HEMCHAND YADAV VISHWAVIDYALAYA,

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SCHEME OF EXAMINATION
&
SYLLABUS
of
M.Sc. (Microbiology) Semester Exam

UNDER

FACULTY OF LIFE SCIENCE

Session 2023-25

(Approved by Board of Studies)
Effective from June 2023

26/5/23 26/5/23 26/05/23

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M. SC. MICROBIOLOGY

Scheme of Examination and Syllabus

July 2023 – December 2023

	Paper No.	Title of Paper	Marks (External)	(Internal)**	Credit
FIRST Semester	I*	Cell Biology	80	20	4
	II	Biomolecules	80	20	4
	III	Microbiology	80	20	4
	IV	Biology of Immune System	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)	80	20	2
		Total		600	

January 2024 – June 2024

	Paper No.	Title of Paper	Marks (External)	(Internal)	
SECOND Semester	I	Genetics and Molecular Biology	80	20	4
	II	Bioenergetics & Metabolism	80	20	4
	III	Instrumentation and Molecular Techniques	80	20	4
	IV	Biometry, Computer and Scientometry	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)	80	20	2
		Total		600	

July 2024 – December 2024

	Paper No.	Title of Paper	Marks (External)	(Internal)	
THIRD Semester	I	Microbial Physiology	80	20	4
	II	Fermentation Technology	80	20	4
	III	Environmental Microbiology	80	20	4
	IV	Medical Microbiology	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)	80	20	2
		Total		600	

January 2025– June 2025

	Paper No.	Title of Paper	(External)	(Internal)	
FOURTH Semester	I	Microbial Biotechnology	80	20	4
	II	Advanced Immunology, diagnostics and prophylaxis	80	20	4
	III	**Special Paper-A:** Food Microbiology **Special Paper-B:** Microbial Ecology	80	20	4
	IV	**Special Paper-A:** Agricultural Microbiology **Special Paper-B:** Industrial Microbiology	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)	80	20	2
		Total		600	
	OR				
		Project Work* **			
		Dissertation	240	60	11
		Seminar based on project	160	40	06
		Viva-voce	80	20	03
		Total		600	
		Grand Total		**2400**	

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*Each theory paper will have 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.

** Each student will be evaluated continuously throughout the semester. There will be a class test based on each theory paper. The full marks will be 10 for each paper. There will be a poster/oral presentation based on each theory paper. The full marks will be 10 for each presentation. Each student will be required to submit a brief write-up (not more than 10 pages) on his/her poster/oral presentation.

***A student of IV semester will have the choice to opt for project work in lieu of four theory papers and two lab courses provided he/she secures at least **65%** or more marks in aggregate in semester I and II. The project has to be carried out in recognized national laboratories or UGC recognized universities. No student will be allowed to carry out project work in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur. The valuation of all the projects will be carried out by an external examiner and HoD of UTD or its nominee at the UTD Centre.

Scheme for Lab Course (for each Semester)	**Maximum Mark 100**	
1	Major Exercise based on paper 1	20
2	Minor Exercise based on paper 1	10
3	Major Exercise based on paper 2	20
4	Minor Exercise based on paper 2	10
5	Spotting/ Interpretation****	10
6	*Viva- voce*	10
	Sub Total	80
	Sessional (Internal)	20
	Total	100

****A student will be required to interpret on the displayed item/material

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M. Sc. Microbiology

FIRST SEMESTER

PAPER I: CELL BIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Molecular organization of membranes- asymmetrical organization of lipids, proteins and carbohydrates. Osmosis, ion channels, membrane pumps and electrical properties of membranes. Active transport by ATP- powered pumps: types, properties and mechanisms.

UNIT II

Transport of proteins into mitochondria, chloroplast and endoplasmic reticulum. Transport of proteins into and out of nucleus. Transport by vesicle formation: exocytosis, endocytosis and its molecular

UNIT III

Cell signaling: Signaling via G-protein linked and enzyme linked cell surface receptors, MAP kinase pathways. Eukaryotic cell division cycle: different phases and molecular events, regulation and control of cell cycle. Apoptosis. Oncogenes and tumor suppressor genes: viral and cellular Oncogenes,

UNIT IV

Organization of chromosomes: Structure of chromosomes, centromere and telomere. States of chromosomes during cell cycle. Mitotic chromosome. Organization of genes in chromosomes Banding. Pattern of chromosomes. Lampbrush and Polytene chromosomes. Chromatin, nucleosomes, DNA packaging, heterochromatin and euchromatin.

Lab Course:

1. Study of chromosome behaviour during Mitosis and meiosis (Onion / Garlic root tips, Onion buds, human lymphocytes.
2. Calculation of mitotic index in growing Onion / Garlic root tips
3. Squash preparation: Polytene chromosome (in chironomus / Drosophila or other insect salivary gland) and Barr body (in buccal epithelial cells).
4. Demonstration of secretory granules in the salivary gland cells of insect.
5. Study of permanent slides.
6. Estimation of DNA
7. Estimation of RNA
8. Sub-cellular fractionation and marker enzymes
9. Identification of biomolecules in different tissues by histochemical techniques
10. Preparation of mitotic plate by carmine squashing method and phase identification.
11. Demonstration of the nuclear matrix networks in onion cells.
12. Study of the effect of chemical agents on chromosomes plant cells.
13. Preparation of Karyotype of metaphase plate.

Books Recommended:

1. H Lodish et al Molecular Cell Biology B Alberts et al. Essential Cell Biology H Lodish et al. Molecular Cell Biology
2. B Alberts et al.Molecular Biology of the Cell
3. G Karp Cell and Molecular Biology: Concepts and Experiments

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M. Sc. Microbiology

FIRST SEMESTER

PAPER II: BIOMOLECULES — Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Carbohydrates: structure, classification, properties and function; derivatives of monosaccharides, homo and hetero-polysaccharides, Peptidoglycan, glycoproteins and liposaccharide. Lipids: Classification, structure and function. Nucleic Acid: Structure of purine and pyrimidine bases, nucleoside and nucleotide; DNA- structure and conformation; RNA - Structure, types and functions.

UNIT II

Amino acids: structure, classification and functions; Synthesis of peptides and protein sequencing. Proteins- properties, covalent structure; secondary, tertiary and quaternary structure of proteins,

UNIT III

Enzyme classification, coenzymes, active site of enzyme, factors contributing to the catalytic efficiency of enzyme; enzyme kinetics- Michaelis-Menten equation, determination of Km, enzyme inhibition, allosteric enzymes, isoenzymes, ribozyme, multienzyme complexes

UNIT IV

Chemistry of porphyrins: Importance of porphyrins in biology; structure of hemoglobin and chlorophyll porphyrins, structure and biological role of animal hormones, structure and biological role of water soluble and fat soluble vitamins.

Lab Course:

1. Specific tests for sugars, amino acids and lipids
2. Formal titration of amino acids
3. Estimation of proteins using ninhydrin and biuret method
4. Estimation of sugar by anthrone and Folin-Wu method.
5. Saponification value and iodine number of fat.
6. Estimation of ascorbic acid.
7. Achromic point determination using salivary amylase
8. Effect of ions on salivary amylase activity.
9. Enzyme assay and kinetics (ex. Amylase, Protease)

Books Recommended:

1. Principles of Biochemistry by Nelson, Cox and Lehninger
2. Biochemistry by G. Zubay
3. Biochemistry by Stryer
4. Biochemistry by Garrett and Grosham
5. Text book of Biochemistry by West, Tood, Mason & Bruglen
6. Biochemistry by White, Handler & Smith
7. Biochemistry by D. Voet and J C Voet

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M. Sc. Microbiology
FIRST SEMESTER

PAPER III: MICROBIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

General characteristics of fungi, classification of fungi, life cycle of selected fungal genus (*Aspergillus*, *Pencillium, Fusarium* and *Mucor*). Economic importance of fungi. Fungi and bioremediation, parasitism, mutualism and symbiosis with plants and animals. Heterothallism, sex hormone in fungi, Mycorrhiza, VAM. Algae: Distribution, classification, reproduction, ecology and importance.

UNIT II

Morphology and ultra-structure of bacteria, morphological types, cell wall of archaebacteria, gram negative, gram positive eubacteria, eukaryotes.

Cell membranes – structure, composition and properties. Structure and function of flagella, cilia, pili, gas vesicles. Cyanobacteria, protozoa, mycoplasma and Rickettsia.

Gene transfer mechanisms, transformation, transduction, conjugation and transfection. Plasmids F: factors colicins and col factors, plasmids as a vector for gene cloning.

UNIT III

Nutritional types (autotrophs, heterotrophs, phototrophs, chemotrophs), growth curves, measurement of growth, factors affecting growth, generation time, growth kinetics. Batch and continuous culture, asynchronous and synchronous culture.

Basis of microbial classification, classification and salient feature of bacteria according to Bergey's manual of determinative bacteriology, cyanobacteria, prochlorons and cyanelles.

UNIT IV

Viruses: Structure and classification of viruses; morphology and ultra-structure; capsids and their arrangements, types of envelopes, viral genome, their types and structure, virus related agents (viroids, prions). General feature of virus reproductions, early events in virus multiplication, virus restriction and modification of host, virus mRNA. General overview of bacterial viruses, RNA and DNA bacteriophages (MS2, ϕX174, M13, T3, T4). Lysogeny and Lytic phase. General account of plant and animal viruses

Lab Course:

1. Glassware preparation and sterilization techniques- wet heat- dry heat- filter types- laminar flow chamber types- CDC- safety levels.
2. Preparation of liquid & solid media, plating, pouring, inoculation and incubation for growth of microorganism
3. Methods of obtaining pure culture of microorganisms (a) streak plate (b) Pour plate, and (c) spread plate methods
4. Microscopic examination of the microorganisms, identification and staining methods
5. Micrometry and camera lucida drawings
6. Study of bacterial growth by turbiditimetry/ spectrophotometry
7. Biomass measurement for fungi
8. Isolation and enumeration of microorganisms from soil by serial dilution agar plating method.
9. Enumeration of viruses by plaque assay technique.
10. Motility of bacteria by hanging drop technique.

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Books Recommended:

- Microbiology: L.M. Prescott, J.P. Harley and D.A. Klein, McGraw Hill Publication.
- General Microbiology: Stanier, Ingrahamana, Wheelis and Painter, Mac Millian Press
- Principles of Microbiology: R.M. Atlas
- Microbiology: Peleczar, Chan & Krieg
- General Virology: Luria, Darnell, Baltimore and Campell
- Introduction to Mycology: CJ Alexopoulos and CW Mims, Wiley Eastern Ltd, New Delhi

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M. Sc. Microbiology

FIRST SEMESTER

PAPER IV: BIOLOGY OF IMMUNE SYSTEM Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Innate immune mechanism and characteristics of adaptive immune response. Cells of immune system: Hematopoisis and differentiation, mononuclear cells and granulocytes. Antigen presenting cells. Primary and Secondary lymphoid organs and tissues. Ontogeny and phylogeny of lymphocytes. Lymphocyte traffic.

UNIT II

Antigen receptor molecules: B-cell receptor complex, Immunoglobulin- structure, types and function. T-cell receptor complex. Major Histocompatibility Complex- types, structural organization, function and distribution. Transplantation and Rejection. Complements in immune function.

UNIT III

Antigens: nature of antigens, factor affecting immunogenicity, Haptens and super antigens. Antigenic determinants. Recognition of antigens by T and B cell. Antigen processing. Role of MHC molecules in antigen presentation and co-stimulatory signals. Antigen and antibody interaction.

UNIT IV

Cell mediated immune response. Cytokines and interleukins- structure and function. Immunity to infections. Hypersensitive reactions and their types. Immunodeficiency disorders. Autoimmunity

Lab Course:

1. Identification of cells of immune system
2. Separation of mononuclear cells by Ficoll-Hypaque
3. Identification of Lymphocytes and their subsets
4. Lymphoid organs and their microscopic organization
5. Isolation and purification of Antigens
6. Purification of IgG from serum
7. Estimation of Levels of gamma globulins and A/G ratio in blood
8. Antigen antibody interaction

Books Recommended:

- Kuby's Immunology: R.A. Goldsby, Thomas J Kindt and Barbara A. Osborne
- Immunology- A short Course: E. Benjamini, R. Coico and G. Sunshine
- Immunology: Roitt, Brostoff and Male
- Fundamentals of Immunology: William Paul
- Immunology: Tizard
- Immunology: Abbas *et al*

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M. Sc. Microbiology

SECOND SEMESTER

PAPER I : GENETICS AND MOLECULAR BIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT – I:

Mendelian principles: Dominance, segregation, independent assortment. Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests
Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions.
Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

UNIT – II:

DNA replication, repair and recombination: Mechanism of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms; Repair of Base-excision, Nucleotide excisions, Mismatch and Double Strand. Guardian of DNA; *p53* and *p21*. Homologous and site-specific recombination.

UNIT – III:

RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, elongation, and termination, RNA processing, capping, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

UNIT – IV:

Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl t-RNA synthetase, and translational proof-reading, translational inhibitors, Post Translational modification of proteins. Protein targeting.

Lab Course:

1. Isolation, purification and estimation of RNA
2. Isolation, purification and estimation of DNA
3. Determination of Tm of nucleic acid
4. Fraction of poly (A) RNA
5. Restriction Digestion
6. Ligation
7. DNA molecular size determination

Books Recommended:

1. H Lodish *et al.:* Molecular Cell Biology B
2. Alberts *et al.* : Essential Cell Biology
3. B Alberts *et al.*: Molecular Biology of the Cell
4. G Karp : Cell and Molecular Biology: Concepts and experiments JD Watson *et al.* : Molecular Biology of the Gene
5. J Wilson and T Hunt : Molecular Biology of the Cell: The Problems
6. B Lewin : Genes VIII
7. JE Krebs *et al.* (Ed.) : Genes X (Lewin's), Jones and Bartlett Publishers, Sudbury, Massachusetts, (2011)

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M. Sc. Microbiology

SECOND SEMESTER

PAPER II: BIOENERGETICS AND METABOLISM Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

First and second laws of thermodynamics. Concept of free energy, High – energy compounds, ATP cycle, structural basis of free energy change during hydrolysis of ATP. Other high – energy biological compounds

UNIT II

Basic concepts of intermediary metabolism. Carbohydrate metabolism: Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, gluconeogenesis, and glyoxylate pathway, inborn errors of carbohydrate metabolism. Regulation of carbohydrate metabolism.

UNIT III

Electron transport and oxidation phosphorylation: electron carriers, Complexes I to IV, substrate level phosphorylation, mechanism of oxidative phosphorylation, Shuttle system for entry of electron, Biosynthesis and degradation of Lipids, Regulation of lipid metabolism.

UNIT IV

Nitrogen Assimilation. Biosynthesis of amino acids. Degradation of amino acids. Regulation of amino acid metabolism. Biosynthesis and degradation of purine and pyrimidine nucleotides.

Lab Course:

1. Protein estimation by Lowry, Bradford and Spectrophotometric method
2. Estimation blood cholesterol
3. Estimation of sugar by Nelson- Somogyi and Benedict's reagent
4. Isolation and estimation of lipid from seeds and egg.
5. Estimation of inorganic and total phosphorus by Fiske-Subba Rao method
6. Assay of phosphatases in blood and seeds
7. Urease estimation in plant tissues

Books Recommended:

- Principles of Biochemistry by Nelson, Cox and Lehninger
- Biochemistry by G. Zubay
- Biochemistry by Stryer
- Biochemistry by Garrett and Grosham
- Text book of Biochemistry by West, Tood, Mason & Bbruglen
- Biochemistry by White, Handler & Smith
- Biochemistry by with clinical application
- Biochemistry by D Voet and J C Voet
- Enzymes by Dixon and Webb
- Fundamentals of Enzymology by Price and Steven
- Practical Biochemistry by Plummer
- Enzyme Biotechnology by G. Tripathi
- Enzyme Reaction Mechanism by Walsh.
- Enzyme Catalysis and Regulation by Hammes

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M. Sc. Microbiology

SECOND SEMESTER

PAPER III: INSTRUMENTATION AND MOLECULAR TECHNIQUES Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Centrifugation: Principle, techniques. Preparative, analytical and ultracentrifuges, sedimentation coefficient and factors affecting sedimentation coefficient. Application of centrifugation.
Photometry: Basic principles of colorimetry, UV- visible spectrophotometry & IR- spectrophotometry. Spectro flurometry Atomic absorption spectroscopy: Principle, Instrumentation and applications Electrophoresis: Paper electrophoresis, Starch gel, agarose, PAGE-type, 2D-E.

UNIT II

Microscopic techniques: light microscopy, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy
Microtomy: types, principle and applications
Lyophilization: Principle, instrumentation and applications

UNIT III

Chromatography: Paper and Thin Layer Chromatography. Gel filtration, Ion exchange chromatography and Affinity chromatography. Gas-liquid chromatography and HPLC.
Histochemical and immuno techniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *In situ* localization; FISH and GISH.

UNIT IV

Molecular techniques: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, separation methods; RNA, DNA and proteins; 1-D and 2-D, isoelectric focusing gels; Molecular cloning of DNA and RNA fragments in bacterial systems; Expression of recombinant DNA; DNA sequencing. Gene expression; mRNA, cDNA using PCR and qRT-PCR. Micro array based techniques.Molecular Markers for diversity analysis: RFLP, RAPD, AFLP, VNTR, SSR, ISSR, SNP, DArT.

Lab Course:

- Verification of Beers Law
- Determination of absorption maxima
- Quantitative determination, Enzyme kinetics
- Amino acid and carbohydrate separation by paper and TLC
- Ion exchange and gel filtration chromatography
- SDS Polyacralamide Gel Electrophoresis
- DNA electrophoresis
- Separation of sub-cellular organelles by differential centrifugation.
- Isolation of DNA and Agarose gel Electrophoresis
- Amplification of RAPD and AFLP markers.
- Isolation of RNA and Electrophoresis of RNA on denaturing gels.
- cDNA synthesis and cloning
- Isolation of Protein and SDS-PAGE
- In vitro DNA ligation, transformation of E. coli
- Characterization of transformants: DNA gel electrophoresis, Restriction map analysis.

Books Recommended:

- K Wilson and John Walker — Practical Biochemistry: Principles & Techniques

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• S Carson, H Miller and D Scott	Molecular Biology Techniques: A Classroom Laboratory Manual
• TC Ford and J. M. Graham	An Introduction to Centrifugation
• R Baserga and D Malamud	Autoradiography: techniques and application
• T Chard	An Introduction to Radioimmunoassay and Related Techniques , Volume 6
• MD Bruch	NMR Spectroscopy Techniques
• BA Wallace and R William	Modern Techniques for Circular Dichroism and Synchrotron Radiation, Volume 1
• J Sambrook, EF Rritsch and I Maniatis	Molecular cloning: A Laboratory Manual
• PD Dabre	Introduction to Practical Molecular Biology
• JD Watson, NH Hopkins, JW Roberts, JA Steitz and AM Weiner	Molecular Biology of Gene (4th Edition)
• J Darnell, H Lodish and D Baltimore	Molecular Cell Biology (2nd Edition)
• B Alberts, D Bray, J Lewis, M Raff, K Roberts and JD Watson	Molecular Biology of the Cell (2nd Edition)
• Benjamin Lewin	Gene VII
• JM Walker and R Rapley	Molecular Biology and Biotechnology
• SB Primrose	Molecular Biotechnology

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M. Sc. Microbiology

SECOND SEMESTER

PAPER IV: BIOMETRY, COMPUTER AND SCIENTOMETRY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Introduction to biostatistics. Types of biological data: data on different scales. Frequency distributions. Cumulative frequency distributions. Random sampling. Parameters and statistics. Measures of central tendency and dispersion: Mean, Median, Mode, Range, Variance and Standard deviation. Coefficient of variation. The effects of coding data. Data transformations: Log-transformation, Square-root transformation and Arcsine transformation. Distribution: normal and binomial.

UNIT II

Statistical errors in hypothesis testing. Testing goodness of fit: Chi-square goodness of fit. Heterogeneity Chi-square. The 2 x 2 contingency table. One sample hypothesis. Two- sample hypothesis. Testing for difference between two means (*t*-test). Testing for difference between two variances (*F*-test). The paired sample *t*-test. Multiple-sample hypothesis (ANOVA): Single factor and two factors ANOVA. Simple linear regression. Regression *vs.* Correlation. Regression equation. Interpretations of regression functions. Simple linear correlation. The correlation coefficient.

UNIT III

Introduction to MS-Office software: Word processing; Creating new document, Editing documents, Adding graphics to documents, Word tables. Management of Workbook & Worksheets; Applications, Features, Using formulas and functions, Features for Statistical data analysis, Generating charts/ graph. Presentation software; Working in PowerPoint, Creating new presentation, Working with slides.

UNIT IV

Introduction to Internet and Applications. Basics of internet, e-mailing, Search engine – Google and Yahoo; PubMed, Scopus, Web of Science, Google Scholar, Indian Citation Index, Science Citation Index (SCI), h- index, i-10-index. Journal Impact Factor (JIF). Introduction to Plagiarism and Cyber laws.

Lab Course:

1. Exercises for data distribution
2. Exercises for computation of measures of central tendency
3. Exercises for computation of measures of variability
4. Computation of correlation coefficient, r, and regression constants
5. Data analysis by ANOVA and multiple-range tests
6. Hypothesis testing by *t*-test, F-test, and Chi-square test
7. Graphical presentation of data using a suitable package
8. Statistical analysis of a data using a suitable package
9. Preparation of document using a suitable package
10. Preparation of slides using a suitable package

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Books Recommended:	
Campbell RC	Statistics for biologists
Zar JH	Biostatistical Analysis
Wardlaw AC	Practical Statistics for Experimental Biologists
Snedecor GW & Cochran WG	Statistical Methods
Sokal RR & Rohlf FJ	Introduction to Biostatistics Sumner M
	Computers: Concepts & Uses
White R	How Computers Work
Cassel P *et al.*	Inside Microsoft Office Professional Coleman
P and Dyson P	Mastering Internets
Gralla P	How the Internet Works
Shelly GB, Vermaat ME, Cashman TJ	Microsoft 2007: Introductory Concepts and Techniques
Habraken J	Microsoft Office 2003 All in One Microsoft Office 2010 In Depth
Gilmore B	Plagiarism: Why it happens, How to prevent it?
Buranen L and Roy AM	Perspectives on Plagiarism and Intellectual Property in a Post-Modern World
Kumar Anupa P	Cyber Law
Sood V	Cyber Law Simplified

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M. Sc. Microbiology

THIRD SEMESTER

PAPER I: MICROBIAL PHYSIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Aerobic metabolism of methane and methanol: Methane and methanol users, Oxidation of methane, Formaldehyde and formic acid, assimilation of C-1 compounds.

Anaerobic respiration: Sulphur compounds and nitrate as electron acceptors, electron transport in SO_4 and NO_3 reducers. Anaerobic metabolism of glucose, Fermentation process, modes of glucose fermentation (lactic acid, ethanol, acetic acid, butyric acid, acetone and butanol, format and propionate). Transport of nutrients across membrane.

UNIT - II

Biosynthesis of peptidoglycan, teichoic acid, lipopolysaccharide, biosynthesis and degradation of essential amino acids, microbial degradation of aromatic, polycyclic and halogenated aromatic compounds. Microbial metabolism of hydrogen.

UNIT - III

Microbial photosynthesis: Historical account, structure of photosynthetic pigments i.e., chlorophylls and bacterio-chlorophylls, carotenoids, phycobilins, primary photochemistry and electron transport (light harvesting, charge-separation and electron transport in anoxygenic photosynthesis), ATP synthesis. Eubacterial photosynthetic microbes, development of photosynthetic apparatus, carbon metabolism. Cynobacterial organization of photosynthetic apparatus. Halobacterial photo-phosphorylation.

UNIT - IV

Nitrogen metabolism: Biological nitrogen fixation, Mechanism of nitrogen fixation, ammonia assimilation, properties and regulation of glutamine synthetase, glutamate synthetase, glutamate dehydrogenase. Biochemistry of methanogenesis; bio-transformation of steroid and non-steroid compounds.

Lab Course:

1. Qualitative of assay of different extra-cellular enzymes
2. Quantitative assay of alkaline and acid phosphatases from microorganisms.
3. Determination of Km value of beta- fructofuranosidase from yeast
4. Antibiotic sensitivity test
5. Measurement of CM-cellulase by viscometric and reducing sugar method.
6. Experiment on production of enzymes and optimizing parameters for enzyme production in shake flask culture using *Aspergillus niger, Saccharomyces cerevisiae* for production of amylase, invertase respectively.
7. Experiment on production of citric acid and optimizing parameters for citric acid production in shake flask culture using *Aspergillus niger*.

Books Recommended:

1. Brown TA (1999) Genome. John Wiley & Sons (Asia) PTE. LTD.
2. Goeddel DV (1990) Methods in Enzymology, vol 185, Gene Expression Technology. Academic Press, San Diago.
3. Kaufman PB, Wu W, Kim D and Cseke LJ (1995) Molecular and Cellular Methods in Biology and Medicine. C. Press, Florida.
4. EL-Mansi E.M.T. and Bryce C.F.A. Fermentation Microbiology and Biotechnology. Taylor & Francis.

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M. Sc. Microbiology

THIRD SEMESTER

PAPER-II: FERMENTATION TECHNOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

General Considerations: Fermentation biotechnology – An historical perspective, metabolic pathways and metabolic control mechanisms, primary and secondary metabolites, genetic regulation and catabolite repression, Fermentation kinetics, kinetics of substrate utilization, product formation.

UNIT - II

Types of bio-reactors, their design and instrumentation: Fed batch bio-reactors, continuous stirred tank bio-reactors, plug flow tubular reactors; multiphase reactors, packed bed, bubble column , fluidized bed and trickle bed bio-reactors, animal and plant cell bio-reactors, non-ideal mixing, batch and continuous sterilization, immobilized bio-catalysts, sensors for medium and gases.

UNIT - III

Industrial production of microbial biomass (SCP, and mushrooms), alcohol, organic acid (citric acid, gluconic acid, itaconic acid), amino acids (L- glutamic acid, L- lysine and L-aspartic acid), enzymes and antibiotics (Penicillin), microbial polysaccharides and polyesters.

UNIT - IV

Scale up, instrumentation control, Bio-sensors in bio-process monitoring and control. Downstream processing: Removal of microbial cells and solid matter, precipitation, filtration, centrifugation, disintegration of cells, extraction methods, concentration methods, purification and resolution of mixtures, drying and crystallization.

Lab Course:

1. Experiment on production of alcohol and optimizing parameters for alcohol production in shake flask culture using *Saccharomyces cerevisiae.*
2. Experiment on production and optimizing parameters for SCP in shake flask culture.
3. Experiment on production of enzymes and optimizing parameters for enzyme production in solid-state fermentation using wheat bran and other agricultural solid waste.
4. Protein purification methods: affinity chromatography, ion exchange and gel filtration.
5. Recovery of products from solid state cultures -Recovery of intracellular products: Cell disruption procedures by sonication,
6. Carbohydrate catabolism by microorganisms (oxidation and fermentation of glucose)
7. Fermentation of carbohydrates.

Books Recommended:

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- EL-Mansi E.M.T. and Bryce C.F.A. Fermentation Microbiology and Biotechnology. Taylor & Francis.
- Alberghina Lilia. Protein Engineering in Industrial Biotechnology. Harwood Academic Publishers.
- Jogdand S. N. Gene Biotechnology. Himalaya Publishing House.
- Olguin J. Eugenia, Sanchez Gloria & Hernandez Elizabeth. Environmental Biotechnology and Cleaner Bioprocesses. Taylor & Francis.
- Prescott & Dunn's. Industrial Microbiology. 4th ed, CBS publishers & Distributors.
- Bullock John and Kristiansen Bjorn. Basic Biotechnology. Academic Press.
- A.H. Patel. Industrial Microbiology

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M. Sc. Microbiology

THIRD SEMESTER

PAPER III: ENVIRONMENTAL MICROBIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Distribution and ecology of microorganism: airspora- concepts and components, indoor and outdoor air spora, aeroallergens, Ecosystem- concept, components, food chains, food webs, and trophic levels. Energy transfer efficiencies between trophic levels. Environmental factors influencing the growth and survival of microorganism. Physical factors- temperature, light, osmotic pressure and hydrostatic pressure. Chemical factors- pH, O2 and CO2. Microorganisms of extreme environments: Psychrophiles, Mesophiles, thermophiles, acidophiles, alkalophiles, halophiles and specific habitats.

UNIT - II

Microbiology of water: aquatic ecosystems-types- fresh water (ponds, lakes, streams) - marine (estuaries, mangroves, deep sea, hydrothermal vent, saltpans, coral reefs). Zonation of water ecosystems– upwelling-eutrophication- food chain. Drinking and potable water, ecology of polluted water, microbiological treatment processes. Waste water disposal and reclamation. Brief account of major water borne diseases and their control measures.

UNIT – III

Soil microbiology: Micro flora of various soil types (bacteria and nematodes): rhizosphere- phyllosphere – brief account of microbial interactions symbiosis, mutualism, commensalism, competition, amensalism, synergism, parasitism, predation, biological N2 fixing organisms, symbiotic fungi, Phosphate solubilizing organisms, Ecology of litter decomposition; extracellular enzymes (hydrolases), heterotrophic potential

UNIT -IV

Biodegradation of Cellulose , Lignins and hydrocarbons (superbug). Composting, treatment of solid wastes. Bioaccumulation of metals. Biodeterioration: classification of Biodeterioration of materials (monuments, paints, rubbers, plastics, fuels, lubricants, metals, stone, cosmetics, toiletries). GMO and

Lab Course:

1. BOD & COD estimation in water sample
2. Study of microbial contaminants from water and wastewater.
3. Study of air borne microorganisms using various methods.
4. Assay of anti-fungal and antibacterial properties of agro-chemicals and fungicides.
5. Assessment of quality of oils using saponification value, iodine number, and free fatty acid composition.
6. Study of thermophilic microorganisms.
7. Bacteriological examination of water by multiple-tube fermentation test.
8. Determination of coliforms to determine water purity using membrane filter method.
9. Lipase production test.
10. Isolation of Rhizobium from root nodule.
11. Measurement of spore size using micrometry
12. Isolation of microorganisms from rhizosphere and phylloplane.

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- Michael, T. Madican; John. M. Mmmartinko and Jack Parker. Brock. Biology of Microorganisms.
- Microbiology of Extreme Environments edited by Clive Edwards
- Olguin J. Eugenia, Sanchez Gloria & Hernandez Elizabeth. Environmental Biotechnology and Cleaner Bioprocesses. Taylor & Francis.
- Michel. R. Introduction to Environmental Microbiology. 1999

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M. Sc. Microbiology

THIRD SEMESTER

PAPER-IV: MEDICAL MICROBIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Normal microbial flora of human body, role of resident flora, host microbe interactions. Classification of medically important microorganisms. Infection and infectious process - routes of transmission of microbes in the body. Source of infection for man; vehicles or reservoirs of infection. Mode of spread of infection. Pathogenesis: Infectivity and virulence.

UNIT –II

Classification of pathogenic bacteria. *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium*, Non sporing Anaerobes, Organism belonging to Enterobacteriacea, vibrios, Non fermenting gram negative bacilli *Yersinia; haemophilus; Bordetelia; Brucella*; *Mycobacteria, Spirochaetes, Actinomycetes; Rikettsiae, Chlamdiae.*

UNIT- III

General properties of Viruses; Viruses Host Interactions, Pox viruses, Herpes viruses, Adeno viruses; Picarno viruses; Orthomyxo viruses; Paramyxo viruses; Arboviruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno deficiency viruses.

UNIT- IV

Mycology - Human mycotic infections caused by Dermatophytes, Histoplasma, Cryptococcus, Candida, opportunistic mycoses. Mycotoxins. Description and classification of pathogenic fungi and their laboratory diagnosis.

Parasitology - Medical importance of Entamoeba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria. Laboratory techniques in parasitology.

Lab Course:

1. Identification of micro flora of mouth, skin and wounds
2. Identification of enteric pathogens by TSIA medium
3. Identification of dermatophytic fungi
4. Identification of important human parasites
5. IMVIC test/other specific tests

Books Recommended:

- Prescott & Dunn's. Microbiology. CBS Publishers & Distributors.
- Anantnarayan R and Panikar CKJ: Text book of Microbiology, Orient Blackswan Pvt. Ltd.
- Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
- Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications
- Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby

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M. Sc. Microbiology

FOURTH SEMESTER

PAPER-I: MICROBIAL BIOTECHNOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Techniques of Microbial technology: Scope of genetic engineering, restriction and modification enzymes, ligation and transformation, agarose and polyacrylamide gel electrophoresis, Southern, northern, western blotting, polymerase chain reaction, DNA sequencing, cloning vectors- plasmids, bacteriophages, phagemids, cosmids. YAC, BAC.

UNIT - II

Basics of Genomics, RNA interference, Cloning strategies, cDNA synthesis and cloning, mRNA enrichment, DNA primers, linkers, adaptors and their synthesis, library construction and screening; Cloning interacting genes, two and three hybrid systems, cloning differentially expressed genes, nucleic acid microarrays; Site directed mutagenesis and protein engineering, immobilization techniques.

UNIT - III

Microbial screening, selection and strain improvement, bacterial enterotoxins, peptide hormone, interferons.

Biofertilizers, Biopesticides, , Enzyme in pulp and paper industry, Bioremediation.

UNIT - IV

Role of national and international organization in biotechnology, cooperative efforts, government programs for biotechnology development and applications, patenting biotechnological process and products in different fields, regulation for bio-hazardous products.

Lab Course:

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Estimation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/phagemid vectors.
8. Preparation of single stranded DNA template.
9. Gene expression in *E. coli* and analysis of gene product
10. PCR

Books Recommended:

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1. Bruce A White (1997) PCR Cloning Protocols. Hanuman Press Totowa, New Jersey.
2. Bruce Birren, Eric D Green, Sue Klapholz, Trichard M Myers, Horald Riethman, & Jane Roskenus (1999) Genome Analysis: A Lab Manual vol.1,vol.2,vol.3, Cold Spring Harbor Lab. Press.
3. Daniel L Hartl, Elizabeth & Jones W (1998) Genetics: Principles and Analysis. Jones & Bartlett Publishers.
4. Davies JA & Rez WS (1992) Milestones in Biotechnology Classic papers on Genetic Engineering. Butterworth-Heinemann, Boston.
5. Glick Molecular Biotechnology.
6. Glover DM and Hames BD (1995) DNA Cloning: A practical approach, IRL Press, Oxford.
7. Kaufman PB, Wu W, Kim D and Cseke LJ (1995) Molecular and Cellular Methods in Biology and

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M. Sc. Microbiology

Max. Mark 80

FOURTH SEMESTER

PAPER-II: ADVANCED IMMUNOLOGY, DIAGNOSTICS AND PROPHYLAXIS

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Generation of diversity in BCR and TCR. Light and heavy chain gene recombination. Recombination Signal sequences. Heavy chain constant region genes. Class switching. Membrane and secreted immunoglobulins. Organization and arrangement of T-cell receptor genes.

UNIT - II

Synthesis and production of immunoglobulins. Monoclonal antibody. Designer antibody.

Regulation of immune response by antigen, antibody, immune complex, MHC and cytokines. Autoimmunity and autoimmune disorders. Immunological tolerance. Immunity to microbial and parasitic infections. Immunodeficiency diseases.

UNIT - III

Principles of antimicrobial action and resistance of antibiotics. Antimicrobial susceptibility testing Anti-fungal and anti-cancer compounds. Nosocomial infection, common type of hospital infections and their diagnosis and control.

Immunoprophylaxis: Principles of Vaccination. Immunization practices. Vaccines against important bacterial and parasitic diseases. DNA vaccines; passive prophylactic measures. Viral vaccines and antiviral

UNIT - IV

Diagnosis of microbial diseases - Collection, transport and preliminary processing of Clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis.

Principles of immunodiagnostics. Antigen-antibody based immunodiagnosis and the techniques involved – Enzyme, Radio and Fluorescence Immunoassays, Immunoblotting, Flow cytometry. Effector cell assays, Cytotoxic assays. Isolation of pure antibody. Application of monoclonal antibodies in immunodiagnostics.

Lab Course:

- Preparation of Parasite/ microbe Antigen and analysis by PAGE
- Immunizations and Production of Antibody
- Antigen antibody reaction by Double Diffusion, Counter Current and Immuno electrophoresis, RID and ELISA
- Western Blot Analysis
- Immunodiagnosis using commercial kits
- VDRL and RPR Test.

Books Recommended:

- Prescott and Dunn's. Microbiology. CBS Publishers & Distributors
- Anantnarayan R and Panikar CKJ: Text book of Microbiology, Orient Blackswan Pvt. Ltd.
- Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
- Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications
- Kuby's Immunology: R.A. Goldsby, Thomas J Kindt and Barbara A. Osborne
- Immunology- A short Course: E. Benjamini, R. Coico and G. Sunshine
- Immunology: Roitt, Brostoff and Male
- Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby

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M. Sc. Microbiology

FOURTH SEMESTER

Special Paper - PAPER-III (A): FOOD MICROBIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

Microbial flora of fresh food, grains, fruits, vegetables, milk, meat, eggs and fish. Microbiological examination of foods for their infestation by bacteria, fungi & viruses. Chemical preservatives and food additives. Factors influencing microbial growth in food- Extrinsic and intrinsic factors. Food as a substrate for micro-organism.

UNIT- II

Canning, processing for heat treatment - D, Z and F values and working out treatment parameters; microbial spoilage of canned foods, detection of spoilage and characterization. Mold and mycotoxin contamination of food, aflatoxins, ochratoxins, trichothenes, zearalenone, ergot mycotoxins. Role of microorganisms in beverages– beer, wine and vinegar fermentation.

UNIT- III

The roles of microorganisms in the food industry, positive and negative perspectives. Food-borne infections and intoxications: Bacteria and nonbacterial-with examples of infective and toxic types- *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia*; nematodes, protozoa, algae, fungi and viruses. Food borne outbreak- laboratory testing procedures; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross-contamination.

UNIT- IV

Prevention Measures-Food sanitation in manufacture and retail trade; Plant sanitation- Employee's Health standards-waste treatment-disposal- quality control. Government Agency and Food Safety Policy: Government Branches (FDA, CDC, USDA and how they work to control food safety), HACCP, Risk Assessment.

Lab Course:

1. Isolation and identification of microorganisms from fermented food, fruits, cereal grains and oil seeds.
2. Determination of quality of milk sample by methylene blue reductase test.
3. Screening of mycotoxin.

Books Recommended:

- M.R. Adams and M.O. Moss: Food Microbiology, Royal Society, Cambridge
- William, C. Frazier and Dennis C. Westhoff: Food Microbiology, Tata McGraw Hill
- Banwart GJ: Food Microbiology CBS Publishers & Distributors, New Delhi.
- Hobbs BC and Roberts D: Food Poisoning and Food Hygiene, Edward Arnold, London

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M. Sc. Microbiology

FOURTH SEMESTER

Special Paper - PAPER-III (B): MICROBIAL ECOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

History, significance and developments in the field of microbial ecology
Contributions of Beijerinck, Winogradsky, Kluyver, Van Niel, Martin Alexander, Selman A. Waksman, Environmental chemistry, Atmosphereic pollutants, Types of wastes, The Atmosphere, Organization of life, Ecosystems.

UNIT- II

Microorganisms & their natural habitats
A. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora
B. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats.
Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes
D. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
E. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

UNIT- III

Succession of microbial communities in the decomposition of plant organic matter
Biological Interactions
A. Microbe–Microbe Interactions: Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents
B. Microbe–Plant Interactions: Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/ nonsymbiotic - biofertilizers)
C. Microbe–Animal Interactions: Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont

UNIT- IV

Biogeochemical cycles an introduction
Carbon cycle: Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin)
Nitrogen cycle: Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution.
Phosphorous cycle: Phosphate immobilization and phosphate solubilization

Lab Course:

Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action
Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC) Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
Detection (qualitative) of the presence of enzymes (dehydrogenase, amylase, urease) in soil. Isolation of Rhizobium from root nodules of legumes
Isolation of Azotobacter/Azospirillum from soil Isolation of phosphate solubilizers from soil

Books Recommended:

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- Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
- Atlas RM. (1989). Microbiology: Fundamentals and Applications. 2nd Edition, MacMillan Publishing Company, New York.
- Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition.

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M. Sc. Microbiology

FOURTH SEMESTER

Special Paper - PAPER-IV (A): AGRICULTURE MICROBIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

Structure and characteristic features of the following Biofertilizer organisms: Bacteria: Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia. Cyanobacteria: Anabaena, Nostoc, Fungi: Glomus, Gigaspora, Sclerocystis, Amanita, Laccaria.
Biofertilization processes - Decomposition of organic matter and soil fertility and vermicomposting. Mechanism of Phosphate Solubilization and phosphate Mobilization.

UNIT- II

Biofertilizers – biological nitrogen fixation – Nitrogenase enzyme – symbiotic nitrogen fixation- (Rhizobium, Frankia) – non symbiotic nitrogen fixation (Azotobacter - Azospirillum), VAM- ecto- endo- ectendo mycorrhizae and their importance in agriculture.

UNIT- III

Major Biogeochemical Cycles and the organisms: carbon – nitrogen - phosphorous and sulphur. Biopesticides: toxin from *Bacillus thuringiensis, Psuedomonas syringae.* Biological control - use of Baculovirus, protozoa and fungi.

UNIT- IV

Microbial diseases of crop plants: symptoms, causal organisms and control.
Fungal diseases (Late blight of potato, Tikka disease of groundnut, red rot of sugarcane).
Bacterial diseases (bacterial blight of rice, citrus canker, Tundu disease of wheat) and
Viral diseases (Tobacco mosaic, leaf curl of papaya, yellow vein mosaic of bhindi).

Lab Course:

1. Isolation and enumeration of bacteria from different soil type.
2. Isolation and enumeration of fungi from different soil type
3. Preparation of Winogradsky Column to study the various soil microflora.
4. Isolation of Rhizobium from root nodules.
5. Isolation of Azotobacter from soil.
6. Isolation of Cyanobacteria from paddy field.
7. Measurement of pH of soil sample.

Books Recommended:

Bagyraj and Rangasamy: Agricultural Microbiology

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M. Sc. Microbiology

FOURTH SEMESTER

Special Paper - PAPER-IV (B): INDUSTRIAL MICROBIOLOGY Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

Introduction to industrial microbiology

Brief history and developments in industrial microbiology Fermentation processes

Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations

UNIT- II

Bioreactors/fermenters

Components of a typical bioreactor, types of bioreactors-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

UNIT- III

Control parameters, industrially important strains, media ingredients Measurement and control of fermentation parameters

Control and monitoring of different parameters in a bioreactor; pH, temperature, dissolved oxygen, foaming and aeration

Isolation of industrially important microbial strains

Primary and secondary screening, strain development, preservation and maintenance of industrial strains Media and ingredients for industrial fermentations

Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

UNIT- IV

Down-stream Processing

Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying

Lab Course:

1. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
(a) Enzyme: Amylase
(b) Amino acid: Glutamic acid
(c) Organic acid: Citric acid
(d) Alcohol: Ethanol
(e) Antibiotic: Penicillin
2. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

Books Recommended:

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

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