75	100
	Internship/Project – Dissertation	4	4	3	25	75	100
MICSCT4.1	Agricultural Microbiology	4	4	3	25	75	100
	Practical Based on paper 4.1	2	4	3	15	35	50
	Practical Based on paper 4.2	2	4	3	15	35	50
	Project colloquium and Viva	2	4	3	15	35	50
	Practical Based on paper 4.4	2	4	3	15	35	50

Digital References/ Study material:

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https://onlinecourses.swayam2.ac.in/cec19_bt11/preview

Practical Based on paper 1.4 Virology and Mycology

1. Isolation of plant viruses from sap.
2. Isolation of lipolytic microbes from soil-plate method and estimation of total lipid
3. Isolation of slime molds, fungi from water, soil, air, cereals and cereal based products.
4. Staining of fungi (Lactophenol cotton blue).
5. Isolation of fungi from plant material: Epiphytic fungi, washing method, implant method, impression method, maceration method; endophytic fungi.
6. Growth measurement of fungi- linear and biomass.
7. Effect of environmental (pH, temperature) and nutritional factors (carbon, nitrogen sources) on growth of fungi.
8. Screening for antibiotic producing microbes (antibacterial, antifungal)
9. Study of fungal metabolites
10. Measurement of concentration of fungal conidia by Haemocytometer.
11. Measurement of fungal cells by Micrometer.
12. 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.

Paper-2.1 HC: Microbial Physiology and Metabolism

1.	Microbial Nutrition: Classification of organisms based on Carbon source, energy source and electron source, Macro and Micronutrients. Microbial growth: Phases of growth, factors influencing growth, Measurement of growth, Continuous and Synchronous growth.	**12 h**
2.	Microbial Photosynthesis: Light Energy, Photolysis of Water, Photosynthetic Pigments, Cyclic and Non-Cyclic Photophosphorylation, Calvin's Cycle. Biological Oxidation: Electron Transport System, Oxidative Phosphorylation, Mechanism and Inhibitors of oxidative phosphorylation. Energetics of Oxidative Phosphorylation.	**12 h**
3.	Fermentation Reactions: Types of fermentation reactions, Homo and Hetero-fermentation pathways; Alcohol and Lactic acid fermentation pathways. Bioenergetics: Laws of thermodynamics, Free energy, Enthalpy, Entropy, High energy compounds, Oxidations and Reductions, Redox potential. Carbohydrate metabolism: Glycolysis-significance, energetics and regulation. Glycogenesis, glycogenolysis, gluconeogenesis-Significance, regulations; TCA cycle-significance, energetics and regulations. Glyoxylate cycle. Amphibolic nature of TCA cycle. HMP shunt.	**12 h**
4.	Lipid Metabolism: Fatty acid oxidation (β-oxidation), energetics of palmitic acid oxidation. Ketone bodies, ketogenesis, utilization of ketone bodies, overproduction of ketone bodies (Ketonemia, ketonuria, ketosis), extra mitochondrial biosynthesis of long fatty acids (palmitate), significance and regulation. Synthesis of triacylglycerols, metabolism of phospholipids and glycolipids. Biosynthesis and degradation of cholesterol.	**12 h**

5.	Metabolism of amino acids: Transamination, deamination, decarboxylation; Urea cycle - regulation. Metabolism of ammonia; Synthesis and degradation of Glycine, phenylanine and Tyrosine, Synthesis and degradation of Sulfur containing amino acids. Nucleotide metabolism: Synthesis of IMP, AMP and GMP, Salvage pathway for purines, degradation of purine nucleotides. Biosynthesis and degradation of pyrimidine nucleotides.	**12 h**

After successful completion of this course students are expected to be able to:

CO-1: Gain a fundamental understanding of cellular composition, membrane transport, energy metabolism, and the ways microorganisms grow, proliferate, and die in a given environment.

CO-2: Understand the regulation of biochemical pathways and possible process modifications for improved control over microorganisms for microbial product synthesis.

CO-3: Understand the microbial physiology and know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement

Reference Books:

1. Lehninger, A. L. (2017). *Lehninger principles of biochemistry* (7th ed.). W.H. Freeman and Company.
2. Harper, H. A., & Rodwell, V. W. (2018). *Harper's illustrated biochemistry* (31st ed.). McGraw-Hill Education.
3. Powar, R., &Dhaginawala, A. (2019). *Biochemistry* (4th ed.). Himalaya Publishing House.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular biology of the cell* (6th ed.). Garland Science.
5. Moat, A. G., Foster, J. W., & Spector, M. P. (2016). *Microbial physiology* (5th ed.). Wiley-Blackwell.
6. Doelle, S. W., & van der Werf, M. J. (2013). *Microbial growth on C1 compounds* (1st ed.). Springer Science & Business Media.
7. Dewey, I. W., & Sutherland, J. W. (2018). *Microbial physiology* (2nd ed.). Academic Press.
8. Rose, A. H., & Tempest, D. W. (1970). *Advances in microbial physiology* (Vol. 4). Academic Press.
9. Voet, D., Voet, J.G., & Pratt C.W.(2022). *Fundamentals of Biochemistry: Life at the Molecular Level* (6th ed.). Wiley.
10. Caldwell DR.(1996). Microbial Physiology and Metabolism. Brown Publishers.
11. Oren A., PapkeR.T.(2010) Molecular Physiology of Microorganisms.Caister Academic Press.
12. Berg JM,Tymoczko JL,StryerL.(2021) Biochemistry(9th ed.).W.H.Freeman and Company.

Digital References/ Study material:

https://archive.nptel.ac.in/course.html
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https://onlinecourses.swayam2.ac.in/cec19_bt11/preview

Practical Based on paper 2.1 Microbial Physiology and Metabolism

1. Determination of growth curve and generation time.
2. Determination of optimum pH, temperature for growth of bacteria and fungi.
3. Lipid saponification value of fats, Iodine number of fatty acids.
4. Qualitative analysis of lipids.
5. Estimation of microbial enzymes – amylase, protease, invertase, cellulase, lipase, catalase and phosphatase.
6. Determination of K_m and V_{max}. and K_I
7. Extraction and separation of aflatoxin by paper chromatography.
8. Effect of pH, temperature, enzyme concentration, substrate concentration and inhibitors on enzyme activity.
9. Qualitative and quantitative estimation of carbohydrates.
10. Effect of different substrate (Primary, secondary &tertiary) on microbial growth
11. De-amination of Amino acids.
12. De-carboxylation of Amino acids.

Paper-2.2 HC: Microbial Genetics and Molecular Biology

1.	Historical Preview of Genetics: Development of microbial genetics, contributions of various scientists, time line of the development of microbial genetics Chemical basis of heredity; early concepts of genes; discovery of the chemical basis of heredity - experimental evidences, Mendelian principles and classical genetics, Genetic concepts, use of microorganisms in genetic studies Genomic structure and organization: Organization of genetic material - Genome organization in viruses, bacteria and eukaryotes. Interrupted genes, gene clusters. Structure of nucleosome, chromatin and chromosome.	**12 h**
2.	Genetic recombination: In bacteria; transformation, conjugation, competence, lysogeny, generalized and restricted transduction, sexduction, fine structure mapping, recombination in viruses Transposable elements: Replicative transposition, Non-replicative transposition, Excision and transposase-mediated rearrangements, Insertion sequences, transposons, and integrons. Regulation of transposition, Use of transposons. Chromosomal rearrangements, Transposons and evolution.	**12 h**
3.	Mutations: Types of mutations, null, leaky, and conditional mutations, mutations as random or adaptive events; Mutagenic agents – physical, chemical and biological; molecular basis of mutations; Mutants – isolation, selections, screening and enrichments, Uses of mutants. Reversion and suppression - Reversion assays –Ames Test. Structure of nucleic acids: Structure of DNA and its elucidation, structural polymorphism in DNA, extra-chromosomal DNA. Structure of RNA Systems that safeguard DNA: DNA repair mechanisms – photo reactivation, mismatch repair, recombination repair, SOS repair. Replication of DNA, evidence of semi-conservative replication. Mechanism and enzymology of DNA replication. Regulation of DNA replication. Replication of RNA.	**12 h**
4.	Transcription: Biosynthesis of RNA in prokaryotes and eukaryotes, DNA dependent RNA polymerase, initiation, elongation and termination of transcription. Post transcriptional processing - removal of intron transcripts, addition of 5' cap and 3 poly A tail, processing of mRNA, rRNA and tRNA. Reverse transcription. Genetic code and translation: Elucidation and salient features of genetic code, wobble concept, Involvement of ribosome in translation, ribosome structure, initiation, elongation and termination of polypeptide chain synthesis in prokaryotes and eukaryotes, extra ribosomal factors, post translation modifications of proteins, ribosome cycle.	**12 h**
5.	Regulation of gene expression: Enzyme induction and repression, constitutive expression and housekeeping genes, Operon concept, negative and positive regulation, catabolite repression, regulation of lac Operon, trp Operon, arabinose Operon, divergent Operon, attenuator regulation, translational regulation, feedback inhibition. Gene silencing: Transcriptional – genomic imprinting, paramutation, transposon silencing, histone modifications, position effect; Post transcriptional – RNA interference, RNA silencing.	**12 h**

After successful completion of this course students are expected to be able to:

CO-1: Understand the genetic, epigenetic, and genomic mechanisms governing microbial physiology in a changing environment.

CO-2: Explain the principles and concepts of prokaryotic and eukaryotic genetics, viral genetics, and their application in research.

CO-3: Explain mutagenesis, mutation, and mutants and their significance in microbial evolution

Reference Books

1. Hays, W. (2023). The genetics of bacteria and their viruses. CBS Publ. New Delhi.

2. Jenkins, J.B. (2022). Genetics. Houghton Mifflin Co., Boston.
3. Strickberger, M.W. (2023). Genetics. MacMillan Publ. Co. Inc. New York.
4. Stent, G.S., & Calendar, R. (2022). Molecular Genetics. Freeman & Co., San Francisco.
5. Lewin, B. (2023). Genes VIII. John Wiley & Sons, New York.
6. Watson, J.D., et al. (2022). Molecular biology of the Gene. Pearson Education India.
7. Hartwell, L.H., et al. (2023). Genetics – from Genes to Genomes. McGraw Hill Publ.
8. Miller, G., et al. (2022). An introduction to Genetic Analyses. Freeman & Co., NY.
9. Maloy, S.R., Cronan, J.E., &Freifelder, D.M. (2023). Microbial Genetics. Jones & Bartlett Series.
10. Streps, U.N., &Yasbin, R.E. (2022). Modern Microbial Genetics. Wiley Blackwell Publ.

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Practical Based on paper 2.2 Microbial Genetics and Molecular Biology

1. Isolation of Genomic DNA from *E. coli*.
2. Agarose gel electrophoresis for separation of Nucleic acids
3. Estimation of DNA, RNA and plasmids, and determination of purity and concentration of isolated DNA using spectrophotometer.
4. Separation of proteins by SDSPAGE, salt fractionation of Yeast protein and quantification, estimation of protein by Lowry's method, RFLP and RAPD analysis, and restriction digestion of DNA.
5. Isolation of plasmids from bacteria by agarose gel electrophoresis, digestion of the gene of interest with suitable restriction enzymes, and ligation of the digested gene in a vector.
6. Preparation of competent *E. coli* cells for Bacterial transformation, transformation of the vector into the host cell and selection of the desired clones, induction of gene expression and purification of the induced protein from the host, and amplification, purification and separation of PCR product.
7. Induction and study of physical and chemical mutagens in bacteria/fungi.
8. Study of mutagenic effect and Induction of mutation in yeast/bacteria by chemical/radiation method.
9. Plasmid curing in bacteria
10. Transformation and selection of transformants
11. Conjugation and gene mapping in *E.coli*
12. Isolation of bacteriophages and phage titration, and study of replica plating technique.

Paper-2.3 SCT (A): Environmental Microbiology

1.	Introduction: Origin, Concept and Development of Environmental Microbiology. Microbial Community: Ecosystem, habitat and niche. Concept and dynamics of microbial population and community. Structure and functions of microbial communities. Ecological succession. Microbial diversity: Diversity of microorganisms in different environments. Conventional and molecular methods of studying microbial diversity. Microbes in extreme environments. Extremophiles - Psychrophilic, thermophilic, acidophilic, alkalophilic, halophilic and barophilic. Mechanism of adaptation in extremophilic microorganism.	**12 h**

2.	Water Pollution: Sources, Characteristics of water pollutants, health hazards due to water pollution. Standard water quality criteria, Water quality testing (MPN technique). Eutrophication - causes, consequences and prevention. Waste water treatment: Primary-physical processes; Secondary-biological treatment by fixed biofilm systems (trickling filters, RBC, fluidized bed reactors), suspended systems (activated sludge process, oxidation lagoons, anaerobic digesters, septic tank); Tertiary- Filtration (sand beds & membrane filters) chlorination, ozonization, radiation and reverse osmosis.	**12 h**
3.	Air pollution and Radiation hazards: Sources and characteristics of air pollutants; Health hazards due to air pollution; Green house gases and green house effect. Ozone hole and acid rain. Radiation hazards and safety measures – sources, effect of radiations and safety measures. Soil pollution: Sources and characteristics of soil pollutants. Effects of soil pollution on human health and crop productivity.	**12 h**
4.	Solid waste management: Handling and treatment of solid wastes. Sludge handling and disposal- sludge processing, screening, dewatering, thickening, conditioning; stabilization-aerobic and anaerobic digestion (biomethanogenesis). Handling of biohazard and hospital wastes. Biodegradation of xenobiotics: Microbial degradation of pesticides, polycyclic aromatic hydrocarbons, natural and synthetic polymers (cellulose, pectin, lignin, detergents, plastics).	**12 h**
5.	Microbiological indicators: Concept and significance. Microbiological indicators of water and air pollution. Microbial remediation: Concept and scope of bioremediation. Methods and types of bioremediation of contaminated soil and water using microorganisms. Microbial leaching: Origin and concept. Mechanism and role of microorganisms in recovery of important minerals - Iron, Copper and Gold.	**12 h**

After successful completion of this course students are expected to be able to:

CO-1: Understand the general biology of microorganisms and the general concept of microbial ecology.

CO-2: Understand the role of microorganisms as agents of environmental change.

CO-3: Understand microbial processes aimed at solving environmental problems

Reference Books:

1. Brock, T.D. (1987). *Principles of microbial ecology* (2nd ed.). Prentice Hall Publ. Co.
2. Alexander, M. (2007). *Microbial Ecology* (2nd ed.). John Willey & Sons.
3. Atlas, R.M., & Bartha, R. (2018). *Microbial ecology: Fundamentals and applications* (5th ed.). Benjamin/Cummings.
4. Bitton, G. (2011). *Wastewater Microbiology* (4th ed.). John Willey & Sons.
5. Mitchell, R. (2010). *Environmental Microbiology* (2nd ed.). John Willey & Sons.
6. Hurst, C.J., Crawford, R.L., Knudsen, G.R., McInerney, M.J., Stetzenbach, L.D., & Walter, M.V. (Eds.). (2019). *Manual of Environmental Microbiology* (5th ed.). ASM Press.
7. Fletcher, M., & Gray, T.R.G. (Eds.). (1988). *Ecology of microbial communities*. Cambridge University Press.
8. Rose, R.D. (1991). *Air Pollution & Industry*. Reinhold Co.
9. Tchobanoglous, G., Burton, F.L., &Stensel, H.D. (2003). *Wastewater Engineering: Treatment and Reuse* (4th ed.). McGraw Hill Int. Publ.
10. APHA, AWWA, WEF. (1998). *Standard Methods for the Examination of Water and Wastewater* (20th ed.). American Public Health Association

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Practical Based on paper 2.3 Environmental Microbiology (A)

1. Detection of coli forms for determination of purity of potable water samples MPN method
2. Isolation of Bacteriophages from sewage water samples
3. Study of micro flora of industrial waste and effluents
4. Determination of DO, DOC, CO_2, BOD, COD and TDS of water samples (RO water, Tap water, Pond water and Sewage waste water)
5. Isolation of Xenobiotic degrading bacteria by selective enrichment technique
6. Study on Biogenic methane production
7. Estimation of phosphate, sulphates, nitrates and major cations (Na, K, Mg, and Ca) in water samples
8. Effect of industrial effluents/ heavy metals on seed germination and seedling growth
9. Sampling and quantification of airborne endotoxins by Limulus Amoebocyte Assay.
10. Field excursion to an industrial area to assess environmental impact
11. Isolation and determination of Iron and Manganese reducing bacteria
12. Selective enrichment of auxotrophic and antibiotic (Tet^R, Ref^R) mutants (Isolation of antibiotic resistant microbes from Hospital waste)

SCT2.3 (B) BIOPHYSICS, BIOSTATISTICS AND BIOINFORMATICS	
Course Credits: 4	**Total No. of Hours: 60** **No. of Teaching Hours per Week: 4 Hrs**

Unit 1- Introduction to Biophysics **10 Hrs**

Chemical buildings blocks; structure of atoms, bonds within molecules – ionic, covalent, hydrogen, electrostatic, disulphide and peptide bonds, vander Waals forces, bond length, bond energies, bond angles; isomerism - structural, geometrical, optical isomerism; secondary bonding; weak interactions.

Unit 2Proteins: **10 Hrs**

Molecular organization of proteins – primary, secondary, tertiary and quaternary structures; principles of ionization; predicting properties from amino acid composition; unusual amino acids, stabilizing forces, conformational properties of polypeptides, Ramchandran plot, domains and motifs; structure-function relationship; study of three dimensional structures of proteins – cytochromes, lysozyme, trypsin, immunoglobulins

Unit 3- a) Nucleic acids: **14 Hrs**

Purine and pyrimidine bases, nucleosides and nucleotides, conformational parameters of nucleic acids and their constituents, nucleic acid geometrics, base pairing, base stacking, Chargaff's rule, DNA polymorphism, DNA supercoiling; hyperchromicity; modified nucleotides, tertiary structure of nucleic acids.

b) Membranes:

Lipid structure and their organization, phase titration in lipids, polysaccharides, molecular shapes and conformation; comparision of different membrane models.

c) Methods in biophysical analysis:

Spectorscopy – UV, IR, fluroscence, Raman spectroscopy; CD, ORD, EM, NMR, X-ray diffraction.

Unit 4- Introduction to Biostatistics: **12 Hrs**

Measures of central tendency (Mean, median and mode), Measure of dispersion (range,

standard deviation, standard error mean), confidence limits, simple significance tests based on the normal distribution; use of Student's t-test, regression analysis, ANOVA, multiple regression, LSD, Chi-square test, statistical basis of biological assays direct and indirect assays, probit, logit, LD_{50}, ED_{50}, slope ratio assay; use of calculators and computer programs for statistical analysis.

Unit 5-Introduction to Bioinformatics: **14 Hrs**

Data base types – nucleotide databases, protein data bases, NCBI, DDBJ, EMBO, OMIM, genomics and the genome projects, finding and retrieving sequences, similarity searching (BLAST), sequence allignments: pairwise and multiple allignments and comparision; Molecular phylogenetics – molecular clock hypothesis, concept of phylogenetic tree, types of trees, elementary idea of clustering and cladistic methods

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Understand the constituents and working of a cell as a whole

CO-2 Enumerate the various cell organelles with their function and the differences in cellular organization of various life forms

CO-3 Describe various types of cell multiplications and divisions and differences between them

CO-4 Retrieve information from available databases and use them for microbial identifications and drug designing.

CO-5 Understand the techniques and underlying theory of UV- Visible, IR, NMR and Raman, AAS, XRD and mass spectroscopy

CO-6 Understand the basic knowledge of statistics and tools used for several quantitative analysis in microbiology

Reference:

1. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: life at the molecular level (5th ed.). Wiley.
2. Upadhyay, S. K., & Upadhyay, S. K. (2017). Biophysical chemistry (2nd ed.). Himalaya Publishing House.
3. Karp, G. (2019). Cell and molecular biology: concepts and experiments (8th ed.). Wiley.
4. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W., & Weil, P. A. (2018). Harper's illustrated biochemistry (31st ed.). McGraw-Hill Education.
5. Nelson, D. L., Cox, M. M., & Lehninger, A. L. (2017). Lehninger principles of biochemistry (7th ed.). W.H.Freeman.
6. Chang, R., & Goldsby, K. A. (2014). Chemistry (12th ed.). McGraw-Hill Education.
7. Branden, C., & Tooze, J. (1999). Introduction to protein structure (2nd ed.). Garland Science.
8. Adams, R. L., & Nicholson, H. B. (1993). Biochemistry of nucleic acids (2nd ed.). Chapman and Hall.
9. Rhodes, G., & Guss, J.M.(2001). Crystallography made crystal clear: a guide for users of macromolecular models (2nd ed.). Academic Press.
10. Lacroix-Zephir, Z., & Critchlow, T.(2003). Bioinformatics: managing scientific data (1st ed.). Morgan Kaufmann Publishers.
11. Wardlaw, A.C.(1985). Practical statistics for experimental biologists(2nd ed.). John Wiley and Sons.
12. Higgins,D.G., & Taylor,W.R.(2000). Bioinformatics: sequence alignment and Markov models(1st ed.). Oxford University Press.
13. Rastogi,V.B.(2015). Essentials of biostatistics(2nd ed.). New Age International Publishers

Practical Based on paper 2.3 Biophysics, Biostatistics and Bioinformatics (B)

Biophysics

1. Determination of Melting temperature of DNA
2. Determination of Lambert's Beers Law
3. Determination of Maximum absorption of any two dyes
4. Determination of LD_{50}, ED_{50} and MIC

Biostatistics

1. Biostatistical problems solving using Barr and Pie diagram
2. Measures of central tendency and dispersion
3. Students' t test, Chi-square test, and Analysis of variances (ANOVA)

Bioinformatics

1. Introduction to Bioinformatics
2. NCBI, EMBO DDBJ and OMIM
3. Home page descriptions and list of soft-wares of Nucleotide databases
4. Designing of oligonucleotides
5. Sequence similarity searching using BLAST analysis
6. Sequence comparison using Multiple sequence alignment
7. Construction of Phylogenetic tree methods
8. Prediction of gene in an DNA sequence using gene prediction algorithm
9. Study of Protein sequence databases
10. Prediction of amino acid sequence of a protein

Paper- 2.4: OE: Microbes in Human welfare

1.	Introduction to microorganisms; Definition, Discovery of microorganisms, Spontaneous generation vs. biogenesis. Contributions of Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming. Types – viruses, mycoplasma, rickettsia, bacteria, fungi, actinomycetes, algae and protozoa; General characteristics, structure and reproduction of microorganisms. Distribution of microorganisms: In air, water and soil; On and in the bodies of plants and animals.	**10 h**
2.	Appearance of microorganisms: Microscopic observations- Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pilli. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls. Different types of microscopes, different shapes and sizes of microorganisms, staining properties, staining of cells organelles and inclusion bodies. Isolation and cultivation of microorganisms: Sterilization methods (physical and chemical); Media – preparation, ingredients and types; Pure culture techniques.	**10 h**
3.	Microorganisms and human Health – Role of microorganisms in human health; Action of antibiotics to combat microbial diseases; Microbial vaccines as prophylactic measures; Concepts and principals of immunity to microbial infections; Major human diseases caused by important microbial pathogens. Microorganisms and Industry: Microbial fermentations; Bioprocess engineering; Raw materials; Types of fermenters and fermentations; Production of antibiotics, enzymes, organic acids and pigments.	**10 h**

After successful completion of this course students are expected to be able to:

CO-1: Understand the history and scope of microbiology
CO-2: Learn about viruses, mycoplasma, rickettsia, bacteria, fungi, actinomycetes, algae, and protozoa. They will also study the general characteristics, structure, and reproduction of microorganisms.
CO-3: Understand the distribution and appearance of microorganisms
CO-4: Understand microbes in food: Students will learn about fermented food products such as nutritive and medicinal value of fermented foods; probiotics; nutraceuticals.

Reference Books:

1. Stanier, R. Y. (1977). General microbiology (3rd ed.). Cambridge University Press.
2. Lammert, J. M. (2011). Techniques in microbiology: A student handbook (1st ed.). W. H. Freeman.
3. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2014). Brock biology of microorganisms (14th ed.). Pearson.
4. Atlas, R. M., & Bartha, R. (2013). Microbial ecology: Fundamentals and applications (5th ed.). Benjamin Cummings.
5. Pelczar Jr., M. J., Chan, E. C., & Krieg, N. R. (1988). Microbiology: Concepts and applications (2nd ed.). McGraw-Hill.
6. Frazier, W. C., &Westhoff, D. C. (2008). Food microbiology (5th ed.). Tata McGraw-Hill Education.
7. Doyle, M.P., Beuchat, L.R., & Montville, T.J.(1997). Food microbiology: Fundamentals and frontiers (1st ed.). ASM Press.
8. Atlas, R.M., & Bartha, R.(1998). Microbial ecology: Fundamentals and applications (3rd ed.). Benjamin Cummings.
9. Mitchell, R.(2004). Environmental microbiology (2nd ed.). Wiley-Liss.
10. 10.Subba Rao, N.S.(2002). Soil microbiology (4th ed.). Oxford & IBH Publishing Co.

Digital References/ Study material:

https://archive.nptel.ac.in/course.html
https://archive.nptel.ac.in/courses/102/103/102103015/
https://onlinecourses.swayam2.ac.in/cec19_bt11/preview

Paper-3.1 HC: Recombinant DNA Technology

1.	Methods of studying DNA – Density gradient sedimentation, zonal centrifugation, isopycnic separation, electrophoretic separation, agarose, polyacrylamide, pulse field electrophoreses, southern blotting, northern blotting, labeling – radioactive and non-radioactive labeling. DNA sequencing - direct sequencing, indirect sequencing, Maxam and Gilbert method, Sangers method, RNA sequencing,	**12 h**
2.	Nucleic acid hybridization – Design and construction of probes, nick translation, hybridization, liquid hybridization, solid hybridization, determination of stringency conditions. Applications of nucleic acid hybridization. Enzymes used in recombinant DNA technology, Restriction endonucleases – Type, I, II &III, Nucleotide kinase, reverse transcriptase, T4 DNA ligase, Klenow polymerase and others, restriction mapping, RFLP and RAPD.	**12 h**
3.	Plasmid vectors - Use of natural plasmids as vectors, artificial plasmid vectors, pSC 101, pBR 322, pUC 18, Ti and Ri plasmid vectors. Bacteriophage vectors – Insertion vectors, replacement vectors, cosmid vectors, phagemid vectors, shuttle vectors and M13 based vectors. BACs, YACs and HAC	**12 h**