DnyanopasakShikshan Mandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: MANISHA U. KHISTE **Department: MICROBIOLOGY**

Program: MSc FY **Subject**: Microbiology **Course Code**: MB101

Paper Title: Microbial Physiology

Unit Number	**Unit Name**	**Topics**	**Unit-wise Outcome**
Unit 1	Bacterial Chemolithotrophs and Phototrophs	Physiological groups of Chemolithotrophs, Ammonia oxidation by membrane of genus Nitro groups, Nitrate oxidation by nitro group of genera, Oxidation of molecular hydrogen by Hydrogenomonas species, Ferrous and sulfur/sulfide oxidation by Thiobacillus species. Photosynthetic microorganisms, Photosynthetic pigments and generation of reducing power by cyclic and non cyclic photophosphorylation, Electron transport chain in photosynthetic Bacteria, Carbon dioxide fixation pathways.	**Distinguish different groups of chemolithotrophs andanalyse photosynthetic microorganisms,pigment and cyclic,noncyclicphotophoshoryltionelectron transport chain.carbon dioxide fixation pathways.**
Unit 2	Bacterial Respiration	Bacterial aerobic respiration: Components of electron transport chain free energy changes and electron transport, Oxidative phosphorylation and its theories of ATP formation, Inhibition of electron transport chain, Electron transport chain in some heterotrophic bacteria,Mechanism of oxygen toxicity, Catalase, Super oxide dismutase. Bacterial anaerobic respiration: Introduction, Electron transport chain in some anaerobic	**Illustrate bacterial aerobic respiration and anerobic bacterial respiration .electron transport chain in heterotrophs.**

		bacteria, Nitrate, Carbonate and Sulfate as electron acceptors.	
Unit 3	Bacterial Permeation	Structure and organization of membrane (Glyco-conjugants and Proteins in membranesystem), Methods to study diffusion of solutes in bacteria (Passive diffusion, Facilitated diffusion, Different mechanisms of active diffusion). Proton motive force, PTS, Role of permeases in transport, Different permeases in E. coli, Transport of amino acids and Inorganic ions in microorganisms and their mechanisms.	**Analyze structure and organization of membrane and classify different methods to study diffusion of solute in bactria.understsnd transport ofamino acid and inorganic ions in microorganisms and their mechanisms**
Unit 4	Bacterial Sporulation	Sporulating bacteria, Molecular architecture of spores, Induction and stages of Sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation, Heat resistance and sporulation.	**Understand bacterial sporulation. Distinguish different stages of sporulation and influence of different factors.**

Specify Course Outcome:

Distinguish and describe physiological groups of chemolithotrophs and phototrophs.describe how aerobic respiration differs from anaerobic respiration.compare contrast the different cellular transport processes with regard to protein involved and energy source used. Specify.

Program Outcome:

Utilize microbiological concepts to summarize, analyse,and synthesize scientific and microbiology related literature.

Signature of Teacher

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College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: R. K. Joshi **Department: Microbiology**

Program: M. Sc.first year **Subject**: **Microbiology** **Course Code**: **MB- 102**

Paper Title: Advances in virology

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	Classification, Cultivation and Detection of Viruses	properties of viruses, Cataloguing of Viruses- International Committee on Taxonomy of viruses (ICTV), Structure based classification, Baltimore classification and Homes classification, LHT system of classification, Morphology and Ultra structure of Viruses. Cultivation of Viruses: Introduction, Cell culture, Embryonated egg and Laboratory animals. Detection of viruses in the host, Measurement of infectious units, Measurement of virus particles and their components, One step growth cycle, Assay of viruses, Physical (Electron microscopy) and Chemical methods (Protein and Nucleic acid studies), Infectivity Evaluate assay.	Identify properties of viruses, and classify the viruses. Evaluate Detection of viruses in the host,
Unit II:	**Multiplication of Viruses**	Introduction, Architecture of cell surfaces, Interaction of viruses with cell receptors, Uptake of macromolecules by	Categorize the virus replicationby different methods Genomic replication of Viruses

		cells, Mechanism of virus entry into cells, Transport of viral genome into the cell nucleus. Genomic replication of Viruses (DNA/RNA), mRNA production by animal viruses, Mechanism of RNA synthesis, Transcription mechanism and Post transcriptional processing, Translation of viral protein, Assembly, Exit and Maturation of progeny virions. Multiplication of bacteriophages.	(DNA/RNA), mRNA production by animal viruses,
Unit III	**Viral Pathogenesis**	Host and virus factors involved in pathogenesis, Patterns of infection, Pathogenesis of animal viruses (Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxivirus and Orthomyxovirus), Pathogenesis of plant viruses (TMV) and Insect viruses (NPV). Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.	Distinguish between different viral diseases and study viral diseases with pathogenesis and treatment.
Unit IV	**Prevention and Control of Viruses**	Introduction, Viral vaccines, Preparation of viral vaccines, New vaccine technology, Antiviral drugs, Virus evolution and Emergence of new viruses.	Prepare for theoretical preparation of vaccines Study viral evolutionary pattern. Compare between antiviral drugs.

Specify Course Outcome :

Identify and classify viruses. Compare the viruses with Structure ,size,shape nucleic acid content.Assessment of viruses,replication of viruses. Diseases caused by viruses its pathogenesis and Treatment.Development of new vaccines, Antiviral drugs theoretically. Evaluate the viruses in evolutionary pattern.

Specify Program Outcome:

Prepare students for viral studies such as size , shape , diseases, etc. Students are able to understand viral vaccines antiviral drugs. Evaluate Evolutionary pattern.

Signature of Teacher

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College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: SyedaTasleem Syed Gani **Department: Microbiology**

Program: M. Sc **Subject**: **Microbiology** **Course Code**: **MB-103**

Paper Title: FOOD AND DAIRY MICROBIOLOGY

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Food and Dairy Fermentations**	Starter culture, Biochemical activities production and preservation of following: i)Soy Sauce ii) Sauerkraut iii) Sausages iv) Vinegar v) Cheese vi) Fermented milk products vii) Tea and Coffee viii)Indian fermented foods (Indigenous & Traditional).	Employ skills to Prepare fermented food products by Compare biochemical activities at different parameters.
Unit II:	**Preservation and Spoilage of Food**	Principles of food preservation, Heat processing, Irradiation, High-pressure processing-Pascalization, Low-temperature storage, Chemical preservatives and Naturally occurring antimicrobials, Traditional methods of food preservation, Food packaging, Minimal processing technology for preservation of fresh foods,	Operate Traditional methods of food preservation, Evaluate General types of Microbial spoilage. Collect information about preservation techniques.

		Use of antioxidants, Use of natural Preservatives. General types of Microbial spoilage, Factors affecting kind and rate of spoilage, Spoilage of Fruits, Vegetables and Juices, Microbial spoilage of Milk products (Butter and frozen desserts). General principles underlying Meat spoilage, Microbial spoilage of Fish, Poultry, Sea foods and Fresh Egg.	
Unit III	**Quality Assurance in Foods**	Food borne bacterial infections and intoxications: i) *Clostridium,* ii) *Salmonella,* iii) *Shigella,* iv) *Staphylococcus,* v) *Campylobacter,* vi) *Listeria*. Mycotoxin (Rubratoxin and Alfa Toxins), Phycotoxins in foods. Quality assurance: Microbiological quality standards of food, Government regulatory practices and policies- FSSAI, FDA, EPA, HACCP, ISI, FPO, MFPO, MMPO, Codex Alimentarius, BIS, AGMARK.	Demonstrate & Examine Food borne bacterial infections and intoxications. Negotiate Microbiological quality standards of food.
Unit IV	**Advances in Food Microbiology**	Microbial enzymes in food & dairy industry (Proteases, Lipases, Amylases and Pectinase), Molecular diagnostic techniques for detection of food borne pathogens [Biosensors, Nucleic Acid-based Tests (NAT) & Different PCR-based techniques]. Probiotic foods and their applications, Genetically Modified Foods- Applications, Health & Safety aspects, SCP as	Point out Molecular diagnostic techniques for detection of food borne pathogens. Implement knowledge about Safety aspects, Utilization of by-products.

		food, Utilization of by-products i) Whey ii) Molasses.	

Specify Course Outcome:

Apply the scientific methods to food science problem. Apply critical thinking & analytical evolution to contemporary food science information.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Aithal. S.C **Department: Microbiology**

Program: M. Sc **Subject**: **Microbiology** **Course Code**: **MB – 104**

Paper Title: BIOINSTRUMENTATION

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Laboratory techniques**	Biosafety in microbiological laboratories: General safety measures, Personal protection, Chemical and Biological hazards, Spillage and Waste disposal, First aid. Theory, Principle, Working and Applications of: pH meter and Laminar Air Flow. Efficacy testing protocols for Autoclave, pH meter and Laminar Air Flow. Centrifuge machine types and Centrifugation: Differential, Rate zonal, Isopycnic, Density gradient, Rotor types and Ultra centrifugation.	Understand biosafety in microbiological laboratories. Predict Personal protection, Chemical and Biological hazards, Spillage and Waste disposal, First aid.
Unit II:	**Chromatography Techniques**	Theory, Principle, Apparatus, Methods and Applications of Paper Chromatography,TLC, HPTLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Chromatography, and HPLC.	Become skilled in handling Chromatographic Apparatus used in laboratory along with knowledge of Theory, Principle, Methods and Applications of Chromatography techniques.

Unit III	**Electrophoretic Techniques**	Theory, Principle, Apparatus, Methods and Applications of Paper Electrophoresis, PolyAcrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis. Principle and Applications of: Iso-electric Focusing, Immuno Electrophoresis, Enzyme-Linked Immunosorbant Assay (ELISA), Southern, Northern and Western Blotting.	Gain capability in handling Apparatus, Methods and Applications among different Electrophoresis techniques Students also Define and explain various fundamentals of spectroscopy, qualitative and quantitative analysis.
Unit IV	**Spectroscopic and Radio-isotopic Techniques**	Principle, Working, Instrumentation and Applications of: UV/Vis spectroscopy, IR spectroscopy, Atomic absorption spectroscopy, NMR spectroscopy, Mass spectroscopy, Raman spectroscopy. Introduction to radioisotopes and their biological applications, Principles and Applications of Geiger Muller (GM) counter, Solid and Liquid scintillation counter, Autoradiography, Radioimmunoassay (RIA) and Radiation Dosimeters.	Students are enabling to Appraise & Develop competence to integrate biological information with computational software. Properly use aseptic techniques, including sterilization. Know General bacteriology and microbial techniques. Study various spectroscopic techniques and its instrumentation.

Specify Course Outcome:

Bioinstrumentation techniques trains students for gaining expertise in the microbial world by Study the concept of separation science and its applications. Study the concept of radiochemical analysis along with industrial analyzers.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshan Mandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Manisha U Khiste **Department; microbiology**

program: MSc SY **Subject**: Microbiology **Course Code**:MB201

Paper Title: MICROBIAL METABOLISM

Unit Number	**Unit Name**	**Topics**	**Unit-wise Outcome**
UNIT I	**Thermodynamics and Bioenergy Transduction**	Basic aspects of bioenergetics: Entropy, Enthalpy, Modes of ATP generation, Hypothesis of phosphorylation. Chemiosmotic energy transduction, Chemiosmotic theory fundamentals. Basic morphology of Energy transduction membrane: Mitochondria and Sub mitochondrial particles, Respiratory bacteria and derived preparation, Chloroplast and thylakoids, Photosynthetic bacteria and Chromatophore.	**Understanding the basic concepts of enthalpy,entropy,and chemiosmosis energy. Design basic morphology of energy transduction membrane.**
UNIT II	CarbohydrateMetabolism	Major Carbohydrate catabolic pathways, their regulation and significance: EMP, HMP, ED, PKP, TCA, Methyl glycoxal	**Analyse catabolic pathways their regulation and significance. Describe catabolism of**

		bypass, AnapleroticSequences, Glycerol metabolism, Catabolism of different carbohydrate. Fermentations: Ethanol, Lactate, Butyrate and Butanol-acetone, Mixed Acid, 2, 3- butandiol, Propionate, Succinate, Acetate, Methane and Sulphate.	**different carbohydrate fermentation.**
UNIT III	Metabolism of OrganicNitrogenousCompounds	Biosynthesis of Amino acid: Oxaloacetate and Pyruvate families, Phosphoglycerate family,α-Oxogluterate family, Aromatic amino acids and L-histidine synthesis. Nucleic acid metabolism: Biosynthesis and Catabolism of purine and pyrimidine nucleotide.	**Evaluate biosynthesis of amino acid aromatic amino acids and L-histidine.explain nucleic acid biosynthesis and catabolism.**
UNIT IV	Hydrocarbon Metabolism, Endogenous Metabolism and Microbial growth on C_1 compounds(	Microbial degradation of aliphatic hydrocarbon (Monoterminal, Biterminal oxidation), Microbial degradation of aromatic hydrocarbon via Catechol, Protocatachuate, Metaclevage of Catachol, Protocatachuate, Homogentisate pathway Microbial synthesis, Degradation and regulation of glycogen, Poly-phosphate, Poly β hydroxybutyrate (PHB) production.Microbial growth on C1 compound.	**Describe microbial degradation of aliphatic hydrocarbon and aromatic hydrocarbon**

Specify Course Outcome:

Discuss the biosynthesis and the degradation pathway involved.specify the biological significance of biomolecules in metabolism.Overview of major biomolecules-carbohydrates,lipids,proteins,amino acids nucleic acids.

Specify Program Outcome:

Understand and apply theoretical and practical knowledge for carrier orientation in view of microbial genetics and molecular biology ,occurrence of metabolic events and its relation to environment , food , medical and agriculture and dairy microbiology.

Signature of Teacher

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College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Aithal. S.C **Department: Microbiology**

Program: M. Sc **Subject**: **Microbiology** **Course Code**: **MB – 202**

Paper Title: MODERN MICROBIAL GENETICS

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**DNA Replication, Damage and Repair**	Unit of replication, Enzymes involved in replication origin and replication fork, Fidelity of replication, Extrachromosomal replicon. Types of damage: Spontaneous damage, Thermal damage, Damage due to radiation, Oxidative damage, Hydrolytic damage, Alkylation, DNA damaging agents. DNA repair pathways: Damage reversal, Base Excision repair, Nucleotide excision repair, Methyl directed mismatch repair, Very short patch repair, Recombination repair, SOS system.	Elucidate central cell biological processes and how they are regulated (for example: replication and protein synthesis and gene expression).

Unit II:	**Transcription and Translation Process**	Structure of RNA polymerase (RNAP), Transcription factors, Structure and Functions of different types of RNA, Promoter structure, Transcription cycle and Fidelity of transcription. Structure of ribosomes, Genetic code, Initiation complex, Activation and functioning of tRNA, Translation cycle, Polysomes, Post-translational modifications (PTMs) and Recycling.	Understand how molecular cell biology forms the foundation of biotechnology.
Unit III	**Regulation of Gene Expression in Bacteria**	Common modes of regulation: Co-ordinate regulation, Auto regulation, Negative and Positive regulation, stringent response, Lac operon, Trp operon, Arabinose operon. Transcriptional regulation: Regulation by repressors and activators, Alternative sigma factors, Regulation of RNAP activity, Regulation of transcription termination (regulation by attenuation). Translational regulation: Regulation at the level of initiation, Elongation and Termination. Regulation of gene expression in bacteriophages. Introduction to Quorum-sensing Regulation of Gene Expression in bacteria.	Explain DNA repair and recombination in terms of mutation and evolution. Appraise Common modes of regulation.
Unit IV	**Genetic Recombination and Mapping in Bacteria**	Background and perspectives of Genetic Recombination. Introduction to different types of genetic	Comply knowledge about perspectives of Genetic different types of genetic

		maps. Molecular mechanism of gene transfer and genetic mapping by: i. Co-transformation in Transformation, ii. Interrupted Mating and Time-of-Entry in Conjugation, iii. Linkage maps by breakage and re-joining in Transduction iv. Use of Transposons in Genetic Mapping.	maps. Molecular mechanism of gene transfer and genetic mapping by different mapping techniques.

Specify Course Outcome:

After completing the course the students will be able to: The objective of the course is to make student understand about the structure and function of biologically important molecules. Students will learn about DNA, RNA and the molecular events that govern cell functions.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: R. K. Joshi **Department:Microbiology**

Program: M. Sc first year **Subject**: **Microbiology** **Course Code**: **MB -203**

Paper Title: Bioprocess Engineering

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Introduction to Industrial Bioprocess Engineering**	Definition of bioprocess engineering, Bioprocess engineer, Biotechnology and bioprocess engineering, Approach of biologist and engineers towards research, Regulatory constraints of bioprocess. Batch growth (growth pattern and kinetics in batch culture, Environmental factors affecting growth kinetics), Monod's equation, Continuous culture, Chemostat and Turbitostat (Construction and Working), Mixed culture in nature, Industrial utilization of mixed culture.	**Prepare the concept of bioprocess engineering and approach of microbiologist towards research. Compare between chemostat and turbidostat.**
Unit II:	**Bioreactors**	Design of basic bioreactor, Bioreactor configuration, Design features, Individual parts, Baffles, Impellers, Foam separators, Spargers,	**Design of Bioreactor, bioreactor configuration,designing of bioreactor with features,**

		Culture vessel, Cooling and heating devices, Probes for on-line monitoring, Computer control of fermentation process. Ideal batch reactor, Ideal continuous flow stirred tank reactor, Packed bed reactor bubble column reactor, Fluidized bed bioreactor, Trickle bed reactor (Their basic construction, Working, and distribution of gases).	**individual,parts baffies impellers,foam separators, etc are studied by construction, working and distribution.**
Unit III	**Mass Transfer and Sterilization**	Transport phenomena in bioprocess system: Gas liquid mass transfer in cellular systems, Basic mass transfer concept, Rate of metabolic oxygen utilization, Determination on oxygen transfer rates, Determination of Kla, Heat transfer, Aeration/Agitation and its importance.	**Appraise the phenomenon of gas liquid mass transfer in cellular system. Determination of oxygen transfer rates.**
Unit IV	**Upstream processes and Down Stream Process (11)**	. Upstream processes: Inoculum development, Formulation of production media, Sterilization of bioreactors, Air supply, Media, Maintenance of stock culture, Scale up of the Process from shake flask to industrial level, Solid state fermentation process.	**Analyse Upstream and downstream processingsterilization of bioreactors. Scale up of process from shake flask to industrial level.**

Specify Course Outcome:Complete knowledge of Bioreactor design features , structure, parts are studied by students .Downstream processing, Upstream processing are also studied by students.

Specify Program Outcome: Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Syeda Tasleem Syed Gani **Department: Microbiology**

Program: M. Sc **Subject**: **Microbiology** **Course Code**: **MB – 204**

Paper Title: ENZYME TECHNOLOGY

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Extraction and Purification of Microbial Enzyme**	Importance of Enzyme purification, Different sources of enzyme, Extracellular and Intracellular enzyme, Physical and Chemical methods used for cell disintegration, Enzymefractionation by precipitation (using Temperature, Salt, Solvent, pH etc.), Liquid-liquidextraction, Ionic Exchange, Gel electrophoresis, Affinity chromatography and other specialpurification methods, Enzyme crystallization technique, Criteria of purity of enzyme, Pitfallsin working with pure enzyme.	InterpretExtracellular and Intracellular enzyme,purification.IdentifyDifferent sources of enzyme. ReviseCriteria of purity of enzyme, Pitfalls in working with pure enzyme.

Unit II:	**Enzyme Kinetics and Enzyme Inhibition**	Enzyme kinetics: Steady state kinetics, Brigs Haldane equation, MichaelisMenten equation, The Monod-Wyman-Changeux (MWC) Model, the Koshland-Nemethy-Filmer (KNF) Model. Irreversible, Reversible, competitive, Noncompetitive and Uncompetitive Inhibition with suitable examples and their kinetics studies, Allosteric regulation, Types of allosteric regulation and their significance in metabolic regulation and their kinetics study (Hills equation).	AppraiseSteady state kinetics,with suitable examples. RelateTypes of allosteric regulation and their significance in metabolic regulation and their kinetics study (Hillsequation).
Unit III	**Enzyme as a biocatalyst and Enzyme Engineering**	Structure of active sites, Role of Ionizable group in catalysts, Study on vitamins and co-enzymes: Structure and functions with suitable examples, Metallo enzymes and Metal ions as co-factors and enzyme activators. Chemical modification and site directed mutagenesis to study structure – function relationship of industrially important enzyme.	Explain Structure of active sites.Interpretfunction relationship of industrially important enzyme.

Unit IV	**Immobilization and Applications of Microbial enzymes**	Properties of Immobilized enzyme, Methods of immobilization: Adsorption, Covalent bonding, Entrapment and Membrane confinement. Analytical, Therapeutic and Industrial applications of Immobilized enzymes.	Justify Properties of Immobilized enzyme, Methods of immobilization:

Specify Course Outcome:

This course provides the theory & knowledge relevant to the Enzymology principles including fundamental properties of enzymes.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: R.K. Joshi **Department:Microbiology**

Program:M. Sc. second year. **Subject**: **Microbiology** **Course Code**: **MB -301**

Paper Title: Molecular Immunology.

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Organs and cells of immune system**.	Primary lymphoid organs - thymus, bone morrow - structure and function. Lymphatic system - transporter of antigen - introduction. Secondary lymphoid organs – spleen and lymphnodes structure and functions. Mucosal associated lymphoid tissue, (MALT) - tonsils. Cutaneous associated lymphoid tissue - keratinocytes and langerhans cells - Location and immunological functions. Lymphoid cells - B-lymphocytes and T-lymphocytes - maturations, activation and differentiation. Receptor on B and T cells. Null cells. γ δ T cells - Intraepithelial lymphocyte (IEL)- function, Mesanglial cells, Microglial cells - Structures and secretions - interleukin I, hydrolytic enzymes, complement proteins, α-Interferon,	**Appraise the students for knowledge of bone marrow, lymphatic system , lymphoid organs,spleen and lymph nodes ,structure and function .Functions of T and B lymphocytes. T and Blymphocytes maturations, activation .**

		Tumor necrosis factor α (TNF-α) (IL-6, GM-CSF, G-CSF, M-CSF). Growth factors associated in haematopoiesis, Granulocytes - Neutrophile, Basophile, Eosinophile - immune response generated against parasite by granulocytes. Mast cell - Structure, function in innate immunity and acquired immunity. Dendritic cell - structure and function.	
Unit II:	**Immunogens and Immunoglobulins.**	Types of antigens - Exogenous, Endogenous, Autologus, Xenogenic and Allogenic. General properties of antigens - Molecular size, chemical composition, foreignness, specificity, Haptens, Superaantigens and Adjuvants: Freund, complete and incomplete adjutants, Depot effect, Macrophage activation, Effect of lymphocyte, Types of antigens - Exogenous, Endogenous, Autologus, Xenogenic and Allogenic. General properties of antigens - Molecular size, chemical composition, foreignness, specificity, Haptens, Superaantigens and Adjuvants: Freund, Pcomplete and incomplete adjutants, Depot effect, Macrophage activation, Effect of lymphocyte, antitumor action,antitumor action,	**Differentiate between exogenous ,endogenous, autologous,Xenogenicand allogenic antigen.Hapten, superantigen and adjuvants ,types ,and properties of antigen.**
Unit III	O**rganization and Expression of Immunoglobulin genes**.	Genetic model for Ig structure, Germ line and somatic variation models, Dryer and Bennett two gene models, K chain genes, λ chain genes, Heavy chain genes, VH gene segments, Gene rearrangement in VH region - In light chain, In heavy chain,	**Analyse the genetic model for Ig structure germ line and somatic variation models .DNA rearrangement in VH gene segment. Generation of antibody**

		Mechanism of variables region DNA rearrangement, Generation of antibody diversity, Regulation of Ig gene transcription	**diversity.**
Unit IV	**Major and Minor Histocompatibility Complexes.**	MHC class-I, MHC class-II - Structure of molecules, gene organization. Genetic polymorphism of molecule, Peptide interaction with molecule, MHC and immune responsiveness, MHC and susceptibility to infectious diseases, Minor MHA - structure, role and genetics, HLA system, Antigen processing and presentation	**Differentiate between MHC class I and class II structure of molecules .Role of MHC in suceptiblity of infecton.**
Unit V	**Clinical immunology**	Hypersensitivity, Immunology of Tumors, Immunodeficiency diseases, autoimmune diseases, Immunomodulation / Immunological tolerance.	**Prepare for hypersensivity, immunology of tumors, immunodeficiency diseases etc**

Specify Course Outcome :

Categorise different types of lymphoid organs as primary and secondary lymphoid organs.Study of antigens, antibody studied by students. Hypersensitivity ,immunodeficiency diseases ,immunological tolerance and autoimmune diseases evaluated by students.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology

Signature of Teacher

DnyanopasakShikshan Mandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Manisha U Khiste **Department:Microbiology**

Program: MSc S Y **Subject**: Microbiology **Course Code**:MB 302

Paper Title: RECOMBINANT DNA TECHNOLOGY

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I	Techniques and enzymes used in genetic engineering.	Core techniques of gene cloning and essential enzyme used in genetic engineering: restriction endonucleases type I, II, III, restriction modification system: nomenclature and classification of type II endonucleases , their activity, DNA ligase: properties and specificities, S1 nuclease, BAL 31 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase and its activity and mode of action. Restriction digestion, ligation and transformation. Hybridization techniques: Northern, southern and colony hybridization,	**Demonstrate techniques gene cloning and categorize essential enzymes in genetic engineering and hybridization techniques.**

		fluorescence in situ hybridization. Restriction map and mapping techniques, DNA fingerprinting, chromosome walking and jumping.	
Unit II	Cloning vectors.	Gene cloning vectors: plasmids and their properties, pBR 322 and pUC18 its derivatives and construction, single stranded plasmid, promoter probe vectors, runway plasmid vectors. Bacteriophage as cloning vectors, EMBL, λgt 10/11, λZAp etc. cosmid vectors. Artificial chromosome vectors (YAC, BACs). Animal virus derived vectors, SV40vaccina/bacculo and retroviral vectors. Expression vectors, pMal, GST, pET based vectors.	**Classify cloning vectors and describe their properties. Explainderivativesof plasmid. Construction of vectors.**
Unit III:	Cloning methodologies	Insertion of foreign DNA into the host cells: transformation , transfect ion : chemical and physical method , liposomes, microinjection, electroporation, biolistic, somatic cell fusion , gene transfer by pronuclear microinjection , plant transformation technology : Basic of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence gene, use of Ti and Ri as plasmids vectors. Cloning and expression in yeast (Saccharomyces,	**Describe methods of DNA insertion into host cell.Apply plant transformation technology.**

		pichiaetc), animal and plant cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, jumping and hopping libraries, phage display, construction of cDNA libraries inplasmids and screening methodology, construction of cDNA and genomic DNA libraries in plasmids in lambda vectors, principles in maximizing gene expression.	
Unit IV	Polymerase Chain Reaction.	Primer design, fidelity of thermal enzymes, DNA polymerase, multiplex, nested reverse transcriptase, realtime PCR touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, T vectors, proof reading enzymes, PCR in gene recombination , deletion , addition , overlap extension and SOEing , site specific mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis.	**Compose polymerchain reaction .Tell PCR in molecular diagnostic viral bacterial detection .explain PCR based smutagenesis.**
Unit V	PCR application.	Sequencing methods: enzymatic DNA sequencing, chemical DNA sequencing of DNA, principles of automated DNA sequencing, RNA sequencing, chemical synthesis of oligonucleotides, gene silencing techniques: introduction to si RNA and si RNA gene technology, micro RNA, construction of si RNA vectors, principle and application of gene silencing	**Classifysequencing method and Construct gene silencing technique.Applyreccobinant DNA technology in medicine ,agriculture, veterinary sciences.**

		and germ line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting, RFLP, RAPD, AFLP analysis. Application of recombinant DNA technology in medicine, agriculture and veterinary sciences	

Specify Course Outcome:Analyze recombinant DNA technology.explain steps and tools in genetic engineering and apply recombinant DNA technology in medicine agriculture and veterinary sciences.

Specify Program Outcome: Understand and apply theoretical and practical knowledge for carrier orientation inview of microbial genetics and molecular biology ,occurrence of metabolic events and its relation to environment , food , medical and agriculture and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Syeda Tasleem Syed Gani **Department: Microbiology**

Program:M. Sc **Subject**: **Microbiology** **Course Code: MB-303**

Paper Title: Microbial Diversity and Extremophiles

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Biodiversity**	Introduction to microbial diversity-Distribution, Abundance, Ecological Niches. Types- Bacterial, Archael, Eucaryal, Characteristics and Classification of Archae (Metahnogens).	Construct,&Demonstrate Phylogenetic relationship between Bacterial, Archael, Eucaryal.
Unit II:	**Thermophiles**	Classification, Hyper-thermophilic habitat and ecological aspects. Molecular basis of thermo-stability, Heat stable enzymes and metabolism, Genetics of thermophiles, Minimal complexity model systems. Commercial aspects of thermophiles and application of thermoenzymes	Illustrate Classification of thermophile on the basis of their habitat.comparitive study of thermophilic enzymes.
Unit III	**Acidophiles and Alkalophiles**	AcidophilesClassification, life at low pH, acido-tolerance, applications.	Inventory Classification of Acidophiles & Alkalophiles.

		Alkalophiles- Isolation, Distribution and Taxonomy. Cell structures-Flagella, Cell wall, Cell membrane. Physiology- Growth conditions, Mutants, Antiporters & alkaliphily. Intracellular enzymes. Molecular biology- Alkalohiles as DNA sources, secretion vectors, promoters Enzymes of alkaliphiles and their applications	Compare different Cell structures of Alkalophiles with mesophilic organisms.
Unit IV	**Psychrophiles**	Conditions for microbial life at low temperature Climate of snow and ice, limits for life at subzero temperature. Microbial diversity at cold ecosystem – snow and glaciers ice, subglacial environments, psychropiezophiles, permafrost, anaerobic and cyanobacteria in cold ecosystem, microalgae in Polar Regions. Molecular adaptations to cold habitats – Membrane components and cold sensing, cold adapted enzymes, cryoprotectants and ice binding proteins , role of exopolymers in microbial adaptations to sea ice.	Differentiate Microbial diversity at different climatic conditions. Appraise Molecular adaptations to cold habitats – Membrane components and cold sensing.
Unit V	**Halophiles and Barophiles**	Halophiles- Classification, Halophilicity and Osmotic protection, Hypersaline Environments, Eukaryotic and prokaryotic halophiles Halobacteria – cell wall. Membranes, compatible solutes, osmo-adaptations or halotolerance, Applications of	Complete Inventory study of Hyper saline Environments, Applications of halophiles and their extremozymes.

		halophiles and their extremozymes. Barophiles- Classification, high pressure habitat, life under pressure, barophily, death under pressure.	

Specify Course Outcome:

Comprehensive study of different parameters affecting growth of microorganisms, & application of different extreamozymes.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Aithal. S.C **Department: Microbiology**

Program: M. Sc **Subject**: **Microbiology** **Course Code**: **MB 304**

Paper Title: Biostatistics, Computer Applications and Research Methodology

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Introduction to biostatistics.**	Basic definitions and applications, sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: types of data, methods of collection of primary and secondary data, methods of data collection, graphical representation by histogram, polygon, ogive curves and pie diagram.	
Unit II:	**Measures of central tendency.**	Measures of central tendency: mean, median, mode. Measures of variability of variation. Correlation and regression: positive and negative correlation and calculation of Karl Pearson co-efficient of correlation. Linear regression and regression equation and multiple linear regressions. ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.	
Unit III	**Tests of**	Tests of significance: small test (Chi-square t-test, F-test), large	

	significance.	sample test (Ztest) and standard error. Introduction to probability theory and distribution (concept without deviation) binomial poison and normal (only definitions and problems) computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot. Computation of mean, variable and standard deviations, t test, correlation coefficient.	
Unit IV	**Computer: Introduction and application.**	Introduction to computers and computer applications: Introduction to computers, Computer applications in research, basics, organization, PC, mainframes and Supercomputers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Introduction in MS Office software concerning Word processing, spreadsheets and presentation software.	
Unit V	**Scientific writing in research.**	Research: Definition, importance and meaning of research, characteristics of research, types of research, steps in research, identification, selection and research problems, formulation of hypothesis. Scientific writing- characteristics. Logical format for writing thesis and papers. Essentials features of abstract, introduction, review of literature, materials, methods, and discussion. Effective illustration-table and figures. Reference styles- Harvard and Vancouver systems.	

Specify Course Outcome:

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshan Mandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: R.K. Joshi **Department;Microbiology**

Program: M.Sc. second year **Subject**: Microbiology **Course Code**: MB-401

Paper Title: Fermentation Technology

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I	**Microbial fermentations**	Metabolic pathways and metabolic control mechanisms, Industrial production of citric acid, lactic acid, enzymes (alpha amylase, lipase, xylase , pectinases, proteases) Acetonebutanol, Lysine and Glutamic acid, Alcoholic beverages, Distilled beverages, Beer, Wine.	**Distinguish between different types of fermentation and industrial production of citric acid,lactic acid, enzymes ,aminoacid and alcoholic beverages, beer, wine.**
Unit II	**Microbial production of therapeutic compounds**	Microbial production of therapeutic compounds (β-lactum, aminoglycosides, ansamycines (Rifamycin), Peptide antibiotics (Quinolinones), Biotransformation of steroids, Vit.B-12 and riboflavin fermentation.	**Revise the knowledge of antibiotics and its production of rifamycin ,βlactum antibiotics, peptides**

			antibiotics.
Unit III	**Modern trends in microbial production**	Modern trends in microbial production of bioplastics (PHB,PHA), Bioinsecticides (thuricides) Biopolymer (dextran, alginates, xanthan, pullulan), Biofertilizer (nitrogen fixer Azatobacter , phosphate solubilising microorganisms), Single cell protein and production of biological weapons with reference to anthrax.	**Distinguish between PHB ,PHA. Biopolymers dextran,pullulan, etc.**
Unit IV	**Biofuels**	Useful features of biofuels. The substrate digester and the microorganisms in the process of biogas production (Biomethanation). Production of bioethanol from sugar, molasses, starch and cellulosic materials. Ethanol recovery. Microbial production of hydrogen gas, biodiesel from hydrocarbons.	**Design and construction of biogas production model practically.**
Unit V	**Immobilization techniques, IPR and Patents**	Some industrial techniques for whole cell and enzyme immobilization. Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical industries. Intellectual Property Rights (IPR), Patents, Trademarks, copyrights, secrets, Patenting of biological materials, International co-operation, Obligations with patent applications, implication of patenting, current issues, hybridoma technology etc. Patenting of higher plants and animals, transgenic organisms and isolated genes, patenting of genes and DNA sequences, plant breeders rights and farmers rights.	**Prepare the students theoretically for immobilization of enzyme its application in food pharmaceutical and chemical industries. IPR patents trademarks, copyrights.**

Specify Course Outcome:Prepare students theoretically for different types of fermentations andanalysis of antibiotic fermentation.Biogas production, alcohol production etc .IPR techniques plant breeders right.

Specify Program Outcome: Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology

Signature of Teacher

DnyanopasakShikshan Mandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Manisha U Khiste **Department:Microbiology**

Program: MSc S Y **Subject**: Microbiology **Course Code**:MB 402

Paper Title: MEDICAL AND PHARMACEUTICAL MICROBIOLOGY

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I	Antibiotics and synthetic antimicrobial agents	Antibiotics and synthetic antimicrobial agents (Aminoglycosides, β lactums, tetracyclines, ansamycins, macrolid antibiotics). Antifungal antibiotics, antitumour substances. Peptide antibiotics, chloramphenicol, sulphonamides and quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives.	**Design antibiotic and synthetic antimicrobial agents and use chemical disinfectants,antiseptic and preservatives.**
Unit II	Mechanism of action of antibiotics	Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principal of drug targeting. Drug delivery system in gene therapy. Bacterial resistance to antibiotics, quionolinones.	**Explain mechanism of action of antibiotic.use of antibiotics quinolone.design mode of action of antibiotic and non-antibiotic antimicrobial agents.**

		Mode of action of bacterial killing by quinolinones. Mode of action of non-antibiotic antimicrobial agents. Penetrating defenses –How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).	
Unit III:	Microbial production and spoilage of pharmaceutical products	Microbial production and spoilage of pharmaceutical products (sterile injectable, non injectable, ophthalmic preparation and implants) and their sterilization. Manufacturing procedure and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.	**Evaluate microbial production and spoilage of pharmaceutical products.design manufacturing procedure.derive pharmaceuticals products by microbial fermentation process**
Unit IV	Regulatory practices, biosensors and applications in pharmaceuticals	Finiancing R & D capital and market outlook, IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drug and biological, legislative perspective. Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug. Biosensors in pharmaceuticals.	**Discuss regulatory practices,biosensor.apply synthetic drugs microbial enzyme in pharmaceuticals.**

		Applications of microbial enzymes in pharmaceuticals.	
Unit V	Quality assurance and validation	Good manufacturing practices (GMP) and Good laboratory practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, radiation, gaseous and filter sterilization). Chemical and biochemical indicators. Design and layout of sterile product manufacturing unit (Designing of microbiology laboratory). Safety in microbiology laboratory	**Recognise good manufacturing practices and good laboratory practices.Apply quality assurance and quality management in pharmaceuticals.use safety in microbiology.**

Specify Course Outcome; Construct antibiotic microbiological assay drug resistance .explain antimicrobial agent ,mechanism action of antibiotic .apply safety in microbiology .students will gain the knowledge and can work in hospital, pharmacy and industry.

Specify Program Outcome:: Understand and apply theoretical and practical knowledge for carrier orientation in view of microbial genetics and molecular biology ,occurrence of metabolic events and its relation to environment , food , medical and agriculture and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Syeda Tasleem Syed Gani **Department: Microbiology**

Program: M. Sc **Subject**: **Microbiology** **Course Code**: **MB 403**

Paper Title: ENVIRONMENTAL MICROBIOLOGY

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Environment and Ecosystems**	Definitions, biotic & abiotic environment, environmental segments. -Composition and structure of environment. -Concept of biosphere, communities and ecosystems. -Ecosystems characteristics structure and function. -Food chains, Food webs and Trophic structures, Ecological pyramid.	Student is enabling to Differentiate Composition and structure of environment. Sketch Food chains, Food webs and Trophic structures, Ecological pyramid.
Unit II:	**Waste water and Solid Waste Treatment**	-Need for water management, -Sources of measurement of water pollution, waste types solid and liquid. -Waste characterization: physical, chemical and biological. -Waste treatments: Primary, Secondary & tertiary treatments. Aerobic – Trickling filters, oxidation ponds. Anaerobic– Anaerobic	Appraise Need for water management, Sources of measurement of water pollution, waste types solid and liquid. Recognize & realize Waste treatments

		digestion, Anaerobic filters &upflow anaerobic sludge. - Effluent treatment Schemes for Dairy, Distillery, Tannery, Sugar and antibiotic industry (Types, Microbes used, types of effluent treatment plants.) - Bioconversion of solid waste & utilization as fertilizer. - Bioaccumulation of heavy metal ions from industrial Effluents.	
Unit III	**Biodeterioration, Biotransformation & Recovery of Metals & Metalloids.**	Concept of Biodeterioration. - Biodeterioration of paints, paper & Leather. -Biochemistry and Microorganisms involved in recovery of Metals and Oil. -Microbial transformation of Mercury & Arsenic.	Interpret Biodeterioration of paints, paper & Leather. Collect information about Microorganisms involved in recovery of Metals and Oil.
Unit IV	**Bioremediation of Xenobiotics.**	Microbiology of degradation of xenobiotics in the environment, Ecological considerations, Decay behavior. Biomagnification and degradative plasmids, hydrocarbons, substituted hydrocarbons, Oil pollution, Surfactants and Pesticides.GMO'S & its environmental impact assessment and ethical issues.	Discuss & demonstrate Microbiology of degradation of xenobiotics in the environment, Ecological Considerations, Decay behaviour.
Unit V:	**Global environmental problems, Impacts and Management.**	Biotechnological approaches for tackling following issues a) Ozone depletion and UV – B. b) Green House Effect and CFC. c) Acid rain & CO_2, SO2. d) Acid mine drainage & H_2SO_4. e) Eutrophication and P, N. f) Biocorrosion.	Express ideas about Global environmental problems, Impacts and Management.

Specify Course Outcome:

Recognise & describe the characteristics of important microorganisms in Global environmental problems, Impacts and Management..

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Aithal . S.C **Department: Microbiology**

Program: M. Sc **Subject**: **Microbiology** **Course Code**: **MB – 404**

Paper Title: Bioinformatics, Proteomics and Genomics

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	**Introduction to Bioinformatics.**	Definition and history of bioinformatics. Internet and bioinformatics. Introduction to data mining. Applications of data mining. Biocomputing: Introduction to string matching algorithms. Database search technique sequence comparison and alignment technique.	Aimed to provide an overview of various bioinformatics tools, databases available and sequence analysis.
Unit II:	**Biological database.**	Database, Database management system, biological databases and information resources, classification of biological databases, PubMed-the central repository for biological database, ENTREZ, linking databases with sequence retrieval system, online mendelian inheritance in man, ExPASy, EMBL nucleotide sequence database, Ensembl. Sequence alignment: Introduction, biologically motivated problems in computer science, similarity and difference of DNA, Nomenclature. Alignment: Pairwise alignment, scoring function	Provide knowledge on database concept, management, and retrieval along with utilization in gene and protein analysis.

		insequence alignment, models for alignment, global alignment, local alignment, end-space free alignment, gap penalty. Database similarity searching: BLAST search, FASTA, PAM units and PAM matrices.	
Unit III	**Multiple sequence alignment.**	Introduction, multiple alignments to a phylogenetic tree, dynamic programming and computational complexity, progressive alignment method. Multiple sequence alignment of related sequence: Position specific scoring matrices, profiles, PSI-BLAST, Markov Model or Markov chain, genetic algorithms and simulated annealing, identification of motifs and domains in multiple sequence alignment.	Impart basic knowledge of patenting, intellectual property rights, laws available and copyrights.
Unit IV	**Proteomics.**	Introduction, methods of studying proteins. Proteomics databases: varieties of protein databases, protein sequence databases, protein family databases, protein data bank, protein structure classification, protein structure prediction, protein functions, protein-protein interactions, practical applications of proteomics.	Impart basic knowledge of statistics and tools used for several quantitative analyses in microbiology. Studying proteins. Proteomics databases.
Unit V	**Genomics.**	Introduction, genomics, genome mapping, genome projects, methods for gene sequence analysis, types of genomics, gene functions, analysis of gene expression, significance of genome sequencing, human genome project, identifying gene involved in human disease, gene therapy, drug designing.	Retrieve information from available databases and use them for microbial identifications and drug designing. Gain ability to modify gene and protein structures in simulated systems.

Specify Course Outcome:

Students are able to predict the significance of the biological phenomenon on the basis of available data set. Impart basic knowledge of patenting, intellectual property rights, laws available and copyrights.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: Syeda Tasleem Syed Gani & Manisha U. Khiste Department: Microbiology

Program: M. Sc. F.Y. **Subject**: **Microbiology** **Course Code**: Lab course I,II,III & IV

Paper Title: Lab Course Work (Annual Practical)

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I: **Lab Course –**I	Based on theory paper MB-101 & MB-102	(MB-101) **1.** Isolation of photosynthetic bacteria. **2.** Glucose uptake by *E. coli / Saccharomyces cerevisiae* [Active and Passive diffusion]. **3.** Effect of UV, pH, disinfectants, chemicals and heavy metal ions on spore germination of *Bacillus* sp. **4.** Determination of Iron Oxidation Rate of *Thiobacillusferrooxidans.* **5.** Determination of Sulfur Oxidation Rate of *Thiobacillusthiooxidans.* **6.** Enrichment and cultivation of Chemolithotrophic bacteria. **7.** Estimation of calcium ions present in sporulating bacteria by EDTA method. **8.** Demonstration of utilization of sugars by oxidation and fermentation techniques. (MB-102) 1. Isolation of coliphage by plaque formation assay.	Complete Isolation techniques methodology, Arrange practical to analyze effect of different parameters for lab course Based on theory paper MB-101 & MB-102.

		2. One-step growth curve for determination of virus titre. 3. Induction of lambda lysogeny by UV radiations. 4. Studies on Specialized transduction. 5. Isolation of lambda DNA and their characterization. 6. Amplification of lambda DNA by PCR. 7. Cultivation and assay of virus using embryonated eggs and tissue culture Technique. 8. Study of symptoms of plant viruses by simple detached leaf technique.	
Unit II: **Lab Course −II**	Based on theory paper MB-103 & MB-104	(MB-103) 1. Production and estimation of lactic acid by *Lactobacillus* s*p*. 2. Extraction and estimation of Diacetyl. 3. Isolation of food poisoning microorganisms from contaminated food products. 4. Extraction and detection of Aflatoxin from infected foods. 5. Preservation of Potato/Onion by UV radiation. 6. Production of fermented milk by *Lactobacillus acidophilus.* 7. Rapid analytical technique in food quality. 8. Isolation and Characterization of Casein from milk. 9. Detection of quality of meat products: i. Estimation of tyrosine value to measure deteriorative changes ii. Isolation of *Salmonella* from meat/food sample. (MB-104) 1. Production and estimation of lactic acid by *Lactobacillus* s*p*. 2. Extraction and estimation of Diacetyl. 3. Isolation of food poisoning microorganisms from contaminated food products.	This lab course Based on theory paper MB-103 & MB-104 Provide knowledge about Production and estimation of different food products to Demonstrate quality of food.

		4. Extraction and detection of Aflatoxin from infected foods. 5. Preservation of Potato/Onion by UV radiation. 6. Production of fermented milk by *Lactobacillus acidophilus.* 7. Rapid analytical technique in food quality. 8. Isolation and Characterization of Casein from milk. 9. Detection of quality of meat products: i. Estimation of tyrosine value to measure deteriorative changes ii. Isolation of *Salmonella* from meat/food sample. 1. Efficacy testing of autoclave employing chemical and biological autoclave indicators. 2. Standardization of pH meter using standard buffers. 3. Studies on pH titration curves of amino acids/acetic acid and determination of pKa values and Handerson-Hasselbach equation. 4. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC and Paper Chromatography. 5. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments). 6. Paper Electrophoresis of proteins. 7. Separation of Proteins/Nucleic acids by gel electrophoresis. 8. Density gradient centrifugation.	
Unit III **Lab Course – III**	Based on theory paper MB-201 & MB-202	(MB-201) 1. Isolation and identification of Reserve food material (Glycogen / Polyphosphate/ PHB) of *B. megaterium.* 2. Demonstration of endogenous metabolism in *B. megaterium* or *E.coli* and their	This lab course aims to provide the students with analytical and on hands practical skills in techniques.

		survival under saturation condition. 3. Quantitative estimation of amino acid by Rosen's method. 4. Quantitative estimation of sugar by Sumners method. 5. Quantitative estimation of protein by Folin Lowry/Biuret method. 6. Preparation and analysis of polar lipids from *S. aureus* and *E.coli*. 7. Isolation of hydrocarbon degraders. (MB-202) 1. Purification of chromosomal/plasmid DNA and study of DNA profile. Confirmation of nucleic acid by spectral study. i. Quantitative estimation by diphenylamine test. ii. DNA denaturation and determination of Tm and G+C contents. Agarose gel electrophoresis of DNA. 2. Effect of UV radiations to study the survival pattern of *E. coli* /yeast. Repair mechanisms in 3. Isolation of antibiotics resistant mutants by chemical mutagenesis. 4. Ampicillin selection method for isolation of autotrophic mutants. 5. Extraction and purification of RNA from *S. cerevisiae*. 6. Studies on gene expression in *E. coli* with reference to Lac operon. 7. Study of conjugation in *E. coli*. 8. Restriction digestion and Agarose gel electrophoresis of DNA. 9. Generalized transduction in *E. coli* using p1 phage.	

Unit IV **Lab Course –IV**	Based on theory paper MB-203 & MB-204	MB-203 1. Isolation of Industrially important microorganisms for microbial processes. 2. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer. 3. Cultivation and determination of growth curve of bacteria *E. coli* in batch reactor/flask. 4. Continuous cultivation of bacteria in laboratory (Chemostat) 5. Study of mixed culture and its comparison with the pure culture (growth pattern). 6. Designing of batch bioreactor. 7. Determination of Oxygen Absorption rate as a function of flask size. 8. Determination of Oxygen Absorption rate as a function of RPM on shaker. 9. Determination of KLa. 10. Fermentative production and recovery of amino acid (Glutamic acid). 11. Fermentative production and recovery of alkaline protease. 12. Estimation of amino acids. 13. Estimation of Alkaline protease. MB-204 1. Microbial production, Extraction, Purification and confirmation of alpha amylase / Lipase. 2. Determination of efficiency of enzyme purification by measuring specific activity at various stages viz. Salt precipitation, dialysis, electrophoresis etc. 3. Effect of pH and Temperature on enzyme activity (amylase/ lipase) 4. Studies on enzyme activation	Understand practically qualitative and quantative description of the basic enzymatic phenomena and processes.Develop ability to link theoretical knowledge of enzymology with its practical application in industry health and environmental protection.Isolate industrially important microorganism for production of industrially important antibiotics, amino acids ,enzymes

		and inhibition of extracted alpha amylase / Lipase. Effect of heavy metal ions, Chelating agents activators and inhibitors. 5. Immobilization of cells and enzyme using sodium alginate and egg albumin and measurement of enzyme activity (amylase / Lipase). 6. Studies on impact of immobilization of enzyme activity in terms of temperature tolerance and Vmax and Km using various forms of alpha amylase/ Lipase. 7. Determination of molecular weight of enzyme using PAGE technique. 8. Preparation of biosensors of urease and determination of its activity.	
Paper –V (Seminar) MB-105	Based on theory paper MB101 – 104 & LAB: I &II	Topic chosen by students according to their choice & interest.	This paper enable students to present their gained knowledge ,developing soft skills of presentation Searching research paper from the web sources for improving their presentation skills, this paper motivate student to reading research paper and knowing current status of the specialized area. This course will impart proficiency of presentation of different skills, gaining knowledge in area of presentation skills.

Specify Course Outcome:

Students are able to Justify, Estimate, and Evaluate various Applied microbiology trains students for gaining expertise in the microbial world and the way it interacts with humans. It looks at how we can harness and utilize the powers of the microbes in areas ranging from food & dairy microbiology, microbial physiology, bioinstrumentation, & extends to industrial applications. A wide range of microbial by-product production, quality assessment and health hazard monitoring is possible by students who get well versed in this course.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher

DnyanopasakShikshanMandal's

College of Arts, Commerce and Science, Parbhani

Pro-forma for program and course outcomes (2.6.1)

Name of Teacher: R.K. Joshi **Department: Microbiology**

Program: M.Sc. second year **Subject**: **Microbiology** **Course Code**: **MB - 204**

Paper Title: Lab Course Work (Annual Practical)

Unit Number	Unit Name	Topics	Unit-wise Outcome
Unit I:	Based on theory paper MB-301 &MB-302	(MB-301) 1. Ag – Ab reaction Agglutination - Slide – widal test - Tube - Dreyer's technique - Bordet Durham's technique - Quantitative widal test. * Precipitation - Slide - VDRL, RPR, RA * Complement fixation test - Coomb's test (demonstration) 2. Radial Immunodiffusion. 3. Immunohaematology. * DLC, TLC, RBC count * Blood grouping - ABO system - Rh grouping 4. Separation of serum proteins by electrophoresis. 5. Preparation of 'H' antigen of S. typhi by Craigies tube method. 6. Preparation of 'O' antigen of S. typhi by phenol agar method. (MB-302) 1. Demonstration of gene cloning, 2. DNA fingerprinting. 3. DNA ligation by T4 DNA ligase. 4. DNA molecular size	Students of M.Sc 2nd year are enable to perform practicalby Comparing various parameters according to different immunological techniques. They demonstrate gene cloning, Isolation of genomic DNA and it's confirmation by Southern blotting.

		determination. 5. Isolation of genomic DNA and it's confirmation by Southern blotting 6. Isolation of plasmid DNA and its Restriction digestion. 7. PCR amplification from genomic DNA and analysis by agarose gel electrophoresis. 8. RAPD application. 9. Restriction mapping.	
Unit II:	Based on theory paper MB- 303 & MB-304	(MB-303) 1. Isolation of thermophiles from hot water spring (Study at least one thermostable enzyme). 2. Studies on halophiles isolated from high salt habitat. (Study its pigmentation and salt tolerance phenomenon). 3. Studies on alkalophiles and its enzymes (any one) isolated form extreme alkaline environment. 4. Biogenic methane production using different wastes. 5. Isolation of *Thiobacillusferrooxidans*and *Thiobacillusthiooxidans*culture from metal sulfides, rock coal and acid mine water. (MB-304) 1) Representation of statistical data by a) Histogram b) Ogive curve c) Pie diagram. 2) Determination of statistical averages / central tendencies. a) Arithmetic mean b) Median c) Mode. 3) Determination of measure of dispersion. a) Mean deviation. b) Standard deviation and coefficient of variation. c) Quartile deviation. 4) Tests of significance-	Students are enable to isolate thermophilesby studying different parameters at different temperature. Construct, apply statistical knowledge to correlate statistically extracted value by performing knowledge based practical.

		Application of following. a) Chi-square test. b) t-test c) standard error 5) Creating files, folders and directories. 6) Application of computers in biology using MS-office. a) MS-word b) Excel c) Power point. 7) Creating and e-mail account, sending and receiving mails. 8) An introduction to Internet, search engines, websites, browsing ands downloading.	
Unit III	Based on theory paper MB- 401, 402, 403 & 404	(MB-401) 1) Production and characterization of citric acid using *A. niger*. 2) Microbial production of glutamic acid. 3) Production of rifamycin using *Nocardia*strain. 4) Comparison of ethanol production using various organic wastes/raw materials. (Free cells / immobilized cells). 5) Production and extraction of thuricides. 6) Laboratory scale production of biofertilizers. (Nitrogen fixer/ Phosphate solubilizers/ Siderophore producers). 7) Microbial production of dextran by *Leuconostocmesenteroids*. 8) Microbial production of hydrogen gas by algae. (MB-402) 1) Spectrophotometeric/ Microbiological methods for the determination of Griseofulvin. 2) Microbial production and Bioassay of Penicillin. 3) Bioassay of Chloramphenicol/Streptomycin by plate assay method or	**Estimation of acid,production , rifamycin production,thuricides, laboratory scale production of biofertilizer. Detemination of griseofulvin penicillin, etc.**

		turbidometric assay methods. 4) Screening, Production and assay of therapeutic enzymes: Glucose Oxidase/Asperginase/beta lactamase. 5) Treatment of bacterial cells with cetrimide, phenol, and detection of Leaky substances such as amino acids, nucleic acids as cytoplasmic membrane damaging substances. 6) Determination of MIC and LD50 of Ampicillin / Streptomycin. 7) Sterility testing by using *B. sterothermophilus / B. subtilis.* 8) Testing for microbial contamination. Microbial loads from syrups, suspensions, creams, and other preparations, Determination of D-value and Z-value for heat sterilization in pharmaceuticals. 9) Determination of antimicrobial activity of chemical compounds (like phenol, resorcinol and formaldehydes) Comparison with standard products. (MB-403) 1. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids. 2. Determination of indices of pollution by measuring BOD/COD of different effluents. 3. Bacterial reduction of nitrate from ground waters 4. Isolation and purification of degradative plasmid of microbes growing in polluted environments. 5. Recovery of toxic metal ions	

		of an industrial effluent by immobilized cells. 6. Utilization of microbial consortium for the treatment of solid waste [Muncipal Solid Waste]. 7. Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by Pseudomonas species. 8. Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds 9. Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures. 10. Microbial dye decolourization/adsorption. (MB-404) **Use of Internet /software for sequence analysis of nucleotides and proteins.** 1. Studies of public domain databases for nucleic acid and protein sequences. 2. Determination of protein structure (PDB) by using RASMOL, CN -3D software 3. Genome sequence analysis by using BLAST algorithm 4. Protein sequence analysis by using BLAST algorithm	
Unit IV	(Dissertation)	.Project Topic	**Appraise the students in research attitude and to develop different types of research methodology.**

Specify Course Outcome:

Analysis of different types of amino acids ,antibiotics and its estimation of alcohol and enzymes etc.

Specify Program Outcome:

Understand & apply theoretical & practical knowledge for carrier orientation in view of microbial genetics and molecular biology, occurrence of metabolic events & its relation to environment & agriculture, & food and dairy microbiology.

Signature of Teacher