BADDI UNIVERSITY OF EMERGING SCIENCES & TECHNOLOGY
M.Sc. Microbiology (Semester System I-IV)
(Under Credit Based Continuous Evaluation Grading System)

SEMESTER- First

Course Code	Course Name	L (hrs)	P (hrs)	Credits
PMI-101	General Microbiology	4	2	**4 + 1**
PMI-102	Bacteriology	4	4	**4 + 2**
PMI-103	Virology	4	2	**4 + 1**
PMI-104	Microbial Metabolism and Biochemistry	4	4	**4 + 2**
		Total Credits		**22**

SEMESTER- Second

Course Code	Course Name	L (hrs)	P (hrs)	Credits
PMI-201	Immunology	4	4	4 + 2
PMI-202	Genetic Engineering & Molecular Biology	4	2	4 + 1
PMI-203	Industrial Microbiology	4	2	4 + 1
PMI-204	Food Microbiology	4	4	4 + 2
		Total Credit		**22**

SEMESTER- Third

Course Code	Course Name	L (hrs)	P (hrs)	Credits
PMI-301	Mycobiotechnology and Phycobiotechnology	5	4	5 + 2
PMI-302	Medical and Diagnostic Microbiology	5	2	5 + 1
PMI-303	Environmental Microbiology	5	4	5+ 2
PMI-304	Techniques in Microbiology	5	2	5+1
			Total Credits	26

SEMESTER – Fourth

Course Code	Course Name	L (hrs)	P (hrs)	Credits
PMI-401	Computers, Bioinformatics and Biostatistics	5	0	5
PMI-402	Microbial Quality Control in the Food and Pharmaceutical Industries	5	0	5
PMI-403	Recent advances in Microbiology	5	0	5
PMI-404	Computational Techniques in Bioinformatics and Biostatistics Lab		4	2
PMI-405	Project Work	0	8	4
			Total Credits	21

Semester-I

Course Code	Course Title	L	T	P	Credit
PMI-101	**General Microbiology**	**4**	**0**	**2**	**4+1**

Pre-requisites: Students should have knowledge about Biology.

Course Objectives:

1. To provide adequate, basic understanding about Microbiology subject that would enable them to understand the subject & its applications.
2. To students will get in formation of microbiology that would facilitate them to learn the world of microbes in a much better way.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Historical developments of microbiology, scope of microbiology, General structure, distinctive characteristics of protozoa, algae, bacteria, fungi, viruses, bacteriophages-lytic and lysogenic, brief account of organization and classification of microorganisms and salient features of bacteria, prokaryotic cell and eukaryotic cell and their structures. Microscopy: Principle of bright field microscopy, dark field microscopy, fluorescence and immuno-flourescence microscopy, phase contrast and electron (transmission and scanning) microscopy and their applications in microbiology .Staining of microorganisms.

UNIT-II

Morphological and Ultra structure of microbial cell (Gram positive and Gram negative bacteria), Growth and Reproduction of bacteria, population growth and its measurement, effect of environmental conditions (pH, temperature, aeration, etc.) continuous culture, diauxic growth, synchronous cultures.

Nutritional types of bacteria, types of media (selective media, differential media, assay and enrichment media), choice of media, Preservation and maintenance of microorganisms by periodic transfer and cryo-preservation, Lyophilization.

UNIT-III

General account of prokaryotic genome, transformation (*in-vivo* and *in-vitro* transformation), competent cells, *in-vitro* generation of competent cells. Mechanism of transformation and its role in molecular biology. Conjugation's-factor, sexpili, Hfrcells,its mechanism and its role in development of multi drug resistance. Transduction: temperate phage and lysogenic cycle,

Mechanism of transduction, abortive transduction and its role in microbiology.

UNIT-IV

Archaebacteria : Evolutionary trends in relation to Archaebacteria and its properties, Salient features and difference from Eubacteria and eukaryotes, Detailed accounts of thermophiles, halophiles and methanogens, their biochemical and physiological adaptation, biotechnological aspects of extremophiles. General account on control of microorganisms: Control of microbes by physical and chemical agent's sterilization i.e. steam, dry heat, ethylene oxide, Antibiotics: properties and mode of action. Drug resistance and its significance. Antibiotic sensitivity test.

Course Outcomes:

CO1: The student will be able to elucidate different microbiology disciplines, the foundation theories and practices and know microbial interaction with their environment.

CO2: The students will understand the history and developments in the field of microbiology.

CO3: The student will be able to exploit microbiological concepts to review, investigate and make methodical to solve microbiological problems.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms –20 Marks
- Attendence-5marks
- End-Term (100Marks) – 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Stanier,R.Y.Adelberg, E.A.and Ingraham,J.L.(2004).General Microbiology, IVed.Mac Millan Press.
- Pelczer,M.J.Chan,E.C.S.and Krieg,N.R.(2003).Microbiology,V.ed.Mc.GrawHill.
- Prescott.L.M.HarleyJ.P.andL.KleigD.A.(2005).Microbiology,WCB Publishers
- Alcamo,I.E.(2001) Fundamentals of Microbiology,John &Barlett Publishers

Web Resources: Google Scholar, ScienceDirect, Microbes.info, PubMed, Microbiology news

❖ **Perform 7 practical's:**

1. Introduction to general equipment's (autoclave, BOD incubator, hot air oven, laminar air flow, pH meter, colony counter) used in microbiology lab.
2. Media preparation and its sterilization.
3. Determination of cell count by SPC method and DMC method
4. To isolate fungi and yeast from various sources and study their morphology.
5. To study the Diauxic growth.
6. Preparation of Nutrient Agar.
7. To isolate fungi and yeast from various sources and study their morphology.

Course Outcomes:

CO1: Students will be able to understand the various diseases caused by these organisms their life-cycle, symptoms and methods of prevention.

CO2: Students will be able to perform cell culture in lab.

Assessment Model:

Total assessment (Out of 30 Marks)

Preferred Reading:

- James Cappuccino, Microbiology, 10th edition.
- Bani Bharal, Anandita Mandal, laboratory manual, clinical Microbiology

Web Resources: Google Scholar, ScienceDirect, Microbes.info, PubMed,

Course Code	Course Title	L	T	P	Credit
PMI-102	**Bacteriology**	**4**	**0**	**4**	**4+2**

Pre-requisites: Students should have knowledge about Microbes**.**

Course Objectives:

1. To understand historical background, structure, morphology of bacteria.
2. To understand the classification of bacteria and associated bacterial diseases.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

History of bacteriology, Discovery of bacteria, Role of microorganisms in geochemical cycling, transformation of organic and in organic matter, development of microbiology. Contributions of Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Fleming and Edward Jenner in Microbiology.

Morphology and ultra-structure of bacteria, morphological types, cell wall of Gram +ve and Gram –ve bacteria, eukaryotes, L-form, Cell wall synthesis, capsules- types, composition and functions. Cell membranes-structure, composition and properties.

UNIT-II

Importance of microbiology in diagnosis and prevention of infectious diseases. Inflammation: Acute and Chronic inflammation. Ultra structure and functions of flagella, cilia, pili, gas vesicle, chromosomes, carboxysomes, magnetosomes, phycobilisomes, endospore, capsules and S-layer. Reserve food materials- PHB, phosphate granules, oil droplets, cyanophycean granules and sulphur inclusions.

UNIT-III

Bacterial taxonomy based on DNA base homology, 16S rRNA gene sequence and DNA hybridization. Classification of Microorganisms- Hackel`s three kingdom concept, Whittaker`s five kingdom concept, Bergey`s system of Bacterial Classification: General features of Rickettisae, Mycoplasma, Actinomycetes/actinobacteria.

UNIT-IV

Pathogenic Gram+ve bacteria and brief account on diseases caused by: *Streptococcus, Staphylococcus, Clostridium, Mycobacteria* and their morphology and pathogenesis.

Pathogenic Gram -ve bacteria and brief account on diseases caused by: *Escherichia coli, Salmonella, Shigella, Vibriocholerae, Pseudomonas, Neisseria* and their morphology and pathogenesis. Staining methods and their principles (Gram and Ziehl Nelson staining).

Course Outcomes:

CO1: Students will be able to acquire knowledge about historical background of Microbiology.

CO2: They will be able to understand the structure and morphology of bacterial culture.

CO3: Students will learn about the classification of bacteria, bacterial diseases (life cycle and pathogenesis).

Assessment Model:

- Quiz -25Marks
- Average of Two Mid-Terms –20 Marks
- Attendance - 5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Buchanan,R.E.and Gibbens,M.E.(2005) Bergey`s Manual of Systematic Bacteriology Vol.I, II, III & IV,Springer Publications
- Davis,B.D. Delbecco.R.Eisen, H.N.Ginsberg.H.S.and Wood,W.B.Jr.(2000) Microbiology, Harper &Row Publishers
- Stanier,R.Y.,Ingraham, J.L.Wheelis ,M.L.and Painter ,P.R.(2003). General Microbiology, Mac. Millan Press Ltd. U.K.
- Black,J.G.(2004) Microbiology: Principles &Exploration.4th Edition,Wiley Publishers

Web Resources:

- Google Scholar, PubMed, Science Direct

❖ **Perform 7 practical's:**

1. Isolation and enumeration of bacteria from soil by serial dilution and agar plating method.
2. To differentiate bacteria by using Gram Staining Technique.
3. Determination of cell size of different microorganisms.
4. To study morphology of bacteria isolated from soil sample.
5. Determination of cell shape of different microorganisms.
6. Determination of cell count by SPC method and DMC method.
7. Calculation of generation time and growth rate of bacterial culture.

Course outcomes:

CO1: Students will be able to understand the various diseases caused by these organisms their life-cycle, symptoms and methods of prevention.

CO2: Students will be able to perform cell culture in lab.

Preferred Reading:

- James Cappuccino, Microbiology,10th edition
- Bani Bharal, Anandita Mandal, laboratory manual, clinical Microbiology

Web Resources:

- Google Scholar, PubMed, Microbe Online, Sci-Hub

Course Code	Course Title	L	T	P	Credit
PMI-103	**Virology**	**4**	**0**	**2**	**4+1**

Pre-requisites: Students should have the basic knowledge about virus.

Course Objectives:

1. Students will learn about the basic structure of viruses, replication strategy of viral genome and interpret current taxonomy of viruses.

2. Students will be able to characterize important viral diseases of plants, animals (including humans) and understand methods and diagnostic tools used in virology.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Historical account and development of virology, General characteristics, morphology, multiplication, classification of viruses, Bacteriophage. Brief account of Viroids, Prions and Interferon.

UNIT-II

Assay of viruses, biophysical properties of viruses, plaque, pock method and direct count method, Hem-agglutination, serological and molecular based detection of viruses, use of electron microscopy in virology.

Phages: types, general properties of Bacteriophage, detailed description of lambda, M13 phage and T2phage, One Step growth. Isolation, purification and criteria of purity of viruses.

UNIT-III

Plant Viruses- structure, replication and transmission of viruses (Insects, amphids, air, water and soil, agricultural equipment, seeds, sap etc.)

Viral diseases associated with wheat, rice, okra, potato, tobacco and cotton, their symptoms, mode of infections & multiplication, control.

UNIT-IV

Epidemiology, lifecycles, pathogenicity, diagnosis, prevention and treatment of RNA Viruses: Picorna, Orthomyxoviruses, Paramyxoviruses, HIV/AIDS and Oncogeneic viruses.

Epidemiology, lifecycles, pathogenicity, diagnosis, prevention and treatment of DNA Viruses: herpes viruses, hepatitis viruses, adenoviruses and Corona virus and its mode of infection.

Course Outcomes:

CO1: The student will understand the concept of Viruses: structure, classification, replication and properties.

CO2: Students are able to know the lifecycle of viruses.

CO3: They will be able to understand the serological and molecular techniques for the detection of viruses.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms –20 Marks
- Attendence-5 marks
- End-Term (100Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Davis,B.D.Delbecco.R.Eisen,H.N.Ginsberg.H.S.andWood,W.B.Jr.(2004). Microbiology, Second edition. Volume–II, Harper & Row.
- Cann,Allanj.1997. Principles of Molecular Virology, Academic Press London.
- MathewsREF1998. Plant Virology, Academic Press, London.
- Paniker,CJK(2005)A textbook of Microbiology,7th Edition
- Flint,SJ; Enquist, LW;Skalka, AMK(2000) Principles of Virology; molecular biology, pathogenesis and control.

Web Resources:

- Google Scholar, PubMed, Microbe Online, Sci-Hub

❖ **Perform 7 practical's:**

1. Isolation and enumeration of Bacteriophage from sewerage water.
2. To study symptoms of viral infection in plants.
3. To study the effect of temperature on the growth of bacteria/yeast
4. To study the effect of pH on the growth of bacteria/yeast
5. To study the effect of salt concentration on the growth of bacteria/yeast

6. To study the effect of UV-radiations on the growth of bacteria/yeast
7. Qualitative estimation of carbohydrates

Course Outcomes:

CO1: Students will be able to understand the various diseases caused by these organisms their Life-cycle, symptoms and methods of prevention.

CO2: Students will be able to perform cell culture in lab.

Assessment Model:

- Total assessment (out of 30)

Preferred Reading:

- James Cappuccino, Microbiology,10th edition
- Bani Bharal, Anandita Mandal, laboratory manual, clinical Microbiology

Web Resources:

- Google Scholar, Web of Science, Google Books.

Course Code	Course Title	L	T	P	Credit
PMI-104	**Microbial Metabolism and Biochemistry**	**4**	**0**	**4**	**4+2**

Pre-requisites: Students should have the basic knowledge about enzymes, proteins.

Course Objectives:

1. They will be able to understand the classification and properties of carbohydrates, proteins, lipids and amino acids.

2. They will have knowledge of types, structure, function and replication of DNA.

3. They will be able to understand the properties and classification of enzymes and their kinetics. They will be able to understand various metabolic pathways, photosynthesis and growth of bacteria.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Introduction to microbial physiology, bio-energetic, basic concepts, enthalpy, entropy, Gibb`s free energy, Redox pairs in energy production, transport system(Passive, facilitated and active).Metabolism- Anabolism and catabolism, permeation of molecules through vital membranes, ionic influx and proton conducting channels (PPC) for intracellular polymerization of macromolecules.

UNIT-II

Enzymes: Nature, properties, nomenclature and classification of enzymes, co-enzymes, enzymes regulation and its inhibition, factor effecting enzyme activity.

Proteins: Classification, Structure (Primary, secondary, tertiary and quaternary structure) and Functions. Structure and properties of vitamins, co-enzymes, biochemical action of vitamins and water-soluble vitamins, Biosynthesis of vitamins, role of vitamins in the metabolism.

UNIT-III

Photosynthesis (Photo physical, photochemical and biochemical phases) with particular reference to photoautotrophic microbes.

Carbohydrate metabolism: Glycolysis, citric acid cycle, ETC (Complex I, II, III and IV) Chemiosmosis and ATP generation, Gluconeogensis, ED pathway, Pentose Phosphate pathway and glyoxylate cycle.

UNIT-IV

Fatty acids: Structure and properties of fatty acids, oxidation of fatty acids (beta & alpha), Oxidation of long chain fatty acids, Synthesis of lipids, elongation of fatty acids, denaturation of fatty acids, regulation of fatty acid synthesis, cholesterol metabolism, regulation of cholesterol metabolism.

Amino acids: catabolism of amino acids, urea cycle, synthesis of aromatic amino acids. Nucleic Acids: Structure of purine and pyrimidine's nucleotides and its regulation.

Course Outcomes:

CO1: Students will understand the biological importance of various biomolecules *viz.* proteins, fats, vitamins and carbohydrates and their nutritional requirement in the day to day life.

CO2: They will have knowledge of types, structure, function and replication of DNA.

CO3: They will be able to understand the properties and classification of enzymes and their Kinetics. They will be able to understand various metabolic pathways, photosynthesis and growth of bacteria.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms –20 Marks
- Attendance- 5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading

- Champe,PC and Harvey, RA (1994)Biochemistry,2nd Edition, Lippincott Williams and Wilkins
- Nelson, DL and Cox, MM (2005) Principles of Biochemistry, 4th Edition, WH Freeman and Co.
- Moat, A and Foster, JW (2004) Microbial Physiology,4th edition, wiley publications

Web Resources:

- Google Scholar, Web of Science, Google Books.

❖ **Perform 7 practical's:**

1. To check the purity of DNA using UV-Vis spectrophotometer
2. Demonstration of agarose gel electrophoresis.
3. Demonstration of SDS-PAGE electrophoresis
4. Quantitative estimation of carbohydrates by DNS method
5. Quantitative estimation of carbohydrates by anthrone method
6. Quantitative estimation of proteins by Biuret method
7. Quantitative estimation of proteins by Folin-Lowery's method
8. To perform various biochemical tests of bacteria: Acid and gas production from sugars, gelatin liquefaction, starch hydrolysis, casein hydrolysis, nitrate reduction, indole Production, H2S production, methyl red test, Vogues Proskauer's test, citrate utilization, catalase activity, urea activity, oxidase activity.

Course Outcomes:

CO1: Students will be able to understand the various diseases caused by these organisms their Life-cycle, symptoms and methods of prevention.

CO2: Students will be able to perform cell culture in lab.

Assessment Model:

- Total assessment (Out of 30 Marks)

Preferred Reading:

- James Cappuccino, Microbiology,10 th edition
- BaniBharal, AnanditaMandal, laboratory manual, clinical Microbiology

Web Resources:

- Google Scholar, Web of Science, Google Books.

Semester-II

Course Code	Course Title	L	T	P	Credit
PMI-201	Immunology	4	0	4	4+2

Pre-requisites: Students should have the basic knowledge about Blood cells, immunity.

Course Objectives:

1. Students will get knowledge of about Immune system (Cells/Organs) and its role in disease control mechanism.
2. Discipline will make student to understand immunology techniques and the way it is apply in diagnostic and therapeutic techniques and research.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT- I

History of immunology, composition and function of cells and organ system involved in immune system; host parasite relationship. Microbial infections: virulence and host resistance.

Definition of immunity, types of immunity, factors affecting the mechanism of innate immunity, active and passive immunity, local immunity and herd immunity.

UNIT-II

Antigens: Structure and properties, types, adjuvant- antigen specificity, vaccines and toxoids, Antigen processing and presentation.

Immunoglobins- structure, types and, properties, Complement- structure, components and properties, functions, complement pathways and biological consequences of complement activation, Monoclonal antibodies.

UNIT-III

In-vivo and *in-vitro* methods: Agglutination, precipitation, complement fixation, immune fluorescence, ELISA, Radio immunoassay Structure and functions of MHC and HLA

system. Tissue transplantation, tissue Typing methods, graft versus host reaction and rejection. Regulators of immune cell development and function. Structural and functional studies of cytokines, chemokine's and their receptors.

UNIT-IV

Autoimmunity- theories, mechanisms and diseases with their diagnosis, Generation of Antibody Diversity. Hypersensitivity reactions: Antibody-mediated Type–I, Anaphylaxis, Type-II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- Cell mediated hypersensitivity reactions, defects in immune system: Primary and secondary defects.

Course Outcomes:

CO1: Students will learn about types and structure of immune cells, organs and immunoglobulin. Students will be able to evaluate about complement and interferon systems that boost other immunological defenses.

CO2: Students will be able to get depth information of the cellular and molecular basis for hypersensitivity, autoimmune disease and allergic response.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms –20 Marks
- Attendance- 5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Kuby,J.(1992),Immunology, W.H.Freeman, USA.
- Paul,W.E.(1991),Immunology: Recognition and Respons W.H.Freeman ,NewYork Rao,V(2006) Immunology, Narosa Publishers
- Playfair,J.H.L.(1992),Immunology at Glance(5^{th} ed.),Black well Scientific Publication, Oxford.

- Roitt,I.M,Brostoff,J.and Male,D. (1989),Immunology, 2nded.G.M.Publ.,NewYork.

❖ **Perform 7 practical's**

1. Generation of Competent cells and studies the transformation using plasmid.
2. To perform TLC and DLC
3. ESR determination
4. To Perform ELISA
5. To perform Double Immunodiffusion.
6. Restriction digestion of genomic DNA and amplified DNA
7. RNA isolation from dry yeast cells

Course Outcomes:

CO1: Student will learn practical knowledge.

Assessment Model:

- Total assessment (out of 30).

Preferred Reading:

- James Cappuccino, Microbiology,10th edition
- Bani Bharal, Anandita Mandal, laboratory manual, clinical Microbiology

Web Resources:

Google Scholar, Web of Science, Google Books.

Course Code	Course Title	L	T	P	Credit
PMI-202	**Genetic Engineering & Molecular Biology**	**4**	**0**	**2**	**4+1**

Pre-requisites: Students should have the basic knowledge about molecules

Objective:

1. The students with get the basic facts about Molecular biology (replication, transcription and translation) that would facilitate them to learn the subject and its applications.
2. Students will understand the basic practical Molecular Biology techniques (PCR, Cloning & Transformation) and after finishing the lessons the students will have a detailed knowledge on the practical aspects for better understanding of the molecular processes in the cell.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Gene organization in microbes (bacteria, viruses and eukaryotes), structure of DNA and n of DNA, mutations – types, detection and isolation of mutants, DNA repair, DNA transcription, protein synthesis and regulation.

Bacterial recombination, transposons, gene mapping. Nucleic acids: structure and function of DNA and RNA, DNA replication.

Transcription and Translation Genetic Engineering History, Development and Importance

UNIT-II

Regulation of gene expression in eukaryotes and prokaryotes, Concept of operon; general structure and regulation of an operon, *lac*, *trp* and *ara* Operons.

Molecular genetics: DNA cloning. Genomic and cDNA library preparation: Methods for construction of genomic and cDNA libraries vectors used.

Generation of cDNAs, preparation of genomic DNA for library construction.

UNIT-III

Mutagenesis, types of mutants and mutagenic agents, role of mutants in microbial and molecular genetics, DNA damage and repair mechanisms.

Molecular mechanism of recombination, proteins involved in recombination, Transposons, its types and mechanism of transposition.

UNIT-IV

Molecular cloning; techniques and their importance, cloning vectors; plasmid stability and in-Compatibility, properties and uses, selection and characterization of clones, gene probes, labeling. PCR and its principle.

Components of PCR, Types & steps of PCR (Basic, Hot start , Real-Time PCR, Nested PCR) and their applications in molecular biology

Course Outcomes:

CO1: Students will understand the theoretical facts of molecular mechanisms and try to understand the concepts more clearly.

CO2: This course will help the students to learn molecular tools and techniques to become a proficient molecular biologist.

CO3: Students will be aware about the basics techniques of Molecular Biology with particular highlighting on the applications of techniques for industry and academia.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms – 20 Marks
- Attendance-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Friefelder,D.Maloy,S.R.andCronana,J.E.1994.Microbial Genetics,IInd edition,Jones and Barlett Publishers.
- Lewin,B.2008.GenVIII.OxfordUniv.Press.Malacinski,G.M.&FriefelderD.1993.Essentials of Molecular Biology, IInd Edition.Jones and Bartlett Publishers.
- Synder,L.and Champness W.,1997.Molecular Genetics of Bacteria, ASM Press.
- Brown,TA (2002) Genomics,2nd edition BIOS Scientific Publishers LTD.
- Klug and Cummings (2000) Concepts of Genetics,6th edition,Prentics Hall, NewJersy

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Web Recourses:

Google scholar, Springer, NCBI GenBank.

Perform 7 practical's

1. Isolation of genomic DNA from bacteria.
2. Isolation of plasmid DNA from bacteria.
3. To perform Agarose gel electrophoresis.
4. To perform SDS-PAGE plasmid.
6 .PCR amplification of 16S rDNA gene of bacteria.
7. Restriction digestion of genomic DNA and amplified DNA.
8. To perform Double Immuno Diffusion.

Course Outcomes:

CO1: Student will learn practical knowledge.

Assessment Model:

Total assessment (out of 30 Marks)

Preferred Reading:

- JamesCappuccino, Microbiology,10th edition
- Bani Bharal, Anandita Mandal,laboratory manual,clinical Microbiology

Web Resources:

Google Scholar, Science Direct.

Course Code	Course Title	L	T	P	Credit
PMI-203	**Industrial Microbiology**	**4**	**0**	**2**	**4+1**

Pre-requisites: Students should have the knowledge about microbes.

Objective:

1. To understand the importance and applications of microorganisms in the Industry.
2. To learn development and applications of microorganism based bio fertilizers, bio pesticides.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Importance and Applications of industrial microbiology in human therapeutics, isolation and screening of industrially important microbes. Raw materials of industrial importance. Microbial growth (physical characters-gaseous atmosphere, pH, other conditions and nutrition-nutritional classification. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential and enrichment media. Bioreactors, design and components of basic fermentor, specialized fermentors for specific purposes. Fermentation parameters and their optimization, reaction kinetics.

UNIT-II

Fermentation: An overview, Types of fermentation processes- Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (e.g. baker's yeast) and continuous fermentation.

Antibiotic fermentations – production of β lactams (penicillins), semi-synthetic penicillins and amino-glycosides (streptomycin) and organic acids (Citric acid and Itanoic acid). Amino acid production-Glutamic acid and lysine production.

Alcoholic beverages: Process of production of beer, wine and their types.

Large scale applications of microbial enzymes- Enzymes for starch processing, use of genetically modified *Bacillus* strain for production of amylases. Immobilized enzymes for production of HFCS, 6-APA and acrylamide.

UNIT-III

Microbial Products for Agriculture: Biofertilizers– history of biofertilizers, sources of nitrogen and the importance of biofertilizers, description and characteristics of biofertilizers. *Bacillus thuringiensis* as a major biopesticide, transgenic crops from *B. thuringiensis* their development and applications. Other transgenic crops– role of *Agrobacterium.*

Bioremediation of contaminated sites due to industrial pollution. *In-situ* and *ex-situ* bioremediation techniques, role of genetically engineered microbes in bioremediation. Biosurfactants, definition, classification, types and their application in environment.

UNIT-IV

Bioprocessing– Downstream processing of industrial fermentation processes, product purification and recovery, Physico-chemical basis of bio-separation processes, techniques for purification of end products.

Recombinant protein expression with *E.coli* and fermentation. Expression in yeast *Pichiapastoris*, production of therapeutic proteins i.e. recombinant vaccines.

Purification of recombinant proteins: Expression of fusion protein, formation of inclusion bodies, production of Chymosin (Renin) in *E.coli*

Course Outcomes:

CO1: Role of microorganisms in the Industries.

CO2: To understand Biodegradation and Bio detoriation.

CO3: Better understanding of laboratory tools and techniques.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms – 20 Marks
- Attendance-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Stansbury and Whittaker (2003) Principles of Fermentation Technology, Pergamon Press.
- W. Crueger and A.Crueger Biotechnology 2nd Edition. (1992) Panima Publishers.
- Moo Young Comprehensive Biotechnology Vol III and IV (1984) Pergamon Press.
- Prave,E (2004) Fundamental of Biotechnology. Panima Publishing Corporation
- Patel,AH (2006) Industrial Microbiology. Macmillian Press India Ltd.

Web Resources:

Springer, Google Scholar, Scopus.

Perform 7 practical'

1. To study amylase production and its estimation.
2. Citric acid production and its estimation.
3. Sauerkraut production.
4. Determination of TDT of given sample.
5. Isolation of Salmonella from given food samples.
6. To perform wine production.
7. Determination of Iodine number of given fat sample

Course Outcomes:

CO1: Student will learn about how to handle with all the instruments.

CO2: Student will learn about techniques to check the quality of milk and food samples.

Assessment Model:

- Total assessment (out of 30)

Preferred Reading:

- James Cappuccino, Microbiology,10th edition
- Bani Bharal, Anandita Mandal, laboratory manual, clinical Microbiology

Web Resources:

Google Scholar

Course Code	Course Title	L	T	P	Credit
PMI-204	**Food Microbiology**	**4**	**0**	**4**	**4+2**

Pre-requisites: Should have knowledge about microbes.

Course Objectives:

1. To obtain the knowledge about important microflora associated with food and their characteristics.
2. To understand the role of different microorganisms in food spoilage, food fermentation, and food borne diseases.
3. To gain the essential knowledge and applications of various techniques for preserving food.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Food as substrate for microorganisms: Microorganisms important in food microbiology- molds, yeast and bacteria, their importance, principles of food preservation. Asepsis- removal of microorganisms (anaerobic, high temperature, low temperature and drying), Factors influencing microbial growth in food- Extrinsic and intrinsic factors chemical preservatives and food additives, canning.

UNIT-II

Contamination and Spoilage: Cereals, sugar products, vegetables, fruits, milk and milk products, fish and sea foods, poultry, spoilage of canned food, detection of spoilage and characterization. Food borne infection and intoxications: (bacterial and non-bacterial) *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia* and *Aspergillus.*

UNIT-III

Laboratory testing procedures; preventive measures- food sanitation in manufacture and retail trade; food control agencies and its regulations, plant sanitation- Employee's health standards. Waste treatment- disposal and quality control, ISO and HACCP system. Food preservation: Heat processing; pasteurization and appertization, determination of D and Z values. Heat sensitivity of micro-organisms & spoilage of canned foods. Brief account on high pressure processing, low temperature storage– chilling and freezing. Effect of chemical and natural preservations on microbes in food.

UNIT-IV

Food fermentations: Bread, Vinegar, fermented vegetables and biogenic amines. Cheese: introduction, manufacturing principles, general steps in cheese making, types of cheese, cheese ripening, microbial defects, recent technological advances in cultured dairy products technology. Oriental fermented foods: Mycoproteins, tempeh, Soya sauce, idli, natto and poi. Properties of fermented foods and health benefits of fermented foods and beverages.

Course Outcomes:

CO1: Understand about microorganisms associated with food and their characteristics.

CO2: Recognize the role of different microorganism in food spoilage and food fermentation.

CO3: Knowledge of various methods for control of microorganisms in food.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms – 20 Marks
- Attendance-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Frazier and Klesth off (2004) Food Microbiology
- James,MJ (2005) Modern Food Microbiology,4th edition
- Adams,MR and Moss, MO (2003) Food Microbiology

Web Resources:

PubMed, Google Scholar

❖ **Perform 7 practical's**

1. To determine fat, SNF, TSS of the given milk sample.
2. To determine acidity of food sample estimation.
3. Citric acid production and its estimation.
4. Sauerkraut production.
5. Determination of TDT of given sample.
6. To check the quality of milk sample using MBRT.
7. To check the standard plate count of given food sample**.**

Course Outcomes:

CO1: Student will learn about how to handle with all the instruments.

CO2: Student will learn about techniques to check the quality of milk and food samples.

Assessment Model:

Total assessment (out of 30 Marks)

Preferred Reading:

- James Cappuccino, Microbiology,10th edition
- Bani Bharal, Anandita Mandal, laboratory manual, clinical Microbiology

Web Resources:

Google Scholar, ScienceDirect.

Semester-III

Course Code	Course Title	L	T	P	Credit
PMI-301	**Mycobiotechnology and Phycobiotechnology**	**5**	**0**	**4**	**5+2**

Pre-requisites: Students require basic knowledge about fungi and algae**.**

Course Objectives:

1. To apply the knowledge of fungus which are grown in environmental conditions.
2. To learn the concepts of laboratory conditions.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Introduction of fungi, Basic organization and present concept, Types of reproduction, growth parameters, fungal genetics. General characters of fungi and algae, cultivation, cultural characteristics, microscopic morphology, importance of fungi and algae in industry and food production. Yeasts: General characteristics.

Mushroom Biotechnology: production of button mushroom, oyster mushroom, paddy straw mushrooms and shiitake mushroom

UNIT-II

Myco-physiology and metabolism- Primary and secondary metabolites, release of Value Added Products (VAP), role of fungi in nutraceutical, cosmoceutics and pharmaceutics. Economic importance of fungi: role of fungi in biodegradation, bio-deterioration, enzyme production, biological control, myco-herbicides, application of gene cloning in fungal biotechnology.

UNIT-III

Introduction to algae, cellular organization of eukaryotic and prokaryotic algae, Types of reproduction, growth parameters, and algal genetics. Role of algae in fresh water and marine ecosystem, algae association with flora and fauna, algal nitrogen fixation.

UNIT-IV

Algae as bio fertilizers, reclamation of saline and sodic soils, algae as food (SCP),uses of Algae in Fisheries. Economic importance of Algae: Industrial exploitation of algae, use of algae for production of agar-agar, alginate, diatomite, iodine. Role of algae in sewage treatment using high rate oxidation ponds.

Course Outcomes:

CO1: Students will be able to learn the uses of mushrooms, Algae and different fungi in our daily life.

CO2: Students will be able to apply knowledge of medicines which are obtained from Fungi and Algae

CO3: Students will be able to apply knowledge in various laboratory techniques.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms – 20 Marks
- Attendance-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Glazer, AN (2007) Microbial Biotechnology
- Agriose, GN(2005)Plant Pathology,4th edition, Elsevier Publisher
- Smith,AR (2002) Fresh water algae of US, US academic press
- Stewart WDP(2000) Algal physiology and Biochemistry, Academic Press, UK
- MooYoung (2005)Biotechnology Vol.I to IV, Elsevier Publication, UK
- Rose,AH.(2004) Environmental Biotechnology Vol.I to IV, Academic Press, UK

Web Resources:
PubMed**,** Springer**,** Google Scholar, Encyclopedia.

- **Perform 7 practical's**

1. Quantification of proteins, carbohydrates, total lipids and biomass
2. Slide culture technique

3. Quantification of total cellulose, cellulose complex from fungi
4. Quantification of total chlorophyll from algae.
5. Quantification of total carotenoids from algae.
6. Quantification of total phycobilli proteins from algae.
7. Determination of total volatile fatty acids from fungi.
8. Morphological characterization of fungi, algae and actinomycetes.
9. Growth profile of fungi and algae.
10. Isolation of algae, fungi and actinomycetes from soil, water and industrial effluents.
11. Preparation of selective media for fungi and algae.
12. Immobilization of fungal spores and unicellular algae.

Course Outcomes:

CO1: Student will learn about how to handle with all the instruments.

CO2: Student will learn about techniques to check the quality of milk and food samples.

Assessment Model:

- Total Assessment (Out of 30 Marks).

Preferred Readings

- Practical Microbiology. R.C Dubey and D.K.Maheshwari.
- Practical book of Microbiology. K.R Aneja

Web Resources:

Google Scholar, ScienceDirect.

Course Code	Course Title	L	T	P	Credit
PMI-302	Medical and Diagnostic Microbiology	5	0	2	5+1

Pre-requisites: Students require basic knowledge about instruments used in Microbiology laboratory and general concept of Microbiology

Objective:

1. To introduce the basic Microbiological techniques.
2. To understand the collection and isolation techniques of microbes.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

History and scope of medical microbiology, Koch's and River's postulates, germ theory of disease. Host parasite interaction and establishment of disease.

Iceberg concept of disease, kind of diseases: infectious and non- infectious, Disease process (Sign, symptoms and syndromes, types of infectious diseases, stages of infection)

UNIT-II

Normal microbial residents of human body, Characteristics of normal flora, distribution and occurrence of normal flora: skin, respiratory tract, gastrointestinal tract, urinary tract.

Epidemiology: Disease cycle (sources of disease, reservoirs and carriers), transmission of pathogens, route of infection. Primary and secondary infections, epidemic, endemic and pandemic.

UNIT-III

Collection, Transport and Examination of clinical specimens, processing of biological samples; stool, blood and urine Clinical features, laboratory diagnosis. Treatment and prevention of Cholera, Diphtheria, Tuberculosis (DOT treatment), MDR tuberculosis, meningitis and Pneumonia.

UNIT-IV

Application of ELISA, RIA, PCR and RT-PCR in the diagnosis of infectious diseases. Various methods of drug susceptibility testing, action of antibodies and drug resistance, antibiotic assay in body fluids.

Course Outcomes:

CO1: Understand the disease, its causative agents and its prevention and diagnosis.

CO2: Student will understand about the diseases.

CO3: Student will gain knowledge about the laboratory handling of microorganisms.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms – 20 Marks
- Attendance-5 marks
- End-Term (100 Marks)– 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

- Satyers andwhitt (2000) Microbiology, Diversity, Disease and Environment. Fitzgerald Saence Press.
- Baron,CJ. Diagnostic Microbiology,9th edition Mosby Year Book Europe Ltd, UK
- Bhatia, RandIchhpunjaniRL (1994) Essential of medical microbiology, Jaypee Publishers, India.
- Thomas,CGA (1988) Medical Microbiology, Baillian Tindall Publishers, UK

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Web Resources:

Springer, Google Scholar

❖ **Perform 7 practical's**

1. Characterization of normal micro-flora of human body parts.
2. MIC determination for potential pathogen.
3. Antibiotic sensitivity assay.
4. ELISA test.

5. WIDAL test.
6. Isolation of microorganisms from UTI.
7. VDRL test.
8. Isolation of algae, fungi and actinomycetes from soil, water and industrial effluents.

Course Outcomes:

CO1: Student will learn about how to handle with all the instruments.

CO2: Student will learn about techniques to check the quality of milk and food samples

Assessment Model:

Total Assessment (Out of 30 Marks).

Preferred Readings

- Practical Microbiology R.C Dubey and D.K. Maheshwari.
- Practical book of Microbiology. K.R Aneja.

Web Resources:

Google Scholar, ScienceDirect.

Course Code	Course Title	L	T	P	Credit
PMI-303	Environmental Microbiology	5	0	4	5+2

Pre-requisites: Students require basic knowledge in microbiology, instrumentation and Environmental area.

Objective:

1. To understand the use of microorganisms in the environment.
2. To learn how to use microorganism in the laboratory.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Basic components of abiotic and biotic environment, Hydrological cycle and water service cycle, physico-chemical characteristics of water resources, and hydrological characteristics of aquatic environment.

Various parameters of water quality for domestic and industrial use, microbiological indexing of water for industrial use, determination of aquatic environment and various pollutants

UNIT-II

Purification of waste water by aerobic processes, Communal sewage and industrial effluents, Aims and limitations of aerobic bio-processing.

Activated sludge process. Trickling filter process, lagoon process. Mechanism of anaerobic sludge digestion.

Microbiology of cellulose degradation, enzymatic aspects of cellulolysis, Microbiology of Lignin degradation, Enzymology of lignin degradation.

Brief account of microbial degradation of pectin and hemi-cellulose with their potential applications.

UNIT-III

Concept of Bioremediation efficacy testing approaches to bioremediation: Environmental modifications for Bioremediation.

Microbial seeding and Bioengineering Approaches to the bioremediation of pollutants. Gaseous and Heavy metal pollutants.

Microbes as sources of Atmospheric pollutants, microbes as sinks for Bioscrubbers and biofilters.

Bacterial leaching from ores, microorganisms associated with recovery of copper by direct and indirect leaching, uranium leaching.

UNIT-IV

Microbial Insecticides: Needs and advantages of bio-pesticides, bacterial insecticides: *Bacillus thruingensis* and others, Concept of endotoxins, mode of action, cry genes, pre and post translational changes in cry genes, *B. thruingensis* as a present day bioinsecticide.

Biology of baculo viruses, Baculo viruses as Insecticides, Mode of action, mass production and their future potential. Mass production of biopesticides, pros and associated with transfer of biopesticides genes to higher organisms.

Course Outcomes:

CO1: Role of insecticide and pesticide in the environment.

CO2: To understand Biodegradation and Biodetoriation.

CO3: Better understanding of laboratory tools and techniques.

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms – 20 Marks
- Attendance-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Scragg.A.H. (1991). Bioreactors in Biotechnology: A practical approach Ellis Horwood Ltd.
- Demain, AL and Davis,JE(2004)Manual of Industrial microbiology and biotechnology.
- Ramesh, KB (2005) Environmental Microbiology.
- Sharma, PD(2005) Environmental Microbiology.
- Maier, RM ,Peppler, IL and Gerba, CP(2006) Environmental Microbiology.

Web Recourses:

Springer, PubMed.

Perform 7 practical's

1. BOD determination of waste water.
2. COD determination of waste water.
3. Demonstration of bioreactor (construction, working).
4. Detection of Phenolic in effluents.
5. Physical characterization of waste water.
6. To check the presence of detergent.
7. Quantification of H 2 S as pollution indicator.

Course Outcomes:

CO1: Role of insecticide and pesticide in the environment.

CO2: To understand Biodegradation and Biodetoriation.

CO3: Better understanding of laboratory tools and techniques.

Assessment Model:
Total Assessment (Out of 30Marks).

Preferred Readings

- Practical Microbiology R.C Dubey and D.K. Maheshwari.
- Practical book of Microbiology K.R Aneja

Web Resources:
Google Scholar, Wikipedia

Course Code	Course Title	L	T	P	Credit
PMI-304	**Techniques in Microbiology**	**5**	**0**	**2**	**5+1**

Pre-requisites: Students require basic knowledge in purification techniques, about enzymes and General Microbiology.

Objective: The intent of the course is to understand several important concepts.

1. To learn different technique of microbiology.
2. To learn about different instruments used in Microbiology laboratory.

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Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Microscopy, Principle and types of microscopy. Dyes and staining techniques for differentiation of microorganisms. Pure culture techniques and sterilization. DNA isolation (plasmid and genomic), Agarose gel electrophoresis, Genetic Markers, Types and Uses/Applications of genetic markers. Gene cloning, competent cells, transformation and expression, fusion proteins (GFP,GST & His tagged protein).

UNIT-II

Protein purification, native and SDS-PAGE, N-terminal and C-terminal sequencing of proteins, structural elucidation of proteins ELISA and Radiography, Ames assay, complement fixation test, fluorescent antibody techniques, Slot and Blot

UNIT-III

Chromatography Techniques: principles and theory of adsorption chromatography, ion exchange chromatography, affinity chromatography, column chromatography,

Thin Layer Chromatography, Gas-Liquid Chromatography, HPLC and their relevance to microbiology, confocal microscope, enumeration of microbes, centrifuge.

UNIT-IV

UV- Vis spectroscopy, IR- spectroscopy, Fluorescent spectroscopy, NMR, Mass spectroscopy, Atomic adsorption spectroscopy, XRD

Course Outcomes:

CO1: Student will be able to develop a water purification technique

CO2: Know about chromatographic techniques and its applications.

CO3: Will learn about microscopy techniques, spectroscopic techniques (UV-Vis, FT-IR, GC-MS).

Assessment Model:

- Quiz -25 Marks
- Average of Two Mid-Terms – 20 Marks
- Attendance-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Scragg. A.H. (1991). Bioreactors in Biotechnology: A practical approach Ellis Horwood Ltd.
- Demain,AL and Davis,JE(2004).Manual of Industrial microbiology and biotechnology
- Ramesh, KB (2005) Environmental Microbiology
- Sharma, PD (2005) Environmental Microbiology
- Maier, RM, Peppler, IL and Gerba, CP (2006) Environmental Microbiology

Web Resources:

PubMed, Google Scholar.

- **Perform 7 practical's**

1. PCR
2. HPLC of given sugar sample indicator.
3. Assay for eutrophication
4. Bioassay for self-purification of water
5. Thin Layer Chromatography for amino acid production
6. Cultivation and characterization of anaerobes.
7. Demonstration of bioreactor (construction, working)

Course Outcomes:

CO1: Will be able to develop a water purification technique

CO2: Know about chromatographic techniques and its applications.

CO3: Will learn about microscopy techniques, spectroscopic techniques (UV-Vis, FT-IR,GC-MS

Assessment Model:

- Total Assessment (Out of 30Marks).

Preferred Readings

- Practical Microbiology. R.C Dubey and D.K. Maheshwari.
- Practical book of Microbiology. K.R Aneja

Web Resources:

Google Scholar, Wikipedia

Semester-IV

COURSE CODE	COURSE TITLE	L	T	P	Credit
PMI-401	**Computers, Bioinformatics and Biostatistics**	**5**	**0**	**0**	**5**

Pre-requisites: Basic knowledge in computer programming, languages etc.

Objective:

1. To provide the knowledge of computers theory and practical handling.
2. To provide bioinformatics tools for research purpose
3. To provide knowledge about biological databases, sequence alignment and phylogenetic studies.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Computer basics. Concept of Operating systems: Windows and UNIX. Hardware, software, Computer Network concepts. Word processing using MS-Word, formatting the document, tables, mail merge and spell check. Spreadsheets basics with MS Excel, numerical and formula entries, basic mathematical and statistical functions, graphical representation of data.

UNIT-II

Population, samples and sampling procedures, variables, variations and frequency distributions, measures of central tendency and dispersion, element of probability, Gaussian or normal distribution, binomial distribution, Poisson distribution, t-distribution, F-distribution and Chi-square distribution, correlation, and linear regression.

UNIT-III

Introduction to bioinformatics, Historical perspective of bioinformatics, Bioinformatics resources: NCBI, EBI. Databases, Primary and Secondary Databases.

Specialized databases: PubMed, OMIM, Medical databases.

Genome databases at NCBI and EBI Protein databank (PDB) and Nucleic acid databank (NDB). Application of bioinformatics in various fields: Environment biotechnology, Drug designing and Medical microbiology.

UNIT-IV

Sequence and phylogeny analysis, gene identification and prediction, method of gene family identification and outline of sequence assembly.

Mutation matrices, pairwise alignments, Introduction to BLAST, multiple sequence alignment and phylogenetic analysis.

Molecular modeling: introduction, dynamic simulation, conformational search, molecular modeling packages protein modeling.

Course Outcome:

CO1: To learn or generate protein structures.

CO2: Will have knowledge to learn different techniques in bioinformatics.

CO3: Able to operate computer programs.

Assessment Model:

- Quiz -25Marks
- Average of Two Mid-Terms –20 Marks
- Attendence-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Sinha PK and Sinha, P(2005) Computer Fundamental.BPB Publishers
2. Singhal and Singhal (2006). A textbook of bioinformatics, Pragati Edition
3. Baxelvanis,AD (2006) Bioinformatics, WilEx Inter sciences
4. Lesk,AM.(2000). Introduction to protein Architecture: The structural biology of proteins, Oxford University Press, UK
5. Biostatistics: A foundation for Analysis in Health Sciences by W. Danial: John Wiley and Sons Inc.
6. Molecular Evolution: A phylogenetic approach: ROM and Holmas EC, Blackwell Science.

Web Resources:

Google Scholar, PubMed, NCBI, Expasy, EMBL, Genome size Database

Course Code	Course Title	L	T	P	Credits
PMI-402	Microbial Quality Control in the Food and Pharmaceutical Industries	**5**	**0**	**0**	**5**

Pre-requisites: Student should have basic knowledge of data, calculation sand formulas

Objective: After course completion the learners will be able:

1. To understand basic quality control and its applications in pharmaceutical industry.
2. To understand prevalence of microbes in Food and Pharmaceutical Samples
3. To understand the role of important pathogenic organisms in food and pharma industry.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Microbiological Laboratory and Safe Practices: Good laboratory practices - Good laboratory practices, Good microbiological practices; Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

UNIT-II

Determining Microbes in Food / Pharmaceutical Samples Culture and microscopic methods - Standard plate count, Most-probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products; Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

UNIT-III

Pathogenic Microorganisms of Importance in Food & Water Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, McConkey Agar, Sabouraud Agar. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centers (COB, 10 min Resazurin assay)

UNIT-IV

HACCP for Food Safety and Microbial Standards: Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

Course Outcomes: After the end of course, the student will able to:

CO1: Interpolate numerical data.

CO2: Students will learn about statistical methods of analysis and software's used for research purpose

CO3: Students will learn to create hypothesis, how to analyze them and their interpretation.

Assessment Model:

- Quiz -25Marks
- Average of Two Mid-Terms –20 Marks
- Attendence-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- Bliss,C.I.K.(1967) Statistics in biology,Vol.1,Mac-Graw Hill,NewYork.
- Bailey,N.T.J.(2000) Statistical Methods in Biology, English Univ. Press.
- Lachin, Biostatistical Methods

Web Resources:

Google Scholar, PubMed.

Course Code	Course Title	L	T	P	Credits
PMI-403	Recent Advances and Methodology in Microbiology	5	0	0	5

Pre-requisites: Students require basic knowledge in Computer searching tools, Internet study related to research.

Objective:

1.To introduce the Research methods.

To understand the use of internet and websites to study about the journals and developing new research technique.

Note: The question paper will consist of 9 questions. Student has to attempt 5 questions in all, selecting at least one question from each section A, B, C and D. Section E is compulsory.

UNIT-I

Objectives and types of research: Definition and types of research (Descriptive and analytical research, applied and fundamental research, qualitative and quantitative research, conceptual and empirical research).

Research formulation: Defining and formulating research problem and its necessity, selecting the problem, literature review and its importance; Primary and secondary data sources-library(books, journals, periodicals, reference sources, abstracting and indexing sources, reviews, monographs), patents, web (search engines, online libraries, online journals, e-books, e-encyclopedia ,institutional websites); Journals and books standards of research journals (impact factor, ISSN, ISBN, online and print journals, indexed journals, peer reviewed journals), citation index, H-index; Identifying gaps areas from literature review.

UNIT-II

Research design and methods: Developing the research hypothesis; Research design – basic principles and need, important concepts; Observations and facts, laws and theories, prediction and explanation, induction, deduction; Development of models, developing a research plan, exploration , description, diagnosis, experimentation. Reporting and thesis writing: Structure and components of research report, types of report-monographs, review articles, research papers, thesis, books, technical reports and their significance; Different steps in preparation of a written scientific document layout, structure and language of reports, illustrations and tables ,bibliography, references, footnotes.

UNIT-III

Metagenomics: Definition, collection of diverse environmental samples, sequencing, Characterization of the novel genes and strains. Recovery, isolation and Molecular characterization of bacteria from Polar and Non-polar glacial Ice lands. Metabolomics: History, Metabolome, Metabolites, Metabonomics, Analytical technologies, Separation and detection methods, Key applications. Recent developments in nutraceutical, pharmaceutics and bioactive potential of microbes.

UNIT-IV

Genetically Engineered Microbes and their applications in medicine, industry and agriculture. Signal transduction: History, Signaling molecules, Environmental stimuli, Cellular responses, Types of receptor, Cell-surface receptors, G-protein-coupled receptors, Receptor tyrosine kinases, Integrins, Toll-like receptors, Ligand-gate dion channel receptors, Intracellular receptors, Second messengers (Calcium, Lipophilic, Nitric oxide). Application of molecular tools (rep,eric, ISR etc.) in microbial taxonomy

Course Outcomes:

CO1: Will understand how to learn the research pattern

CO2: Learn how to submit your research sequences in internet

CO3: Will relate different research on internet webs

Assessment Model:

- Quiz -25Marks
- Average of Two Mid-Terms –20 Marks
- Attendence-5 marks
- End-Term (100 Marks)– 50 marks
- Total Assessment (Out of 100 Marks)

Preferred Reading:

- An Introduction to Research Methodology by B.L.Garg, R. Karadia, F. Agarwal and U.K. Agarwal, RBSA Publishers, 2002.
- Research Methodology: Methods and Techniques by C.R. Kothari, New Age

International Publishers, New Delhi, 2004.

- Mulhardt, C (2001) Molecular Biology and genomics, Elsevier Academic press Primrose (2006) Principle of Gene manipulation and genomics, 7th edition, Blackwell publishers.
- Wilson and Walker (2005) Practical Biochemistry, 5th edition Cambridge University Press.
- Stryer (2001) Biochemistry, 5th edition, Free man and company

Web Resources:

PubMed, Google Scholar

Course Code	Course Title	L	T	P	Credits
PMI-404	**"Computational Techniques in Bioinformatics and Biostatistics Lab"**	**0**	**0**	**4**	**2**

Pre-requisites: M.Sc .Microbiology

Objective:

1. This course will cover the research methodology and advance research in Microbiology
2. Student will be able to learn the various advanced instruments.
3. Student will be able to search the latest literature on research.

❖ **Student has to attempt any 8 practical's**

1. Representation of Statistical data by

a) Histograms

b) Ogive Curves

c) Pie diagrams

2. Determination of Statistical averages/central tendencies.

a) Arithmetic mean

b) Median

c) Mode

3.Determination of measures of Dispersion

a) Mean deviation

b) Standard deviation and coefficient of variation

c) Quartile deviation.

5. An introduction to INTERNET, search engines and Biological databases.

6. To perform BLAST and FASTA of given nucleotide sequences.

7. Explore GenBank and EMBL nucleotide sequence database.

8. Construct Phylogenetic tree using MEGA software.

9. To explore NCBI database.

Assessment Model:

Total Assessment Out of (30 Marks).

Preferred Readings

1. Practical Microbiology. R.C Dubey and D.K. Maheshwari.

2. Practical book of Microbiology. K.R Aneja.

Web Resources:

Google Scholar

Course Code	Course Title	L	T	P	Credits
PMI-405	**Project Work**	**0**	**0**	**8**	**4**

Pre-requisites: M.Sc. Microbiology

Objective:

1. This course will cover the research methodology and advance research in Microbiology.
2. Student will be able to learn the various advanced instruments.
3. Student will be able to search the latest literature on research.

Teacher specific research: Specialization in Microbiology

Course outcomes:

Students can be exploring their mind toward advance research in Microbiology and give their valuable output toward the benefit of society.

Assessment Model:

Total Assessment Out of (100 Marks) and (50 Marks) in respective semesters.