बिलासपुर विश्वविद्यालय शिक्षण विभाग, बिलासपुर (छ.ग.)

में ''माइक्रोबायोलॉजी एण्ड बायोइन्फॉर्मेटिक्स विभाग'' में

एम.एससी. माइक्रोबायोलॉजी एण्ड बायोइन्फॉर्मेटिक्स कोर्स के अंतर्गत

सत्र् 2016-17 में नियमित छात्रों के लिए लागू
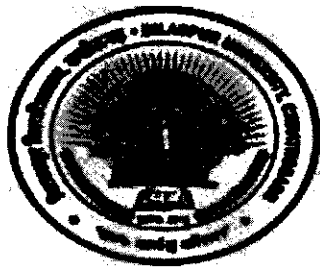
सेमेस्टर पाठ्यक्रम

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एम.एससी. माइक्रोबायोलॉजी एण्ड बायोइन्फॉर्मेटिक्स

M.Sc. Microbiology and Bioinformatics

DEPARTMENT OF MICROBIOLOGY AND BIOINFORMATICS

M.Sc. Microbiology and Bioinformatics

BILASPUR UNIVERSITY

Old High Court Bhavan, Near Gandhi Chowk
Bilaspur (C.G) - 495001

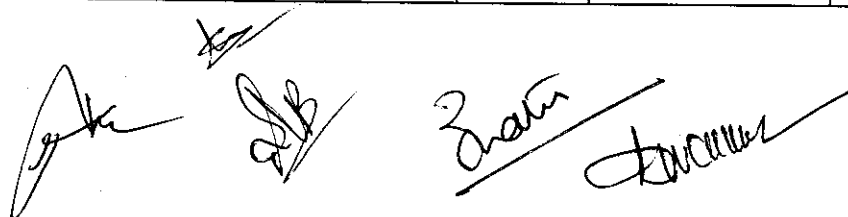# Department of Microbiology and Bioinformatics
Bilaspur University, Bilaspur

M.Sc. Microbiology and Bioinformatics

First Semester

Course Code	Course Category	Course Name	Lectures	Credits	Maximum Marks		
					CIA	External	Total
MB 101	HC	General Microbiology	60	5	25	75	100
MB-102	HC	Bioinstrumentation and Biostatistics	60	5	25	75	100
MB-103	HC	Virology, Mycology and Phycology	60	5	25	75	100
MB-104	HC	Introduction to Bioinformatics	60	5	25	75	100
MB-105	HC	General Microbiology, Bioinstrumentation and Biostatistics Lab	60	2.5	12.5	37.5	50
MB-106	HC	Virology, Mycology, Phycology and Bioinformatics Lab	60	2.5	12.5	37.5	50
			Total	25	Total		500

Second Semester

Course Code	Course Category	Course Name	Lectures	Credits	Maximum Marks		
					CIA	External	Total
MB-201	HC	Biochemistry and Microbial Physiology	60	5	25	75	100
MB-202	HC	Environmental Microbiology	60	5	25	75	100
MB-203	HC	Bioinformatics Databases	60	5	25	75	100
MB-204	HC	Biomolecules and Enzyme Technology	60	5	25	75	100
MB-205	HC	Biochemistry, Microbial Physiology and Environmental Microbiology Lab	60	2.5	12.5	37.5	50
MB-206	HC	Bioinformatics Databases, Biomolecules and Enzyme Technology Lab	60	2.5	12.5	37.5	50
			Total	25	Total		500
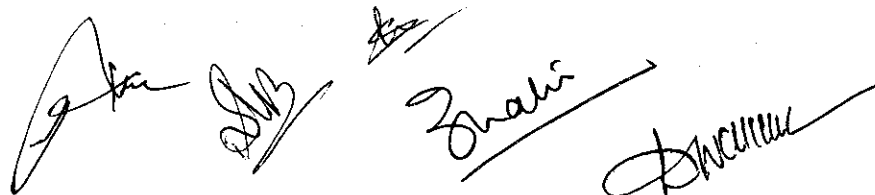
Third Semester

Course Code	Course Category	Course Name	Lectures	Credits	Maximum Marks		
					CIA	External	Total
MB-301	HC	Microbial Genetics and Molecular Biology	60	5	25	75	100
MB-302	HC	Genetic Engineering	60	5	25	75	100
MB-303	HC	Immunology	60	5	25	75	100
MB-304	HC	Bioinformatics and Sequence Analysis	60	5	25	75	100
MB-305	HC	Microbial Genetics, Molecular Biology and Genetic Engineering Lab	60	2.5	12.5	37.5	50
MB-306	HC	Immunology and Sequence Analysis Lab	60	2.5	12.5	37.5	50
			Total	25	Total		500

Fourth Semester

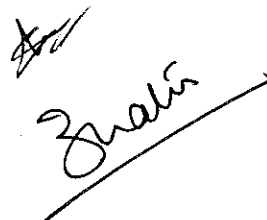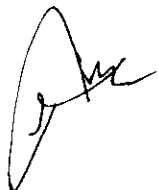| Course Code	Course Category	Course Name	Lectures	Credits	Maximum Marks		
					CIA	External	Total
MB-401	HC	Industrial Microbiology	60	5	25	75	100
MB-402	HC	Programming in PERL	60	5	25	75	100
MB-403	SC-1	Agricultural Microbiology	60	5	25	75	100
	SC-2	Fermentation Technology					
	SC-3	Introduction to Computers, Internet, Programming Languages and Data Structures					
	SC-4	Medical Microbiology					
	SC-5	Drug Designing, Intellectual Property Rights and Patent Laws					
	SC-6	Food Microbiology					
MB-404	HC	Industrial Microbiology and Programming in PERL Lab	60	2.5	12.5	37.5	50
MB-405	HC	Lab on Major Elective	60	2.5	12.5	37.5	50
MB-406	Project Work/ Dissertation	Project Work/ Dissertation	-	5	25	75	100
			Total	25	Total		500

COURSE FRAMEWORK

Course categories offered in the curriculum

There shall be three categories of courses:

a. **HC** Core papers: These papers are compulsory for students.

b. **SC** Elective and Choice Based Paper (MB-403): Students need to select any one paper from SC-1 to SC-6 in IV Semester.

c. **Project Work / Dissertation** (MB-406): Students has to carry out a dissertation/ project work in the IV semester.

Each theory paper will be of 100 marks (25 marks will be on internal assessment and 75 marks will be on external assessment). The internal assessment will encompass three tests of 10 marks each. The best out of two will be considered. There will be an assignment for each paper for which a writeup is to be submitted. The writeup should not be less than 15-20 pages. The student will be presenting his topic of assignment in form of PowerPoint presentation. There will be 5 marks for writeup and presentation.

The practicals for each lab course will be of 50 marks (12.5 marks will be of internal assessment and 37.5 marks will be for practical examination). The internal assessment for practicals will be based on regularity and performance during the complete semester.

MB- 101: GENERAL MICROBIOLOGY

UNIT –I

History and scope of Microbiology: Contributions of eminent scientists in the field of Microbiology. Introduction of prokaryotes. Natural System of Classification, Binomial Nomenclature, International code of Nomenclature of Prokaryotes. Taxon, Species, Strain. Criteria used for Classification – Three Domain Classification, Classification of bacteria according to Bergey's Manual of Determinative Bacteriology. Recent trends in microbial taxonomy: Chemotaxonomy, Molecular methods, Numerical taxonomy, Genetic methods in taxonomy, Serological methods and Taxonomy based on Ecology.

UNIT –II

Sterilization techniques: physical and chemical methods. **Isolation media and Preservation:** Culture media, Isolation and culture techniques. Pure culture techniques and preservation of cultures.

UNIT – III

Morphology and ultra structure of bacteria: Morphological types- shape, size and arrangements. Cell wall of Eubacteria and Archaebacteria. Cell Membrane - structure, composition and properties. Antigenic properties: structure and function of capsule, flagella, pili and cilia. Cytoplasmic inclusions. Characteristic features and economic importance of major groups of Eubacteria and Archea.

UNIT – IV

Nutrition and growth in Bacteria: Nutritional types of bacteria, Physiological requirements (micro and macro nutrients). Cultural characteristics of bacteria, Cultivation of bacteria: aerobic anaerobic, batch, continuous and synchronous cultures. Bacterial growth - growth kinetics, growth rate and generation time, growth curve, factors affecting growth, Nutritional uptake (bacterial transport system).

UNIT-V

Reproduction in bacteria – Binary fission, endospore formation and cell wall synthesis (peptidoglycan synthesis). Recombination in bacteria- Conjugation, Transformation and Transduction.

Recommended Text Books
- Singh, R.P. General Microbiology. Kalyani Publishers, New Delhi (2007).
- Aneja, K.R. Experiments in Microbiology, Plant pathology and Biotechnology, Fourth edition, NewAge International publishers.
- Dubey, R.C. and Maheshwary, D.K. Text book of Microbiology. S.chand and company (1999).
- Powar, C.B. and Daginawal, H.F. General Microbiology. Vol-I and Vol- II, Himalaya Publishing House.
- Chakraborty P. A Textbook Of Microbiology. New central book Agency (2005).

Reference Books

- Prescott, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB Mc GrawHill, New York, (2002).
- Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
- Alcomo, I.E. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers.Sudbury. Massachusetts, (2001).
- Black J.G. Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York, (2002).

LAB

1. Introduction to good laboratory practices and sterilization techniques and preparation of different nutrient media's – Liquid and Solid media- minimal, complex and differential media.
2. Isolation of bacteria from air, water and soil.
3. Morphological characteristics of bacteria- staining (simple and differential staining techniques).
4. Bacterial culture techniques- Broth culture, Pure culture techniques.
5. Measurement of bacterial population by turbidimetry and colony counting by serial dilution of samples.
6. Bacterial growth curve.
7. Antibiotic sensitivity tests- disc method.
8. Preservation of pure cultures: slant preparation, water stock and glycerol stock.
9. Biochemical tests for bacterial identification.

MB-102: BIOINSTRUMENTATION AND BIOSTATISTICS

UNIT –I

Microscopy: Principles, Types of Microscopes, Construction and Working principles. Light microscopy-simple dissection microscope, Compound microscopy, (Bright field, Dark field, Phase contrast and fluorescence microscopy) and stereomicroscopy. Confocal microscopy. Electron microscopy – Principle, construction and mode of operation of scanning and transmission electron microscopy and their limitations. Preparation of specimens for electron microscopic studies (Ultra thin sectioning, negative staining, shadow casting and freeze itching).

UNIT-II

Spectrophotometry: Principles and techniques of colorimetry and Beer's Lambart's law. Spectrophotometry, Spectrofluorimetry, Turbidometry, Flame and Atomic absorbtion Spectrophotometer.
Electrophoresis: Principles and working, types of electrophoresis, Seperation of nucleic acids (DNA and RNA), separation of proteins (native and SDS-PAGE, 2-D gel electrophoresis, Hybridization –Western blot, Northern blot, Southern blot and North-western blot.

UNIT-III

Centrifugation: Basic Principles, Types of centrifugation, centrifugation methods and accessories used for colloidal nature of particles, sedimentation velocity, sedimentation equilibrium and cell fractionation methods.

UNIT-IV

Chromatography: Principle of separation, Types- liquid-liquid, thin layer, adsorption, gas liquid, ion exchange, affinity and HPLC –Principles of each type, instrumentation and accessories-detection methods and systems qualitative and quantitative aspects –applications.

UNIT-V

Biostatistics- Data, Types of data, central tendency of the given data –Mean, Mode, Median, standard error, standard deviation, t-Test of significance, F-test, Chi-square test. Analysis of variance –one way and two way.
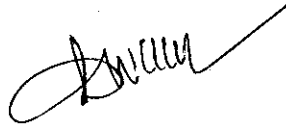**Fundamentals of computers** – Block diagram of computer (input and output devices) – History – Generations – Memory devices – Advantages and Limitations of Computers – Comparison of different operating systems DOS, Windows NT & XP, Application Software's.

Recommended Text Books

- Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th Edition Cambridge University Press (2000).
- Khan I A and Khan I A. Fundamentals of Biostatistics, Ukaaz Publications, (1994).
- Murphy D.B. Fundamental of Light Microscopy & Electron Imaging. 1st Edition. Wiley-Liss. (2001).
- Beckner, W.M., Kleinsmith L.J and Hardin J. The world of cell. IV edition Benjamin/Cummings (2000).

LAB

1. Study of simple and compound microscopes and their handling.
2. Absorption spectra –UV-Visible.
3. Paper chromatography of amino acids and carbohydrates.
4. Thin layer chromatography.
5. Ion-exchange chromatography.
6. SDS Gel electrophoresis.
7. Agarose Gel electrophoresis.
8. Handling and organization of data.
9. Calculation of mean of length of 20 Ashoka leaves.
10. Calculation of mode of length of 20 Ashoka leaves.
11. Calculation of median of length of 20 Ashoka leaves.
12. To perform t- test of significance.
13. To perform ψ^2 test on given data.

M. Sc. Microbiology and Bioinformatics I Semester

MB-103: VIROLOGY, MYCOLOGY AND PHYCOLOGY

UNIT-I

Structure, Culture and Identification of Viruses: Nature and ultrastructure of viruses. Viral related agents: Viroids and Prions. Cultivation of viruses in embryonated eggs, experimental animals and Cell culture. Serological methods for Haemagglutination, complement fixation, IFA, ELISA, RIA.

UNIT-II

Virology: Classification and nomenclature of animal viruses. Life cycles of Herpes, adeno and SV 40, orthomyxovirus, HIV and adenovirus. General idea of plant viruses, Mode of transmission, and their pathological significance, TMV and CMV. Bacteriophage: Classification, morphology and ultrastructure of bacteriophages with special reference to T-phages. ϕX174, M13 and Mu phage. Lytic and lysogenic cycles of bacteriophages.

UNIT-III

General characteristics of fungi: structure and organization of fungus. Reproduction in fungi- Vegetative, asexual and sexual reproduction in fungi. Nutrition and metabolism in fungi. Fungal culture media. Fungi as food- mushrooms. Mycotoxins.
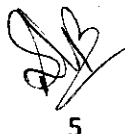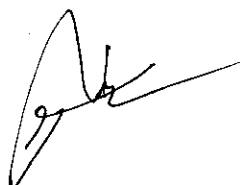
UNIT – IV

Mycology: Myxomycetes, Ascomycetes, Basidiomycetes and imperfect fungi. Mycorrhiza. Morphological features of *Alternaria, Curvularia, Helminthosporium, Fusarium Microsporum.* Lichens: Their types and biological significance.

UNIT – V

Phycology: Distribution of algae. Classification of algae, thallus organization in algae, reproduction in algae. Brief account of Chlorophyta, Bacillariophyta, Phaeophyta, Rhodophyta. Algal ecology and algal biotechnology.

Recommended Text Books

- Pelczar M., Chan E.C.S. and Krieg, N.R. Microbiology.Tata Mc Grew Hill Publishing Co. Ltd., New Delhi.
- Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R. The Microbial World. Printice-Hall of India (Pvt.) Ltd., New Delhi.
- Alexopoulus, C.J., Mims,C.W. and Blackwel, M, Introductory Mycology. John Wiley, New York.
- Mehrotra, R.S. and K.R.Aneja An Introduction to Mycology. New Age International Press, New Delhi.
- Webster, J. Introduction to fungi. Cambridge University Press. Cambridge, U.K. (1985).
- Bessey E.A. Morphology and Taxonomy of fungi. Vikas Publishing House Pvt. Ltd., New Delhi.

LAB

1. Isolation of bacteriophages from sewage.
2. Study of symptoms of viral infection in plants.
3. Mechanisms of Transfer of virus in plants.
4. Study of cytopathic effect of virus in egg.
5. Calculate the bacteriophage number in a sewage sample with the help of PFU.
6. Isolation of storage fungi.
7. Study of morphological characteristics of Aspergillus, Penicillium, Alternaria, Mucor, Rhizopus, Curvularia, Fusarium, Helminthosporium, Fusarium and Yeast.
8. Study of morphological characteristics of edible mushroom.
9. Quantitate the ethanol production by yeast.
10. Isolation of endophytic fungus.
11. Morphological features of Nostoc.

M. Sc. Microbiology and Bioinformatics I Semester

MB- 104: INTRODUCTION TO BIOINFORMATICS

UNIT –I

Bioinformatics concepts: Aim and branches of Bioinformatics, Application of Bioinformatics. Role of internet and www in bioinformatics. Basic bimolecular concepts: Protein and amino acid, DNA & RNA, Sequence, structure and function. Forms of biological information. Types of Nucleotide Sequence: Genomic DNA, Complementary DNA (cDNA), Recombinant DNA (rDNA), Expressed sequence tags (ESTs), Genomic survey sequences (GSSs). DNA sequencing methods: Basic and Automated DNA sequencing, DNA sequencing by capillary array and electrophoresis, Gene expression data.

UNIT –II

Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB and DDBJ: The knowledge of databases and bioinformatics tools available at these resources, organization of databases: data contents. purpose and utility. Open access bibliographic resources and literature databases: PubMed, BioMed Central, Public Library of Sciences (PloS), CiteXplore.

UNIT –III

Sequence databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; Structure Databases: PDB, NDB, PubChem, ChemBank. Sequence file formats: Various file formats for bio-molecular sequences: GenBank, FASTA, GCG, MSF etc. Protein and nucleic acid properties: Proteomics tools at the ExPASy server, GCG utilities and EMBOSS, Computation of various parameters.
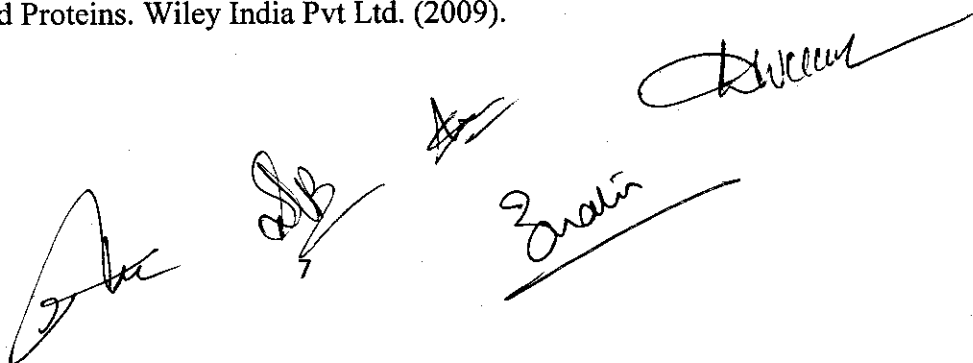
UNIT –IV

Sequence Analysis: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series. matrix derivation methods and principles.

UNIT –V

Sequence alignment: Measurement of sequence similarity; Similarity and homology. Pairwise sequence alignment: Basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.

Recommended Text Books
- Mount D., Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York. (2004).
- Baxevanis, A.D. and Francis Ouellellette, B.F., Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins. Wiley India Pvt Ltd. (2009).

Reference Books

- Teresa K. Attwood, David J. Parry-Smith, Introduction to Bioinformatics. Pearson Education. (1999).
- Jean-michel Claverie Cedric Notredame. Bioinformatics for Dummies. Publisher: Dummies (2007).

LAB

1. Entrez and Literature Searches
   a. PubMed
   b. PubMed central
   c. OMIM / OMIA
   d. Citation matcher
2. SRS of Biological Databases
   a. Nucleotide/ Genome Databases.
   b. Protein Sequence Database.
   c. Structure databases.
   d. Protein Pattern Databases
3. File format conversion
   a. FmtSeq
   b. ReadSeq
   c. Sequence manipulation Suite
4. Sequence Analysis
   a. Dot Plot
   b. Pairwise alignment
   c. Multiple Sequence Alignment
5. Softwares
   a. BioEdit
   b. GeneDoc
   c. ClustalW / X, MEGA, MEME
6. Visualization Tool
   a. RasMol
   b. Cn3D
   c. PyMol

8

MB-201: BIOCHEMISTRY AND MICROBIAL PHYSIOLOGY

UNIT – I

Basic aspects of bioenergetics: First and second law of thermodynamics. Concept of free energy, ATP as a high energy compound. Oxidative photophosphorylation. Detail classification, structure and functions of carbohydrate, protein and lipids.

UNIT – II

Major nutritional types of microorganisms: Autotrophs, Heterotrophs, Chemotrophs, Phototrophs, Lithotrophs and Organotrophs. Physiology and importance of specialized groups of microorganisms: psychrophilic, thermophilic, osmophilic, xerophilic, halophilic, acidophilic, Barophiles microorganisms. Methanogens and methylotrophs. Specific metabolic pathways for generation of hydrogen and methane.

UNIT - III

Nature and expression of microbial growth: Growth phase, growth curve of bacterial population and other microorganisms. Generation time. Measurement of growth: cell mass, cell number and cell constituents. Bacterial growth in batch and continuous cultures, chemostats and turbidostats, synchronous growth. Anaerobic culturing of bacteria.
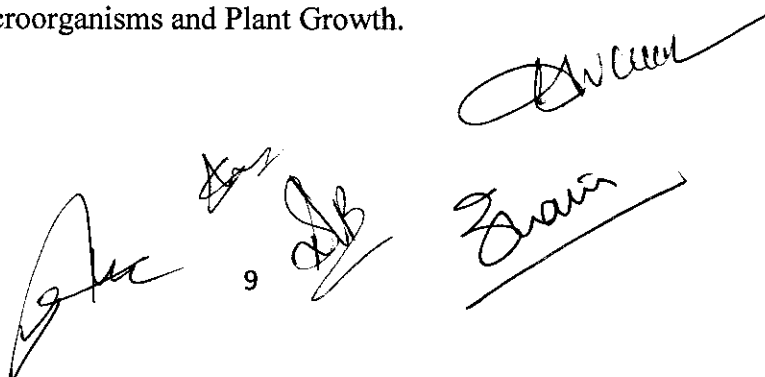
UNIT – IV

Photosynthetic microorganisms: classification and characterization of Photosynthetic microorganisms. General account of photosynthesis and photometabolism. Fermentation of carbohydrates. Fixation of molecular Nitrogen. Nitrification and denitrification. Microbial leaching of minerals.

UNIT – V

Factor affecting growth of microorganisms: Mechanism of antibacterial action. Antibiotics and drugs affecting cell wall and cell membrane, inhibition of DNA synthesis and protein synthesis. Drug resistance in bacteria. Radiation sensitivity.
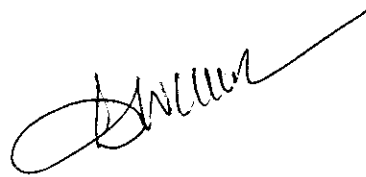
Recommended Text Books
- Stanier, Ingraham, Wheelis and Painter. The Microbial world. Mc Millan Educational Ltd., London.
- Moat and Foster, Microbial Physiology. Wiley.
- Umbreit. Essentials of Bacterial Physiology.
- Skokatch. Bacterial Physiology and Metabolism.
- Kushner, D.J. Microbial life in Extreme Environments. Academic Press.
- Pawar. C.B. Cell Biology.
- Sturart. Harris and Harris. The control of Antibiotic Resistance in Bacteria.
- Franklin and Snow, Biochemistry of Antimicrobial Action. Chapman and Hall, New York.
- Philipp. G. Mannual of Methods for General Bacteriology.
- David T. Plummer. An Introduction to Practical Biochemistry.
- Subba Rao. N.S. Soil Microorganisms and Plant Growth.

LAB

1. Study of morphological characteristics of Nostoc.
2. Study of oligodynamic effect of metals on microorganisms.
3. Study of effect of UV radiations on the growth of fungus.
4. Antibiotic sensitivity test (disk diffusion).
5. Study of effect of salt concentration on microorganism.
6. Study of effect of sugar concentration on microorganism.
7. Isolation of keratinophiles by baiting technique.
8. Isolation of Rhizobium from root nodules.
9. Study of bacterial growth curve by septrophotometric method.
10. Study the anaerobic gas pack jar for cultivation of anaerobes.
11. Biochemical estimations of carbohydrate, protein and lipids.

M. Sc. Microbiology and Bioinformatics II Semester

MB-202: ENVIRONMENTAL MICROBIOLOGY

UNIT –I

Aeromicrobiology: Bioaerosol, Droplet Nuclei. Phylloplane and Phyllosphere microflora. Air borne microorganisms and their significance in human health and plant disease development. Techniques for analysis of air borne microorganisms- The settling plate technique, slit type sampler, liquid impinger, sieve sampler, Anderson's sampler, cascade sampler; Filtration methods. Control of air borne microbes.

UNIT –II

Soil Microbiology: Classification of soil - physical and chemical characteristics, Soil as a habitat for Microbial Growth. Microbial Interactions. Rhizosphere, Rhizoplane. Role of microorganisms in mineral cycling and soil fertility. Biodegradation of organic compounds in soil.

UNIT –III

Aquatic Microbiology: Microbiology of Fresh water (pond and lakes) and Marine water (estuaries, deep sea, hydrothermal vents) Ecosystem. Potability of water, Microbial assessment of water quality. Methods of purification of water. Waste water (sewage) treatment.

UNIT –IV

Biowaste Management and Treatment: Treatment of dairy and Industrial effluent. Solid waste treatment and management. Use of waste for production of food (Mushroom), Biofertilizer (Compost) and biofuel (biogas and ethanol). Biodegradation and Xenobiotics- Plastic, oil spills, and oil refinery waste.
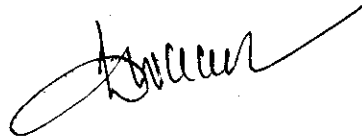
UNIT –V

Microbial activities: Biodeterioration of paper, pulp textile and paints, Biomagnification, Bioaugumentation, Biomining and bioleaching, Biodiesel production from Jatropa, Biomonitoring.

Recommended Text books

- Medigan, M.T., Martinko, J. M. and Parker, J. Brock Biology of Microorganisms. Pearson Education Inc. , New York
- Alexander, M John. Microbial ecology. Wiley & Sons, Inc., New York.
- Alexander, M John. Introduction to soil microbiology. Wiley & Sons Inc., New York.
- Barker, KH. and Herson, D.S. Bioremediation. Mc Craw Hill Inc., New York.

LAB

1. Isolation and enumeration of microorganism from air samples by settle plate technique.
2. Isolation and enumeration of microorganism from water samples by Bait Method.
3. Isolation and enumeration of microorganism from soil samples by serial dilution technique.
4. Determination of BOD of water (Raw/ Treated /Sewage).
5. Detection of Dissolved Oxygen (DO).
6. IMViC Test.
7. Multiple fermentation tube tests for Coliforms.
8. Isolation of cellulase producing microorganisms from soil.
9. Study of antagonism.

MB-203: BIOINFORMATICS DATABASES

UNIT –I

Introduction to Bioinformatics data and databases: Types of Biological data:- Genomic DNA Complementary DNA (cDNA), Recombinant DNA (rDNA), Expressed sequence tags (ESTs), Genomic survey sequences (GSSs). Primary Databases: - GenBank, EMBL, DDBJ. Composite Databases:-NRDB, UniProt, Literature Databases:- Open access and open sources, PubMed, PLoS, Biomed Central.

UNIT –II

Genome Databases: Viral genome database (ICTVdb, VirGen), Bacterial Genomes database (Genomes Online Database – GOLD, Microbial Genome Database - MBGD), Organism specific Genome database (OMIM / OMIA, SGD, WormBase, PlasmoDB, FlyBase, TAIR), and Genome Browsers (Ensembl, VEGA genome browser, NCBI-NCBI map viewer, KEGG, MIPS, UCSC Genome Browser).

UNIT –III

Sequence Databases: Nucleotide sequence Databases (GenBank, EMBL and DDBJ). Protein sequences Databases (Swiss-ProtProt, TrEMBL, UniProt, UniProt Knowledgebase – UniProtKB. UniProt Archive –UniParc, UniProt. Reference Clusters –UniRef, UniProt Metagenomic and Environmental Sequences –UniMES. Sequence motifs Databases – Prosite, ProDom, Pfam, InterPro. Sequence file formats –GenBank, FASTA, PIR, ALN/ClustalW. GCG/MSF.

UNIT –IV

Structure and Derived databases: Primary structure databases (Protein Data Bank –PDB, Cambridge Structural Database –CSD, Molecular Modeling Database –MMDB). Secondary structure databases, Structural Classification of Proteins –SCOP, Class Architecture Topology Homology –CATH, Families of Structurally Similar Proteins –FSSP, Catalytic Site Atlas –CSA. Molecular functions/Enzymatic catalysis databases (KEGG ENZYME database, BRENDA).
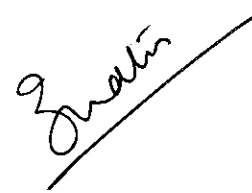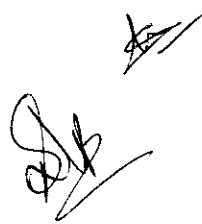
UNIT –V

Bioinformatics Database search engines: Text-based search engines (Entrez, SRS, DBGET /LinkDB). Sequence similarity based search engines (BLAST and FASTA). Motif-based search engines ScanPrositeScanProsite and eMOTIF). Structure similarity based search engines (VAST and DALI). Proteomics tools at the ExPASy server, GCG utilities and EMBOSS.

Recommended Text Books

- Mount D., Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press. New York. (2004).
- Baxevanis. A.D. and Francis Ouellellette, B.F., Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins. Wiley India Pvt Ltd. (2009).
- Teresa K. Attwood, David J. Parry-Smith. Introduction to Bioinformatics. Pearson Education. (1999).

LAB

1. Bioinformatics Resources: NCBI, EBI, DDBJ, RCSB and ExPASy.
2. Open access bibliographic resources and literature databases
   a. PubMed.
   b. BioMed Central.
   c. Public Library of Sciences (PLoS).
   d. CiteXplore.
3. Bioinformatics Resources at the species level
   a. ICTV Database.
   b. AVIS.
   c. VirGen.
   d. Viral genomes at NCBI.
4. Sequence databases:
   a. Nucleic acid sequence databases: GenBank, EMBL and DDBJ.
   b. Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL and UniParc.
   c. Repositories for high throughput genomic sequences: EST, STS and GSS.
   d. Genome Databases at NCBI, EBI, TIGR and SANGER.
5. Structure Databases: PDB, NDB, PubChem, ChemBank, FSSP and DSSP.
6. Derived Databases: InterPro, Prosite, Pfam and ProDom.
7. Sequence file formats: GenBank, FASTA, GCG and MSF.
8. Protein and nucleic acid properties: Proteomics tools at the ExPASy server, GCG utilities and EMBOSS.

MB-204: BIOMOLECULES AND ENZYME TECHNOLOGY

UNIT- I

Introduction to enzymes: Enzyme classification and nomenclature, characteristics of enzymes. Mode of action and kinetics of enzyme catalyzed reactions (K_m and V_{max}). Types and Mechanism of enzyme inhibition, Biotechnological importance of enzymes.

UNIT – II

Microbial sources of enzymes: Primary and secondary screening of microorganisms for enzyme production. Qualitative and quantitative assay of enzyme activity: Amylases, Cellulases, Hemicellulases, Proteases. Natural and synthetic substrates for enzyme assay. Enzymes units.

UNIT – III

Methods of enzyme production: Submerged and Solid State Fermentation (SSF). Important parameters in enzyme production. Enzyme purification Techniques- Precipitation, chromatographic separation-gel filtration, anion and cation exchange, zymography.

UNIT-IV

Techniques used in characterization of enzymes: Determination of molecular weight (SDS PAGE, Gel filtration), Isoelectric point, pH & temperature optima and stability, Inhibition pattern, Product analysis of enzyme action using TLC, HPLC, GC, MS and MALDI-TOF.
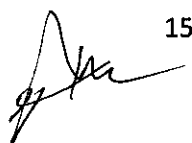
UNIT- V

Molecular biology of enzymes: Amino acid sequencing, structure and function relationship. Protein engineering & directed evolution. Cloning and over expression of microbial enzymes in heterologous host.
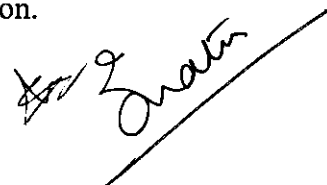
Recommended Text Books

- Berg J M. Tymoczko J L, Stryer L., Biochemistry. 6th Edition. Freeman (2006).
- Prakash Singh Bisen, Anjana Sharma, Introduction to Instrumentation in Life Sciences. Taylor and Francis, (2012).
- James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).
- Casida LE, Industrial Microbiology, J. Wiley, (1968).
- Chisti. Y. Encyclopedia of Bioprocess Technology, Vol-5, John Wiley and Sons, New York.
- Michael L. Shuler and Fikret Kargi. Bioproccess Engineering: Basic Concepts, 2nd Edition. Prentice Hall. (2001).

LAB

1. To isolate industrially important enzyme producers from soil.
2. Qualitative and Quantitative assay of the selected enzyme.
3. Optimization of the enzyme production.
4. Scaling up of the enzyme production in Laboratory fermentor.
5. Analysis of substrate utilization and product formation.
6. Ammonium sulphate precipitation for enzyme concentration.
7. Column Chromatography for purification.
8. SDS PAGE for enzyme purification.

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MB-501: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

UNIT-I

Microbial Genetics: Definition and scope of Genetics. Premendelian and Mendelian genetics. Organization of genetic material in bacteria, Gene transfer mechanisms in bacteria – Conjugation. Transduction and Transformation.

UNIT-II

Fungal genetics: Features and consequences of heterothallism, homothallism, mating types, Vegetative incompatibility, Polyploidy, and aneuploidy. Neurospora –Tetrad analysis and linkage detection. Two point and three point crosses –Induction of mutation –Mitotic recombination in Neurospora –Transposable elements –Gene conversion.

UNIT-III

Organization and process of Eukaryotic genome: components of eukaryotic chromatin, DNA super coiling, satellite DNA, Prokaryotic and Eukaryotic replication, Mechanism of replication, Enzymes and necessary proteins involved, Telomers, telomerase and end replication, DNA Repair-Mismatch, Base-excision, Nucleotide excision and Direct repair, DNA recombination –Homologous site specific and DNA transposition.

UNIT-IV

Transcription: Prokaryotic and Eukaryotic Transcription –RNA polymerase –general and specific transcription factors, regulatory elements-mechanism of transcription regulation. Transcription termination. Post transcriptional modification – 5' cap formation -3' end processing and polyadenylation-splicing, editing, nuclear export of mRNA-mRNA stability.

UNIT-V

Translation: Genetic code –Prokaryotic and Eukaryotic Translation, Translation machinery, Mechanism of initiation –elongation and termination
Regulation of gene expression, operon concept, catabolite repression, positive and negative regulation, inducers and co-repressors, lac operon, ara operon and Tryp Operon.

Recommended Text Books
- Benjamin Lewin. Gene VII, Oxford University Press, (2000).
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc. (2002).
- Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
- Watson. J. D, Baker. T. A, Bell. S. P, Gann. A. Levine. M. Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).
- David Friefelder, Stanely R. Maloy, Molecular biology and Microbial genetics. 2nd Edition, Jones and Barlett Publishers. (1994).
- Brown T.A. Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
- Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
- Glick BR and Pasternak JJ, Molecular Biotechnology, 2nd Ed. ASM press. (2003).
- Uldis N. Streips, Ronald E. Yasbin. Modern Microbial Genetics. 2nd Edition Wiley-Liss,Inc. (2002).

- Russel P J, Essential genetics, Blackwell Science Inc, 2 sub edition, (1987).
- Gardner E J, Simmons M J and Snupstad DP, Principles of genetics, 8th edition John Wiley & Sons, (2006).

LAB

1. Isolation of Plasmid DNA from bacteria.
2. Isolation of Genomic DNA from bacteria.
3. Isolation of RNA from yeast.
4. Quantitative estimation of RNA by orcinol method.
5. Quantitative estimation of DNA by DPA method.
6. Determination of Tm value of DNA.
7. Protein purification by ion exchange chromatography.
8. Protein purification by gel permeation chromatography.
9. Purification of protein by SDS PAGE.

MB- 302: GENETIC ENGINEERING

UNIT –I

Basic techniques in Genetic Engineering: Isolation and purification of genomic and plasmid DNA. Pulse field gel electrophoresis. Nucleic acid blotting (Southern, Northern and Western blotting). RNase protection assay, *in situ* hybridization. PCR methods and application (RT-PCR, RT-Quantitative PCR). DNA sequencing methods- Maxam and Gilbert method, Sanger's dideoxy method, Automated DNA sequencing, pyrosequencing. Oligonucleotide synthesis, Site-directed mutagenesis: Analysis of genetic variation-Single nucleotide polymorphism, RFLP, RAPD, Restriction mapping, Chromosome mapping and chromosome painting, DNA Chips and Microarray.

UNIT –II

DNA manipulating Enzymes: Nucleases, polynucleotide kinase, DNA Ligase, DNA polymerase I, Klenow fragment, RNA dependent DNA polymerase, Terminal deoxynucleotidyl transferase, poly A Polymerase, alkaline phosphatase, Reverse transcriptase. Restriction endonucleases. **Prokaryotic Host-Vector system:** Vectors (Plasmid, Bacteriophage, Cosmids and Plasmid-Phage) for cloning in Prokaryotic host (*E.coli*), shuttle vectors and expression vectors.

UNIT –III

Recombinant DNA concept and Principles of Cloning: Construction of vector, ligation, infection, transduction and Cloning. Cloning in Yeast, Cloning in Animals System, Cloning in Plant System - Properties of Host, vectors and methods of introduction of foreign DNA in host system.

UNIT –IV

Methods of screening and selection of Recombinant clones: DNA Libraries- development of vectors, construction of genomic and full length cDNA Libraries. Screening libraries with gene probes. Sequence dependent screening- colony hybridization, plaque hybridization, Screening by gain of function, Immunological screening, chromosome walking, studying gene function through protein interactions – two hybrid screening, phage display libraries. Analysis of gene expression based on 17 RNA Polymerase, visible marker gene. Gene silencing.

UNIT –V

Applications and legal issues: Applications of genetic engineering in agriculture, veterinary, industry, Forensic Science and Medicine. Transgenic crops, animals, recombinant enzymes, pharmaceuticals- humulin, somatotropin and somatostatin, Ethical, legal, social and environmental issues.
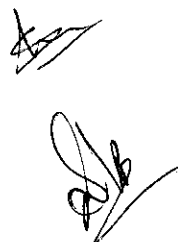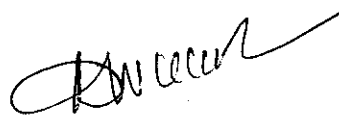
Recommended Text Books
- Singh, R.P. General Microbiology. Kalyani Publishers. New Delhi, (2007).
- Aneja K. P. Experiments in Microbiology, Plant pathology and Biotechnology by, NewAge International publishers Fourth edition
- Dubey R.C. and Maheshwary D.K. Text book of Microbiology. S.Chand and company (1999).

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Reference Books

- Benjamin Lewin, Gene VII, Oxford University Press, (2000).
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc, (2002).
- Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
- Watson. J. D. Baker. T. A, Bell. S. P, Gann. A. Levine. M. Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).
- David Friifield r. Stanely R. Maloy, Molecular biology and Microbial genetics. 2nd Edition, Jones and Barlett Publishers. (1994).
- Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
- Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
- Glick BR and Pasternak JJ, Molecular Biotechnology, 2nd Ed. ASM press. (2003).
- Uldis N. Streips, Ronald E. Yasbin. Modern Microbial Genetics. 2nd Edition Wiley-Liss,Inc. (2002).
- Russel P J. Essential genetics, Blackwell Science Inc, 2 sub edition, (1987).
- Gardner E J, Simmons M J and Snupstad DP, Principles of genetics, 8th edition John Wiley & Sons, (2000).

LAB

1. Plasmid DNA isolation and quantification.
2. Preparation of competent cells.
3. Transformation of plasmid DNA into *E.coli* cells.
4. Analysis of cloned gene and agarose gel electrophoresis.
5. Bacterial Gene Expression(using Lac promoter system).
6. Restriction Fragment Length Polymorphism analysis.
7. RAPD Fingerprinting(Demonstration).

MB-303: IMMUNOLOGY

UNIT –I

Immune Systems: Cells & Organs of immune System, Anatomical Barriers, Types of Immunities, Antigens- Their properties, specificity, haptens, Bacterial toxins, Immunological tolerance.

UNIT –II

Antigen and Antibody: Structure of antibodies & their types, Theories of antibody formation, Immunological tolerance Mechanisms of antibody & antigen reaction, Serological reactions.

UNIT –III

Immune Reactions: Hypersensitivity and their types, Autoimmune disease. Immunoprophylaxis. Active and passive immunization. Tumor immunology.

UNIT –IV

Immunodeficiency and MHC: Transplantation and Rejection, Primary immunodeficiency, Secondary immunodeficiency, The Complement system, Major Histocompatibility Complex.
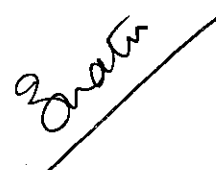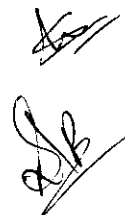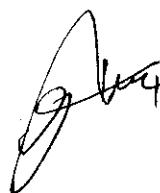
UNIT –V

Microbial Immunology: Infection. Immunity against bacteria, fungus and virus. Immunohematology, Immunology of transplantation and malignancy.

Recommended Text Books
- Bernard, Davis B. Dulbecco, Eisen and Ginsberg. Microbiology including immunology and molecular Genetics. 3rd Edition
- Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
- Kuby. Immunology. 4th edition. W. H. Free man & company.
- Ananthanarayan and Paniker. Text book of microbiology. University press. 8th edition

LAB

1. Widal test.
2. RPR test for Syphillis.
3. Blood group determination.
4. Oucterlony double diffusion test.
5. Immunoelectrophoresis.

MB-304: BIOINFORMATICS AND SEQUENCE ANALYSIS

UNIT –I

Sequence Analysis: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues **Scoring matrices:** basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles. **Database Searches:** Keyword-based Entrez and SRS; Sequence-based: BLAST & FASTA; Use of these methods for sequence analysis including the on-line use of the tools and interpretation of results from various sequence and structural as well as bibliographic databases.

UNIT –II

Pairwise sequence alignment: Basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.

UNIT –III

Multiple sequence alignments (MSA): The need for MSA, basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW and PileUp and their application for sequence analysis (including interpretation of results), concept of dendrogram and its interpretation, Use of HMM-based Algorithm for MSA (e.g. SAM method).

UNIT –IV

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, various types of pattern representations viz. consensus, regular expression (Prosite-type) and sequence profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.
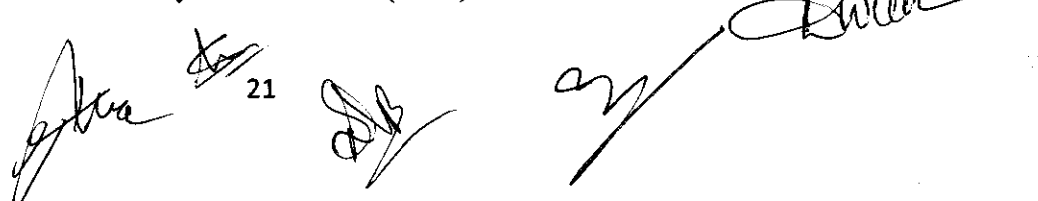**Algorithms for derivation and searching sequence patterns:** MeMe, PHI-BLAST, SCanProsite and PRATT. Algorithms for generation of sequence profiles: Profile Analysis method of Gribskov, HMMer, PSI-BLAST.

UNIT –V

Taxonomy and phylogeny: Basic concepts in systematics, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees, Phylogenetic analysis algorithms such as maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining, Probabilistic models and associated algorithms such as Probabilistic models of evolution and maximum likelihood algorithm, Bootstrapping methods, use of tools such as Phylip, MEGA, PAUP.
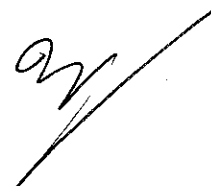
Recommended Text Books
- Mount D., Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York. (2004).
- Baxevanis, A.D. and Francis Ouellellette, B.F., Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins. Wiley India Pvt Ltd. (2009).

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- Primrose, S.B. and Twyman, R.M., Principles of Genome Analysis and Genomics. (3rd Ed.) Blackwell Publishing Company, Oxford, UK. (2003).

LAB

1. Sequence Analysis Packages: EMBOSS, NCBI ToolKit and SMS.
2. Database search engines: Entrez, SRS and DBGET.
3. Pairwise alignment:
   a. Search tools against Databases
       i. BLAST
       ii. FASTA
4. Multiple sequence alignment:
   a. CLUSTALW
   b. Dialign
   c. Multalign
5. Sequence patterns and profiles:
   a. Generation of sequence profiles
       i. PSI-BLAST
   b. Derivation of and searching sequence patterns:
       i. MeMe
       ii. PHI-BLAST
       iii. SCanProsite
       iv. PRATT
6. Protein motif and domain analysis:
   a. MEME/MAST
   b. eMotif
   c. InterproScan
   d. ProSite
   e. ProDom
   f. Pfam
7. Phylogenetic analysis – MEGA, PAUP, PHYLIP

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M. Sc. Microbiology and Bioinformatics IV Semester

MB-401: INDUSTRIAL MICROBIOLOGY

UNIT-I
Development and scope of industrial microbiology: Microbes, their growth curves and production of primary and secondary metabolites. Screening of economically important cultures - Preliminary and secondary screening. Preservation of stock cultures.

UNIT-II
Fermentation equipments: General design of a fermenter, their types and applications. Characteristics of fermentation media, Raw materials, Scale up of fermentation processes, product recovery methods.

UNIT-III
Industrial Healthcare productions: Industrial production of Antibiotics - Penicillin, streptomycin and their derivatives. Production and application of large scale production of recombinant molecules interferon, human proteins –insulin, vaccines, anticancer agents and siderophores.

UNIT-IV
Microbiology and production of alcoholic beverages: Malt beverages, distilled beverages, wine and champagne, Commercial production of organic acids like acetic, lactic, citric and gluconic acids.
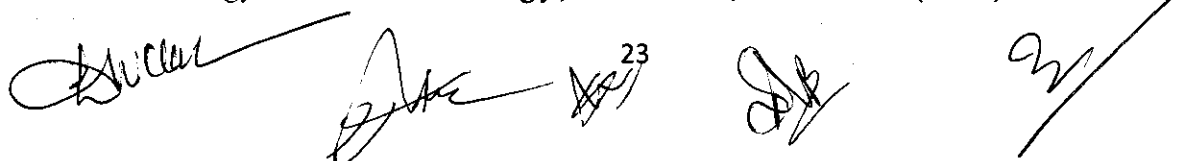
UNIT- V
Applied Industrial Microbiology: Industrial production of Amino acid (L-lysine, L-Glutamic acid), Vitamin B & C, Steroid transformation, Role of microorganisms in petroleum and mining industries, bioleaching of metals.

Recommended Text Books
- Nduka Okafor. Modern Industrial Microbiology and Biotecnology. 1st Edition. Science Publishers. (2007).
- Waites, M.J., Morgan, N.L., Rockey, J.S. and Hington, G. Industrial Microbiology: An introduction. Blackwell science Publishers. (2002).
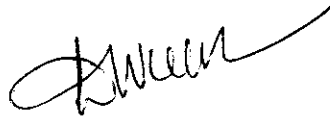
Reference Books
- Richard H. Baltz. Julian E Davies and Arnold L.DemainManual of Industrial Microbiology and Biotechnology. 3rd edition, ASM Press (2010).
- Daniel Forciniti. Industrial Bioseperation :Principles and practice. 1st edition edition, Wiley-Blackwell (2008).
- Reed. G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).
- Demain, A. L. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).
- EL Mansi. E.M.T., Fermentation Microbiology and Biotechnology. 2nd Edition, CRC Taylor & Francis (2007).
- Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. Industrial Microbiology: An Introduction. Blackwell Science Publishers (2002).
- Richard H. Baltz. Julian E. Davies, and Arnold L. Demain Manual of Industrial Microbiology and Biotechnology, 3rd Edition, ASM Press (2010).

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- Daniel Forciniti Industrial Bioseparations: Principles and Practice. 1st Edition, Wiley-Blackwell (2008).
- Reed. G, Prescott and Dunn's Industrial Microbiology, CBS Publishers (1999).
- Demain, A. L, Industrial Microbiology and Biotechnology, II Edition (2001).
- Casida LE, Industrial Microbiology, J. Wiley, (1968).
- James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).

LAB

1. Isolation of industrially important organisms from soil.
2. Preliminary screening of the isolates for any industrially important product by plate method.
3. Secondary screening of the screened isolates by Batch fermentation.
4. Ammonium sulphate precipitation for products of protein nature.
5. Purification by column chromatography.
6. Native PAGE for the preliminary molecular characterization.

M. Sc. Microbiology and Bioinformatics IV Semester

MB-402: PROGRAMMING IN PERL

UNIT –I

Data Structure: Scalar Variables, Scalar Operations and Functions, Array Variables Literal Representation of Array, Array Operations and Functions, Scalar and List Context, Hash Variables, Literal Representation of a Hash, Hash Functions, Using Hashes for the Genetic Code, Gene Expression Data Using Hashes.

UNIT –II

Modular Programming: Subroutines, Advantage of Subroutines, Scoping and Subroutines, Arguments, Passing Data to Subroutines, Modules and Libraries of Subroutines, Concept about File handle, Opening and Closing a File handle, Opening and Closing a Directory Handle, Reading a Directory Handle, File and Directory Manipulation.

UNIT –III

Regular Expression and Pattern Matching: Concepts about Regular Expressions, Simple uses of Regular Expressions, Patterns, Matching Operator, Substitutions, Split and Join functions.
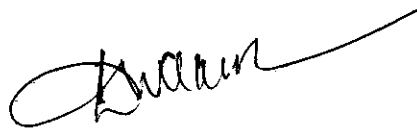
UNIT –IV

Common Gateway Interface (CGI) Programming: The CGI.pm Module, CGI program in Context, Simple CGI programs, Passing Parameters via CGI, Perl and the Web.

UNIT –V

BioPERL: Introduction to Bioperl, Installing procedures, Architectures, General Bioperl Classes, Sequences (Bio::Seq Class, Sequence Manipulation), Features and Location Classes (Extracting CDS), Alignments (AlignIO), Analysis (Blast, Genscan), Databases (Database Classes, Accessing a local database), Implementing REBASE.
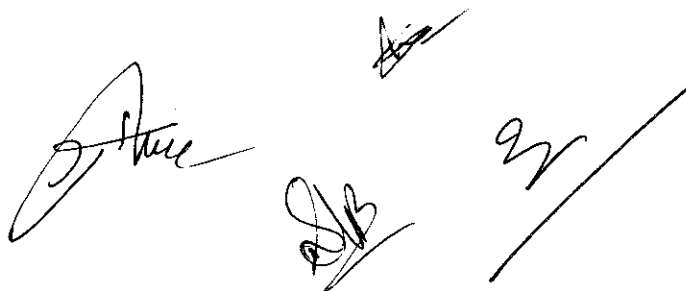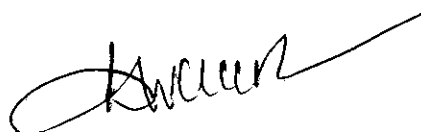
Text Books

- Tisdall, J., Beginning Perl for Bioinformatics. 1st Edition. O'Reilly Publishers. (2004).
- Randal L. Schwartz, Tom Phoenix and Brain d Foy, Learning Perl. 5th Edition. O'Reilly Publishers. (2008).
- Wall, W., Christiansen, T. and Orwant, J., Programming Perl. 3rd Edition. O'Reilly Publishers. 2000.

LAB

1. Uses of Scalar and Array Variables to manipulate DNA/RNA/Protein sequence data.
2. Concatenation DNA fragments, Transcribing DNA into RNA.
3. Calculating the Reverse complement of a DNA strand.
4. Uses of common Array Operators.
5. Uses of do-until Loops.
6. Uses of 'Substr' function to look into the string.
7. Reading a sequence data from a file and writing the results to a file.
8. Opening and closing a Directory Handle, Reading a Directory and other directory manipulation functions.
9. Uses of Subroutines.
10. Uses of Hashes for the genetic code: translating codons into amino acids.
11. Uses of subroutine to read FASTA files.
12. Translate a DNA sequence in all six reading frames.
13. Extract annotation and sequence from GenBank file.
14. Parsing GenBank annotation using arrays.
15. Installing Bioperl, Uses of Bioperl modules for sequence manipulation and accessing local database.

M. Sc. Microbiology and Bioinformatics IV Semester

MB- 403 (Elective -1): AGRICULTURE MICROBIOLOGY

UNIT –I

Introduction to Agriculture microbiology: Soil micro organisms in agro system: Types of microbial communities Interrelationship between plant and microbes: Above and below ground parts and effect of agricultural practices on soil.

UNIT –II

Microbial ecology: Chemical transformation and Nutrient mineralization by microbes in soil. Biological Nitrogen Fixation: Mechanism of nitrogen fixation, Biochemistry of nitrogenase. Genetics of nitrogen-fixation. Rhizobium –Legume Association, formation of root nodule. Importance of Leghaemoglobin.

UNIT –III

Disease Managemnet: Major plant diseases (Bacterial, Fungal and Viral) and their Biocontrol (bioherbicides, biopesticides, biofungicides and Bioinsecticides). Integrated Peat Management.
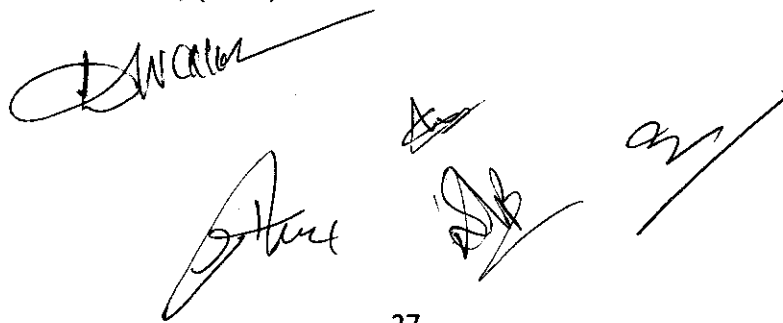
UNIT –IV

Biofertilizer: Bacterial biofertilizer (Nitrogen fixers, PSB), Cyanobacterial biofertilizer and Fungal biofertilizer. Industrial production of Biofertilizer. Green manuring- algalization.

UNIT –V

Plant Tissue Culture: History and Scope, Techniques and Applications. Biotechnology in agriculture- The new green revolution, Transgenic plants. Reclamation of barren lands using microbial technology.
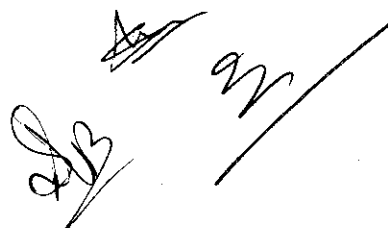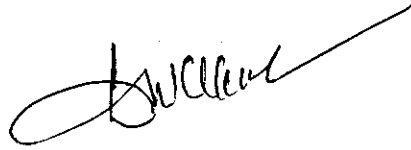
Recommended Text Books

- Eldor A. Paul. Soil Microbiology. Ecology and Biochemistry. VI Edition: AcademicPress, (2007).
- Eugene L. Madsen. Environmental Microbiology: From Genomes to Biogeochemistry. 1 Edition, Wiley-Blackwell Publishing. (2008).
- Agrios, G. N. Plant pathology. Harcourt Asia Pvt. Ltd. (2000).
- Buchanan. B.B., Gruissem, W. and Jones, R.L Biochemistry and Molecular Biology of Plants. 1.K. International Pvt. Ltd. (2000). .
- Mehrotra R S and Ashok Agrawal. Plant Pathology. Tata Mc Graw Hill ,6th reprint (2006).
- K. S. Bilgrami, H. C. Dube. A textbook of modern pathology. 6th Edition,Vani Educational Books, a division of Vikas, (1984).

Lab

1. Isolation and enumeration of bacteria and fungi from soil samples.
2. Isolation of micro-organism from rhizosphere and phyllosphere regions.
3. Isolation and characterization of nitrogen fixing microorganisms from soil (Bacteria and cyanobacteria).
4. Isolation of PSM from soil and study of Phosphate solubilizing efficiency of isolates on Pikovskaya medium.
5. Study of antagonism of micro-organism by dual culture inoculation method.
6. Preparation of MS media for PTC.
7. Preparation explants for inoculation in MS media.
8. Plant Tissue culture techniques (Meristem culture, Callus culture and hardening).

MB-403 (Elective-2): FERMENTATION TECHNOLGY

UNIT – I

Basic concepts of Fermentation: Types of fermentations-aerobic and anaerobic fermentation, Metabolic pathways involved in fermentations. Factors like Temperature, pH and dissolved oxygen influencing Microbial Metabolism. Phenomena of mass and oxygen transfer.

UNIT – II

Bioreactors: General design of Bioreactors, types of bioreactors and their applications- Fed batch bioreactors; Continuous stirred tank reactors (CSTR), Packed bed, Bubble column and Fluidized bed, Animal and plant cell bioreactors.

UNIT – III

Fermentation process -1: Upstream processing, general outline of microbial fermentation process, Process parameters and their optimization. Large-scale processes: Specific requirements of submerged and solid state fermentation.

UNIT –IV

Fermentation process -2: Downstream processing, Methods of product recovery: Filtration, Centrifugation, Distillation, Cell disintegration, Extraction, Concentration, Evaporation, Chromatographic methods: Drying - Vacuum, Freeze and spray drying.

UNIT –V

Control and monitoring of the bioprocess: Physicochemical and biological sensors. Monitoring process, control strategies and automation. Disposal of biomass and toxic materials. Sensors for the medium and gases.

Recommended Text Books

- Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. Industrial Microbiology: An Introduction. Blackwell Science Publishers. (2002).
- Richard H. Baltz. Julian E. Davies, and Arnold L. Demain. Manual of Industrial Microbiology and Biotechnology, 3rd Edition, ASM Press. (2010).
- Daniel Forciniti. Industrial Bioseparations: Principles and Practice. 1st Edition, Wiley-Blackwell, (2008).
- Reed.G, Prescott and Dunn's Industrial Microbiology, CBS Publishers. (1999).
- Demain, A. L, Industrial Microbiology and Biotechnology, II Edition. (2001).
- Iqbal Ahmad, Farah Ahmad, John Pichtel. Microbes and Microbial Technology: Agricultural and Environmental Applications. 1st Edition. Springer, (2011).
- Casida LE, Industrial Microbiology, J. Wiley, (1968).
- James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).

Lab

1. Isolation of Amylase producing organism from soil.
2. Assay of industrially important enzymes.
3. Production of antibiotic by fermentation.
4. Production of citric acid and its assay.
5. Production of enzyme by Batch fermentation.
6. Production of industrially important enzymes SSF.

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MB- 403 (Elective-3): INTRODUCTION TO COMPUTERS, INTERNET, PROGRAMMING LANGUAGES AND DATA STRUCTURES

UNIT –I

Fundamentals of computers: Block diagram of computer (input and output devices) – History -Generations – Memory devices - Advantages and Limitations of Computers – Comparison of different operating systems DOS, Windows NT & XP, Application Software's.

UNIT –II

Introduction to programming languages: Introduction to Programming languages, Problem solving Technique: Algorithm, Flowchart, Compilation, Testing and Debugging, Documentation – Data structures – Array, Stack, Queue, Linked List concepts. C language Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Expression – Data types –Operator precedence - Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do-while, for – nested loop – Arrays.

UNIT –III

Introduction to Database systems: Fundamentals of database - Database models (Hierarchical, Network, Relational and Object-Oriented Models) – RDBMS: Relational Database Management systems - Database System Applications and Security.

UNIT –IV

Algorithm Implementation: Algorithm – Flowchart – Programming language – Compiling and Linking – Testing and Debugging – Documentation – Maintenance - Utility programs. String declaration – String library functions - String Manipulation - Sorting: Bubble sort, Selection sort, Insertion sort – Searching: Linear search, Binary search.
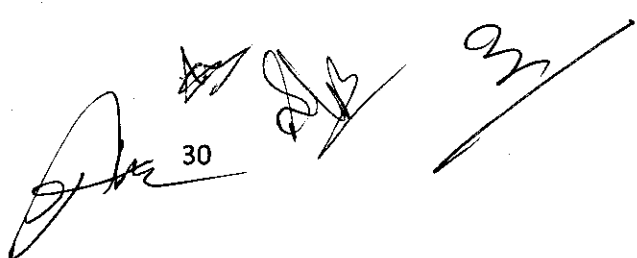
UNIT –V

Internet Technologies: Network Basics Communication Technology – Networking Elements: Networking Hardware, Networking services: Types of Networks – LAN, WAN & MAN, Intranet–Wireless communication – Internet services, Uses of Internet. Web Services – WWW, URL, Servers: Client/ Server essential - Domain Name Server, FTP server, E-mail server, WEB servers, Web publishing-Browsers-IP Addressing, IPV6.
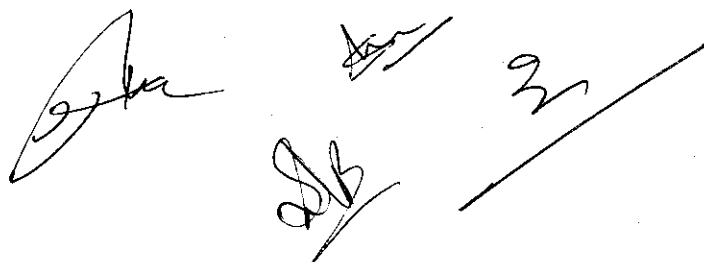
Text Books
- Sherman, J., Basic Computer Skills made easy. Butterworth-Heinemann Ltd, USA. (2001).
- Balaguruswamy, E., Computer Fundamentals and Applications (2nd Ed.). Tata McGraw-Hill Publishing Co. Ltd., India. (1985).
- Tananbaum A.S., Computer Networks. 3 rd Ed. PHI.
- Silberschatz, A., Korth, H.F. and Sudarshan, S., Database System Concepts. 4th Ed. McGraw Hill Publishers, (2002).
- Balagurusamy E. Programming in ANSI C. Tata McGrawHill Publishing Company Ltd. (2007).

LAB

1. Unix/ Linux - Command Line Interface - Internal Commands- External commands.
2. Graphical User Interface: Peer-to-Peer Operating System.
3. Client- Server Operating System.
4. Display a protein details using escape sequence.
5. Calculate rotations per minute [rpm = 1000 $\sqrt{RCF}$ / 11.17r].
6. Create amino acid dictionary using switch construct.
7. SQL - Creating database, Selecting database, Deleting database, Creating table, Modifying Table, Deleting table.
8. Data Manipulation statements: Inserting, updating and deleting records Retrieving Records Retrieving specific rows and columns.
9. HTML - Create a web page to display your details by creating a model web site.
10. Create a web page for an educational institution using HTML tags.

M. Sc. Microbiology and Bioinformatics IV Semester

MB-403 (Elective-4): MEDICAL MICROBIOLOGY

UNIT –I
Normal flora: Host parasite relationship, Normal Microflora of human body (Human Microbiomics), Collection, transport and culturing of clinical samples. Sepsis syndrome.

UNIT –II
Viral diseases: Viral diseases with reference to symptom, pathogenesis, transmission and control of polio, Chicken pox, Hepatitis, Rabies, Influenza, AIDS, Chikungunya and Dengue.

UNIT –III
Bacterial diseases: Important diseases caused by Rickettsia, Chlamydia, spirochaetes, Staphylococci, Neisseria, Clostridia, Mycobacteria, Vibrio.

UNIT –IV
Fungal diseases: Important human diseases caused by fungi with special reference to epidemiology, diagnosis and treatment. Superficial Candidosis, Fungal infection of eye, ear and skin, Ringworm. Subcutaneous Mycoses- Mycetoma, Rhinosporidiosis. Systemic Mycoses- Aspergillosis, Histoplasmosis.
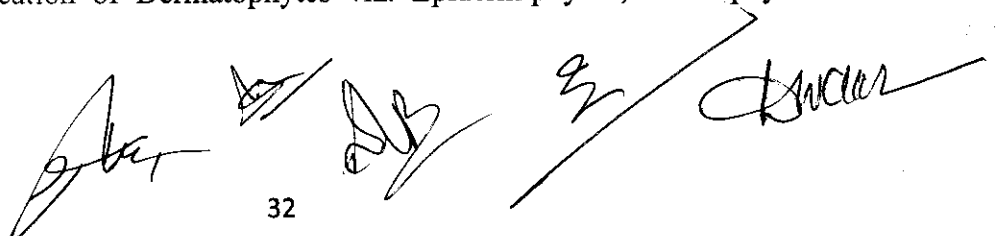
UNIT –V
Chemotherapy: Mechanism of action of antibiotics. Drugs affecting cell wall, cell membrane, DNA & Protein synthesis. Principles of drug resistance in Bacteria. Chemotherapy of fungal diseases.

Recommended Text Books
- Chaapra H.L Textbook of Medical Microbiology.
- Emmons. Bainford. Medical Mycology.
- Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. 7th Edition. University Press Publication. (2005).
- Brooks GF, Carroll KC, Butel JS and Morse SA. Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication. (2007).
- Goering R, Dockrell H, Zuckerman M and Wakelin D. Mims Medical microbiology. 4th edition. Elsevier. (2007).

LAB

1. Determination of phenol coefficient.
2. Study of effect of antiseptics on growth of bacteria.
3. Selective isolation and characterization of Streptococcus on Blood agar medium.
4. Antagonistic effect of *E. coli* on *Staphylococcus aureus.*
5. Isolation of throat infection causing bacteria by swab method.
6. Isolate and identify aeroflora of hospital environment by air sampler and settling plate technique.
7. Isolation and identification of Dermatophytes viz. Epidermiphyton, Trichophyton and Microsporium.

MB -403 (Elective -5): DRUG DESIGNING, INTELLECTUAL PROPERTY RIGHTS AND PATENT LAWS

UNIT- I

Concepts of Computational chemistry: Molecular mechanics and Quantum mechanics. Comparative modeling of proteins: Homology modelling and Fold recognition methods. First and Second generation of drug designing: QSAR, Fundamentals of QSAR- objectives, expressions of biological activity, QSAR parameters related to chemical structure, Analysis of results - correlative methods, and Regression analysis, MFA, 3-D QSAR, QSAR descriptors, Finding new drug targets to treat diseases.

UNIT- II

Advanced Drug Designing: Computer Aided Drug Design (CADD), Pharmacopore properties, Ligand and structure based drug design, Receptors - Structure, function, and pharmacology, Virtual screening. Molecular Docking – Principles and methods for Docking, Docking problem, 3-D database search approaches, Rigid body and flexible docking; Hydropathy. Denovo ligand design.

UNIT- III

Concepts and scope: Overview of Intellectual Property and property rights (IPR), TRIP (Trade related aspects of IPR), General agreement on tariffs and trade, Post GATT scenario.
Patents: patentable inventions and discoveries, claims patent terms Product patents, process patents, Industrial patents, biological patents, Patent acts

UNIT- IV

Trademarks and Copyrights: Geographical Indicators, Trade Secrets and Unfair Competition, Bio-piracy Copyright, Protection of Intellectual property at the National Level.
Ethical and legal issues: Filing and issuing of patents, Enforcement of Intellectual property Rights, Contemporary Intellectual Property Issues, Legal provisions related to IPR.
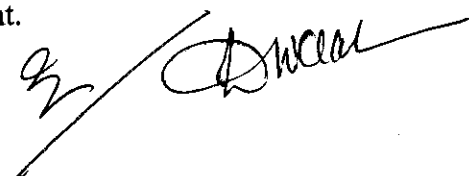
UNIT-V

Repository and regulatory bodies: GMO patents, microbial repositories, genebanks, Indian scenario and regulatory bodies.

Recommended Text Books:
- Casida, L.E.Industrial microbiology.
- Dubey, R.C.Textbook of Biotechnology.
- Das, H.K.Biotechnology.

LAB

1. Model and given protein using online servers
2. Retrieve drugs and find report best drugs for the given diseased protein
3. List out the patent innovations for some pharmaceutical products from microbial origin.
4. Prepare a patent file for filing a patent.
5. Collect annexure's for filing Indian patent and explain in detail.
6. List out online patent centers/websites for filing International patent.
7. List out some online patent procedures and methods.

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MB -403 (Elective-6): FOOD MICROBIOLOGY

UNIT –I

Microorganisms important in food microbiology: fungi, yeast, bacteria, Principles of food preservation. Asepsis, Physical methods (anaerobic condition, high and low temperature, drying), Chemical preservation, food additives, canning. Selection of Industrial strains for food production, strain improvement.

UNIT – II

Principles of food spoilage and spoilage mechanism: Spoilage of vegetables, fruits, meat and meat products. Spoilage of fish and sea foods, poultry products. Spoilage and control of spoilage of alcoholic beverages. Spoilage of canned foods, detection of spoilage and characterization. Food adulteration.

UNIT- III

Food Fermentation: Bread, Vinegar, fermented vegetables. Oriental fermented foods. Technological development in production of alcoholic beverages. Fermentation and production technology of Tea and Coffee, Production of bakery products.

UNIT – IV

Microbiology of milk and milk products: Source of microorganisms in milk. Microbiological examination of milk- Standard plate count, microscopic count, reductase test. Preservation of milk and milk products. Pasteurization, drying of milk. Production of fermented milk and milk products, Technological developments in dairy microbiology.
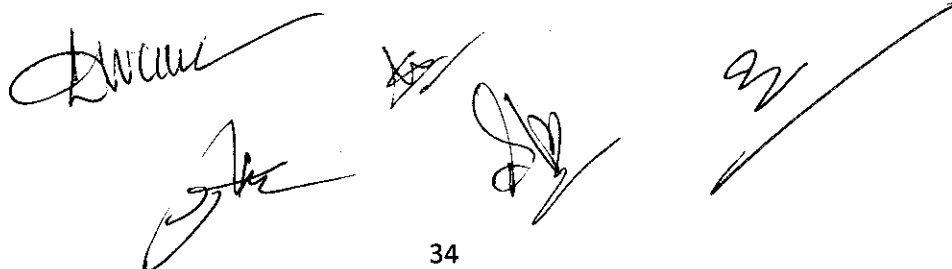
UNIT – V

Food borne diseases: food intoxication botulism, mycotoxicoses, methods of detoxification of toxic foods.

Applications of food microbiology: Microbial production of single cell protein. Genetically modified foods. Nutraceuticals, bacteriocins, prebiotics and probiotics.

Recommended Text Books
- Stanbury, PF., Principles of Fermentation Technology. Whittaker, A and Hall, S.J 2nd Edition. Pergamon Press (1995).
- Banwart, GJ. Basic Food Microbiology. CBS Publishers and Distributors, Delhi. (1989).
- Hobbs BC and Roberts D. Food poisoning and Food Hygiene. Edward Arnold (A division of Hodder and Stoughton) London.
- Dolle Michael P.. Food Microbiology: Fundamentals and Frontiers.
- Joshi. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2.
- John Garbutt. Essentials of Food Microbiology. Arnold International.
- John C. Ayres. J. Orwin Mundt. William E. Sandinee. Microbiology of Foods. W.H. Freeman and Co.

LAB

1. Examination of microbial load in soft drinks, ice creams, packaged and canned foods.
2. Isolation and identification of food poisoning bacteria from contaminated foods or dairy products.
3. Isolation and identification of common molds and yeasts from foods.
4. Isolation, extraction and detection of aflatoxin from food or culture.
5. Production and estimation of lactic acid by Lactobacillus spp. / Streptococcus spp.
6. Role of microbes in fermented foods, bread making and sauerkraut.
7. Determination of quality of milk by MBRT.
8. Assessment of water quality by MPN techniques.

MB-406 PROJECT WORK/ DISSERTATION