# Department of Microbiology
## Dr. Harisingh Gour Vishwavidyalaya, Sagar
Scheme of M.Sc. Program in Microbiology under CBCS System

## Objectives and Learning Outcomes of M.Sc. Microbiology

| **Department of Microbiology** | | | | | | |
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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **I** | **MIC CC 121** | **General Microbiology and Microbial Diversity (Theory)** | **Mid Sem 40<br>End Sem 60** | **04** |

**Course Objectives:**
The major objective of this paper is to build a strong foundation in the microbial diversity, their classification, general properties and the economic importance of relevant prokaryotic and eukaryotic microbes.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:
CO1: Will be able to describe the contribution of some leading microbiologist like Leeuwenhoek, Pasteur, Jenner, Koch, Metchnikoff, Waksman. Also they will gain knowledge about the development of tools which aid in microbial classification and the general properties of Archea.
CO2: Will get knowledge about the general properties, economic importance and their structure of major Eubacterial representative examples. They will also gain the knowledge about the ultrastructure of a microbe.
CO3: Will get an in depth knowledge about the morphological and biochemical identification tests used for major Eubacterial microflora.
CO4: Will get an understanding about the fungal biodiversity and their representative examples.
CO5: Will understand about the classification of virus, their mechanism of replication and their life cycle.

**Facilitating the achievement of Course Learning Outcomes**

| **Unit** | **Course Learning Outcomes** | **Teaching and learning Activity** | **Assessment Tasks*** |
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| 1 | CO1: Will be able to describe the contribution of some leading microbiologist like Leeuwenhoek, Pasteur, Jenner, Koch, Metchnikoff, Waksman. Also they will gain knowledge about the development of tools which aid in microbial classification and the general properties of Archea. | Audio-visual presentation as teaching aid showing the role and major contribution done by leading microbiologists.<br>Use of white/black board for drawing complex diagrams as simple forms.<br>Discussion on the properties of Archea through detailed lecture and extended Q&A sessions. | Student presentation and group discussion on the role of leading microbiologist.<br>Objective type, short and long questions. |

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| 2 | CO2: Will get knowledge about the general properties, economic importance and their structure of major Eubacterial representative examples. They will also gain the knowledge about the ultrastructure of a microbe. | Black/White board based teaching with notes and drawing diagrams to show important features of major Eubacterial examples like Actinomycetes, Spirochetes, Chlamydia, Rickettsia and Mycoplasma.<br>Biochemical and structural details of major ultrastructural components of microbes like Cell wall, Capsules, Endospores etc. Extended Q&A to involve each student in the classroom. Use of audio-visual presentation to aid the teaching. | Visual aid quiz for identification of common bacteria with distinct morphology. Objective type, short and long questions. |
| 3 | CO3: Will get an in depth knowledge about the morphological and biochemical identification tests used for major Eubacterial microflora. | Thought provoking questions and student involvement through their participation. Use of Black/white board for explanation and drawing pathways/flowcharts. Use of audio-visual presentation as teaching aid to discuss the major carbohydrate, oxygen and nitrogen based biochemical tests used to distinguish mainly bacterial population. Books and notes sharing about the topic. | Isolation of microbes from natural sources and their identification using chemical and other tests. Objective type, short and long questions. |
| 4 | CO4: Will get an understanding about the fungal biodiversity and their representative examples. | Fungi are the most diverse group of microbes so they undergo various modifications. Such modifications will be discussed in great details with Black/white board, audio-visual presentation etc. The notes and lecture about the representative examples of various classes of division Mycota like Oomycetes Zygomycetes, Ascomycetes. Basidiomycetes, Deuteromycetes. Extended Q&A sessions about the topic. | Student presentation and group discussion Objective type, short and long questions. |
| 5 | CO5: Will understand about the classification of virus, their mechanism of replication and their life cycle. | Use of internet, computer to show short movies about viral life-cycles. The students will take part in extended Q&A sessions during and after each topic about the shape, classification and their mode of replication of major representative viruses. | Poster and ppt presentation. Objective type, short and long questions. |

*Assessment tasks listed here are indicative, and may vary.

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **I** | **MIC CC 123** | **Principles of Biochemistry (Theory)** | **Mid Sem 40**<br>**End Sem 60** | **04** |

**Course Objectives:**
The main objective of this paper is to apply concepts and principles of biochemistry, importance of carbohydrates, nucleic acids and lipids. Major properties and structures of macromolecules.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:
CO1: Will have gained insight on amino acids and proteins. How these are necessary for various body functions. Also they will gain concepts about the uses of amino acids and proteins.
CO2: Attains knowledge about the classification, structure, properties and major functions of carbohydrates.
CO3: Will get an in depth knowledge about the structural and regulation properties of RNA and DNA.
CO4: Gets introduced to various biological functions of lipids and acquires knowledge about classification, structure, types of lipids and their transduction.
CO5: Will understand about the transport of molecules, membrane proteins and mechanism of signal transduction.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will have gained insight on amino acids and proteins. How these are necessary for various body functions. Also they will gain concepts about the uses of amino acids and proteins. | Familiarizing students with pH and buffer solution preparation.<br>Use of white and black board for drawing complex structures in simple forms.<br>Detailed discussion on amino acids and proteins classification, structure and properties.<br>Having classroom discussion about unusual amino acids, peptides, isoelectric points and zwitter ions role. | Visual aid quizzes for concept learning.<br>MCQs, short and long questions answering. |
| 2 | CO2: Attains knowledge about the classification, structure, properties and major functions of carbohydrates. | Providing students with the broad knowledge about Aldoses, ketoses, mono, di, polysaccharides, and bacterial cell wall components.<br>Monosaccharides metabolism.<br>To understand properties and functional details of carbohydrates.<br>To involve students in performing various biochemical tests of carbohydrate. | Group discussions, class test and diagrammatic representation of various carbohydrates. |

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| 3 | CO3: Will get an in depth knowledge about the structural and regulation properties of RNA and DNA. | Learn about role of RNA and DNA in biological system. Discussion about Watson and Crick model using visual aid.<br>Providing students with the depth concepts about hybridization, central dogma, and gene regulation properties of nucleic acids. | Isolation of DNA and RNA from microbial sources and their identification using sophisticated instruments. |
| 4 | CO4: Gets introduced to various biological functions of lipids and acquires knowledge about classification, structure, types of lipids and their transduction. | Students learn about functions of various types of lipids. And also provides knowledge of various kinds of lipids mechanisms of action and role in cellular machinery. | Student power point presentation and mock test. |
| 5 | CO5: Will understand about the transport of molecules, membrane proteins and mechanism of signal transduction. | Taught about active and passive transport mechanism using hands on training experimentation. Learn about translocation, cell junction, and molecular mechanism of signal transduction. | Poster presentation and model making. Multiple choice class test. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **I** | **MIC CC 125** | **Bioinstrumentation, Bioinformatics and Biostatistics (Theory)** | **Mid Sem 40<br>End Sem 60** | **04** |

**Course Objectives:**
The major objective of this course is to provide training in sophisticated instrumentation and bioinformatics and biostatistics techniques. Students will be trained in instrumentation, bioinformatics tools as well as use of bioinformatics in biological studies.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:
CO1: Will be able to use different sterilization principles and procedures of handling of microbiological goods.
CO2: Be familiar with the microscopy principles involved in various types of microscopy and their applications.
CO3: Will be able to describe the various applications bioinstrumentation used in microbiological field.
CO4: Acquires knowledge about chromatography and characterization of proteins and enzymes.
CO5: Know about variety of databases information available for alignment various aspects of macromolecules structure and function. Role of bioinformatic tools in microbiology and respone surface methodology for optimization of bioprocess.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will be able to use different sterilization principles and procedures of handling of microbiological goods. | Make students group discussion on principle, applications and types of sterilizing agents used in microbiological laboratory. | Match the following type objectives, short and long questions answering. |
| 2 | CO2: Be familiar with the microscopy principles involved in various types of microscopy and their applications. | Having classroom discussions about dark field, phase contrast microscopy, fluorescence microscopy and electron microscopy, along with real time imaging.<br>Live cell imaging and intracellular localization of various microbial cell components using microscopy. | Group discussion on research papers advanced methods of microscopy. |

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| 3 | CO3:<br>Will be able to describe the various applications of bioinstrumentation used in microbiological field. | Enquiry based learning approach to will be used to provide depth knowledge about flow cytometer and spectroscopy, centrifugation various sequencing procedure. | Student will be evaluated by a short class test. |
| 4 | CO4: Acquires knowledge about chromatography and characterization of proteins and enzymes. | Demonstration of various processes of chromatography techniques and their uses to separate amino acids, sugars and other microbial products. | Student power point presentation and mock test. |
| 5 | CO5: Know about variety of databases information available for alignment various aspects of macromolecules structure and functions. Role of bioinformatics tools in microbiology and response surface methodology for optimization of bioprocess. | Detailed discussion about sequence of proteins structure and and their clustering on the basis of bioinformatics tools.<br>Sequence alignment - BLAST, FASTA, CLUSTAL W.<br>Detailed classroom discussion on probability and RSM software for optimization of biological processes. | Short Presentation discussing the highlights of a structural bioinformatics database (individual activity)<br>Hands on individual activity of generating the protein model for a given protein sequence. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **I** | **MIC CC 127** | **Enzyme Technology (Theory)** | **Mid Sem 40<br>End Sem 60** | **04** |

**Course Objectives:**
The major objective of this paper is to in concepts and principles of biochemistry, importance of carbohydrates, nucleic acids and lipids. Major properties and structures of macromolecules.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:

CO1: Will be acquainted with enzymes: classification, nomenclature and characteristics of enzymes with understanding of kinetics and biotechnological importance.
CO2: Will have gained a deep knowledge of primary, secondary screening of industrially important microorganisms for production of different enzymes.
CO3: Will get an in depth knowledge about the microbial enzyme production and enzyme purification techniques.
CO4: Will have gathered understanding of characterization of enzymes and its regulation. Also knows role of enzyme action on substrate and analysis of products using various techniques.
CO5: Will understand details of molecular cloning, expression and protein engineering & directed evolution of microbial enzymes.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will be acquainted with enzymes: classification, nomenclature and characteristics of enzymes with understanding of kinetics and biotechnological importance. | Learn basic concepts of enzyme technology, its kinetics and regulation. Significance of Km, Vmax for enzyme catalyzed reactions. Also study enzyme inhibition and role of enzymes in biotechnology | Student presentation and group discussion. MCQs, short and long questions answering. |
| 2 | CO2 Will have gained a deep knowledge of primary, secondary screening of industrially important microorganisms for production of different enzymes. | Detailed explanation of methods for enzymes (amylases, cellulases, hemicellulases, proteases) screening and assay of activity. | Pictorial quiz for identification of type of enzyme inhibition |
| 3 | CO3: Will get an in depth | Students are introduced to | Practical example- |

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| | knowledge about the microbial enzyme production and enzyme purification techniques. | important parameters in enzyme production and industrially important microorganisms, where they get knowledge of various fermentation processes such as submerged and solid state fermentation strategies. They will also receive in depth idea about recovery methods such as precipitation, chromatographic separation-gel filtration, anion and cation exchange, zymography. | based teaching on Enzyme production and purification. |
| 4 | CO4: Will have gathered understanding of characterization of enzymes and its regulation. Also knows role of enzyme action on substrate and analysis of products using various techniques. | The students are taught about techniques used in characterization of enzymes (SDS PAGE, Gel filtration), Inhibition pattern. The students get information about product analysis of enzyme action using TLC, HPLC, and MALDI-TOF | Student power point presentation and mock test. |
| 5 | CO5: Will understand details of molecular cloning, expression and protein engineering & directed evolution of microbial enzymes. | The students will be taught about the Amino acid sequencing, protein engineering & directed evolution. They will also get crisp details of cloning and expression of microbial enzymes in heterologous host. | The student will be made to work on cloning strategy and details the steps involved in protein engineering. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **II** | **MIC CC 221** | **Microbial Physiology and Metabolism (Theory)** | **Mid Sem 40 End Sem 60** | **04** |

**Course Objectives:**

The major objective of this paper is to introduce similarities between geometrical progression series and microbial growth, to impart in-depth knowledge about the microbial movement and its molecular aspect and also to give comprehensive account on the physiology and metabolism of anabolic and catabolic processes which are the fundamental aspects of the microbial life.

**Course Learning Outcomes:**

Upon successful completion of the course, the student:

CO1: Will get an in-depth understanding about the nature of microbial growth and the concept of various technical terms like Generation time, Batch and Synchronous growth, Apoptosis and Nacrosis etc. They will also be introduced with the concept of signalling used in chemical sensing which is fundamental for the growth of microbial biomass and their number.

CO2: Will get an in-depth knowledge about the carbon metabolism and pathways of energy generation which is the central to the microbial growth.

CO3: Will be introduced to the transport systems without which nutrients cannot be utilized. The students will be able to understand the role of complex nature of PTS system.

CO4: Will have gathered detailed information about the biosynthesis of building blocks of nucleic acid and major families of amino acids.

CO5: Will get detailed understanding about the biosynthesis of aromatic amino acids and phospholipids.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will get an in-depth understanding about the nature of microbial growth and the concept of various technical terms like Generation time, Batch and Synchronous growth, Apoptosis and Nacrosis etc. They will also be introduced with the concept of signalling used in chemical sensing which is fundamental for the growth of microbial biomass and their number. | Use of Black/White board for sharing important technical details about the methamatical steps requred for the derivation of equation used for microbial growth. Use of audio-visual presentation as teaching aid and board notes showing the major differences between Necrosis and Apoptosis which are fundamental pathways for regulation of cell growth. Class notes, discussion, extended Q&A sessions on the terms like Synchronous and Asynchronuous growth and their method of generation using various stats. Solving few examples for determination of mathematical nature of bacterial growth. Use of ppt for showing arrangements and application of various microbial components used for chemotaxis. | Student presentation and group discussion on the components of microbial growth. Objective type, short and long questions. |

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| 2 | CO2: Will get an in-depth knowledge about the carbon metabolism and pathways of energy generation which is the central to the microbial growth. | Black/White board based teaching with notes and drawing diagrams to show important features of major carbon metabolism pathways like Glycolysis, PPP, TCA cycle etc. Extended Q&A to involve each student in the classroom. Use of audio-visual presentation to aid the teaching. | Home Assignments, presentation and group discussion on the components of microbial growth. Objective type, short and long questions. |
| 3 | CO3: Will be introduced to the transport systems without which nutrients cannot be utilized. The students will be able to understand the role of complex nature of PTS system. | Thought provoking questions, Board teaching and use of computer driven presentation to show and teach complex nature of biochemical pathways and their inter-linking and their use in transport of some vital nutrients like Glucose, Mannose etc . Books and notes sharing about the topic involving the transporters and pathways for energy generation. | Home Assignments, presentation and group discussion. Objective type, short and long questions. |
| 4 | CO4: Will have gathered detailed information about the biosynthesis of building blocks of nucleic acid and major families of amino acids. | Nucleic acids are the important building block of microbes. Their pathways will be discussed using Board based teaching and drawing individual pathways and the molecular conversion of purine and pyrimidine etc. The use of computer ppt and or board based teaching to draw flowcharts of each steps showing the step-by-step anabolism of major amino acid families. The students will be asked several questions during and after the completion of topics. | Student presentation and group discussion Objective type, short and long questions. |
| 5 | CO5: Will get detailed understanding about the biosynthesis of aromatic amino acids and phospholipids. | Use of internet, computer, board based teaching to discuss about the biosynthesis of aromatic amino acids like phenylalanine, tryptophan and tyrosine. As biomembranes are made of phospholipids so their step-by-step method of anabolism will be discussed in class using various methods. The students will take part in extended Q&A sessions during and after each topic. | Poster and ppt presentation. Objective type, short and long questions. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **II** | **MIC CC 223** | **Industrial Microbiology (Theory)** | **Mid Sem 40<br>End Sem 60** | **04** |

Course Objectives:
The course will make enthusiasm for students to apply the learning of industrial microbiology concepts toward the development and scope of economically important products of human benefits. The strategies for development of potential strains, large scale production and product recovery will be covered microbiological production of beverages and pharmaceuticals and various economically and industrially important products.
Course Learning Outcomes:
Upon successful completion of the course, the student:

CO1: Will have gained knowledge about industrially important microbial strains screening, detection and assay of fermentation products.

CO2: Understands the concept of fermenter design and process. Critical components of fermentation process and product recovery methods.

CO3: Attains knowledge about production of antibiotics, vaccines. microbial enzymes their application strategies.

CO4: Learns about the production of beverages and organic acids

CO5: Acquires knowledge about various industrially relevant microbial products (amino acids, vitamins and steroids) and their production process. Role of microbes in leather, petroleum and mine industries, bioleaching of metals.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
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| 1 | CO1: Will have gained knowledge about industrially important microbial strains screening, detection and assay of fermentation products. | The students are taught about screening for industrially important cultures where they learn about detection and assay of fermentation products.<br>They will also inform about stock culturing and preservation methods of microbial forms. | MCQs, short and long questions answer based analysis of understanding. |

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| 2 | CO2**:** Understands the concept of fermenter design and process. Critical components of fermentation process and product recovery methods. | Students are taken to fermentation facility and production of various microbial products. In microbial laboratory students are taught to assemble various components of fermenter and also learn about product recovery methods. | Students are asked to prepare detailed report on various Fermenter vessels and their role in fermentation process. |
| 3 | CO3: Attains knowledge about production of antibiotics, vaccines. microbial enzymes their application strategies. | Making students aware about production of antibiotics, (Penicillin, Streptomycin) and vaccines. Provide knowledge about microbial enzymes: Amylases, proteases and cellulases. | Short answer type test based on production of enzymes and antibiotics. |
| 4 | **CO4:** Learns about the production of beverages and organic acids | Students will learn microbiological production of beverages: beer, wine and whiskey. Fermentative production of ethanol, and acetic acid, citric acid, n-butanol. | Student power point presentation and mock test. |
| 5 | CO5: Acquires knowledge about various industrially relevant microbial products (amino acids, vitamins and steroids) and their production process. Role of microbes in leather, petroleum and mine industries, bioleaching of metals. | Discussion about screening and microbial production of amino acids, vitamins. Transformation of steroids. Theory lecture on importance of microorganisms in leather, petroleum and mine industries, as well as bioleaching of metals. | Poster presentation and model making. Multiple choice class test and |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **II** | **MIC EC 221** | **Environmental Microbiology (Theory)** | **Mid Sem 40<br>End Sem 60** | **03** |

**Course Objectives:**

The major objective of this paper is to introduce the role of microbes in regulating our environment. This will be covered through the knowledge about the fundamental methods used for sampling air microfluora, to give an account on the distribution, assay and application of microbes present in water and soil and also the role of microbes in environmental microbiology like rhizosphere zone, biogeochemical cycles and bioremadiation.

**Course Learning Outcomes:**

Upon successful completion of the course, the student:

CO1: Will get an in-depth understanding about the importance of indoor and outdoor air quality in terms of microbial load and their types. They will also get to understand about the various types of air samplers and their distinct features used for air microflora studies.

CO2: Will get an in-depth knowledge about water microbiology with main focus on coliform/non-coliforms contamination, and methods on get small to large scale water purification and terms like BOD, COD which is most common in sewage treatment field.

CO3: Will be introduced to various biogeochemical cycles and the role of microbes in them. Also the concept of solid waste treatment/management with focus on microbes will be there.

CO4: Will have gathered detailed information about the social interactions of microbes in environmental field and some of their exploitation for the production of economically important things like enzymes and antibiotics.

CO5: Will get detailed understanding about the process of bioremediation and industrial waste which could affect microbial populations in the field.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will get an in-depth understanding about the importance of indoor and outdoor air quality in terms of microbial load and their types. They will also get to understand about the various types of air samplers and their distinct features used for air microflora studies. | Use of Black/White board for sharing important technical details about diagrams and application of air samplers and their main features. Use of audio-visual presentation as teaching aid and board notes showing the quality parameters, types and load of microbes in indoor and outdoor environments. Class notes, discussion, extended Q&A sessions on these topics. | Student presentation and group discussion on the application of air samplers for air microbiology Objective type, short and long questions. |

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| 2 | CO2: Will get an in-depth knowledge about water microbiology with main focus on coliform/non-coliforms contamination, and methods on get small to large scale water purification and terms like BOD, COD which is most common in sewage treatment field. | Black/White board based teaching with notes and drawing diagrams to explain the concept of water microbiology. Extended Q&A to involve each student in the classroom. Use of audio-visual presentation to aid the teaching to know the meaning of BOD, COD and concept of water purification at different scales. | Home Assignments, presentation and group discussion on the components of water purification and sewage treatment. Objective type, short and long questions. |
| 3 | CO3: Will be introduced to various biogeochemical cycles and the role of microbes in them. Also the concept of solid waste treatment/management with focus on microbes will be there. | Thought provoking questions, Board teaching and use of computer driven presentation to show and teach complex biogeochemical cycles and role of microbes in such cycles and in the treatment of solid waste. The discussion on some topics like landfill and types of various solid wastes and their disposal. | Home Assignments, presentation and group discussion. Objective type, short and long questions. |
| 4 | CO4: Will have gathered detailed information about the social interactions of microbes in environmental field and some of their exploitation for the production of economically important things like enzymes and antibiotics. | Through the use of class notes, books, and the use of computer ppt and board based teaching such interactions will be discussed. We will take cellulase production, amylase production as an example of enzyme production by microbes. For antibiotic, we will discuss screening, and characterization of wild-type microbes for the production of antibiotic and few major steps for its production. The students will be asked several questions during and after the completion of topics. | Student presentation and group discussion Objective type, short and long questions. |
| 5 | CO5: Will get detailed understanding about the process of bioremediation and industrial waste which could affect microbial populations in the field. | Leather, pharma industry waste contain several toxic chemicals and other nutrients which in environment can modulate the growth and distribution of microbes. Such factors will be discussed using the use of internet, computer, board based teaching. The students will take part in extended Q&A sessions during and after each topic. | Poster and ppt presentation. Objective type, short and long questions. |

*Assessment tasks listed here are indicative, and may vary.

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **II** | **MIC EC 223** | **Methods in Molecular Biology (Theory)** | **Mid Sem 40 End Sem 60** | **03** |

**Course Objectives:**

The course will provide a detailed understanding of methods used in molecular biology. The purpose of this study is to introduce the student to the advanced concepts in electrophoresis, proteomics, cloning strategies and various detection methods. The student will study the molecular methods and experiments used to understand application of genomics and proteomics.

**Course Learning Outcomes:**

Upon successful completion of the course, the student:
CO1: Is able to describe types and applications of electrophoresis.
CO2: Is able to understand the proteomics as a tool for identification of proteins involved in disease conditions, applications.
CO3: Will be able to describe the various types of DNA. Applications of PCR, blotting, DNA fingerprinting, foot printing etc.
CO4: Is able to explain basics of cloning and application of genomics.
CO5: Will have learnt about different molecular methods and assay techniques.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Is able to describe types and applications of electrophoresis. | Lecture on various types of electrophoresis methods performed for separation of genetic materials and proteins including isoelectric point, isolectric focusing and applications of electrophoresis using visual aids. | Power Point presentation and white/ black board will be used to explain the many methods of molecular biology. |
| 2 | CO2: Is able to understand the proteomics as a tool for identification of proteins involved in disease conditions, applications | Providing students with the broad knowledge about PAGE, Western blotting and Immunoprecipitation. To understand proteomics as a tool for identification of proteins involved in disease conditions. Studying intracellular localization of proteins. | Short presentation discussing the highlights of proteomics (individual activity). |
| 3 | CO3: Will be able to describe | Discussion about conventional | Isolation of DNA and |

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| | the various types of DNA. Applications of PCR, blotting, DNA fingerprinting, foot printing etc. | methods for isolation of plasmids genomic DNA and RNA. Immunological assays and PCR-based methods. The student will learn about various blotting techniques such as Southern and Northern. Interactive lecture on recent advances in DNA fingerprinting, DNA foot printing | RNA from microbial sources and their identification using sophisticated instruments. |
| 4 | CO4: Is able to explain basics of cloning and application of genomics. | The students will be taught about cloning strategies and use of restriction enzymes, vectors and selectable markers gene. | The student will be made to design a cloning experiments and detail the steps involved in application of genomics. |
| 5 | CO5: Will have learnt about different molecular methods and assay techniques. | The student will be made familiar with the use of different molecular methods such as microarray, 2-D electrophoresis, 2-Hybrid systems, RNA interference, Ribonuclease protection assay. The student will be explained the importance of protein-protein interactions. | The students will be assessed in their abilities using quiz competition and short written assignment. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **II** | **MIC OE 221** | **World of Microbes (Theory)** | **Mid Sem 40 End Sem 60** | **2** |

**Course Objectives:**
The objective of the course is to familiarize students with bacteriology, mycology, virology, industrial microbiology and tools and techniques used in microbiology laboratory. The student will receive hands-on training in various culturing and screening of industrially important microbes and techniques used in production of microorganisms based products.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:
CO1: Will have gained knowledge about characteristic features, classification and importance bacteria.
CO2: Understands the concept of morphological features, classification (taxonomy) and characteristics of fungi.
CO3: Attains knowledge about morphological features, ultrastructure and life cycle of viruses.
CO4: Will receive knowledge about various industrially relevant microbial products (enzymes, antibiotics). Role of microbes in production of food, dairy products.
CO5: Is aware the usage of tools and techniques used in microbiology laboratory.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will have gained knowledge about characteristic features, classification and importance bacteria. | Detailed discussion on the general characteristics of bacteria and the classification and importance of actinomycetes, mycoplasma and cyanobacteria. | MCQs, short and long questions answer based analysis. Diagrammatic presentation on power point slides. |
| 2 | CO2: Understands the concept of morphological features, classification (taxonomy) and characteristics of fungi. | Make students conversant with the concept of mycology. Also provide in depth knowledge of classification (taxonomy) and characteristics of different classes of fungi in details. | Slide preparation, and mounting of fungal cultures for viewing in microscope. |
| 3 | CO3: Attains knowledge about morphological features, ultrastructure and life cycle of viruses. | Provide knowledge about structure and classification of viruses. Role of viral agents, viz. viroids and prions. Life cycle of RNA and DNA viruses. | Poster presentation and model making. To learn about isolation of bacteriophage using plaque forming method. |
| 4 | CO4: Will receive knowledge | Use of powerpoint slides and | Student power point |

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| | about various industrially relevant microbial products (enzymes, antibiotics). Role of microbes in production of food, dairy products. | pictorial design to familiarization of students with the production of microbial enzymes and antibiotics.<br>Discussion on fermented food and dairy products. | presentation and mock test. |
| 5 | CO5: Is aware the usage of tools and techniques used in microbiology laboratory. | Provide knowledge about different tools and techniques to aware about culture media preparation isolation using different techniques as well as keen knowledge about sterilization procedures. | Hands on practical assignment on different techniques of microbiological laboratory. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **III** | **MIC CC 321** | **Medical Microbiology and Immunology (Theory)** | **Mid Sem 40<br>End Sem 60** | **04** |

**Course Objectives:**

The objective of this course is to understand the epidemiology, pathogenicity, diagnosis & control of important bacterial, fungal, viral and protozoan diseases related to medical microbiology. Also study immunology their structure and organization, and functions to serve as the defense system of the body. It would also make the students understand the serological methods in disease diagnosis.

**Course Learning Outcomes:**

Upon successful completion of the course, the student:

CO1: Will be able to gather information about epidemiology, pathogenicity, diagnosis & control of important bacterial diseases

CO2: Will have gained insight on important human diseases caused by fungi (Mycoses); host defences & control against fungi.

CO3: Will be able to understand the classification and nomenclature of animal viruses. Identification, serological assay and control of viruses.

CO4: Will be able to understand the medical importance of protozoan diseases, classification, structure and physiology.

CO5: Will be able to apply the knowledge gained to understand serological methods in disease diagnosis as well as prophylaxis and chemotherapy of bacterial, viral and fungal diseases.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will be able to gather information about epidemiology, pathogenicity, diagnosis & control of important bacterial diseases | In class room students learn about the role of different bacterial diseases like tuberculosis, anthrax, typhoid, diptheria, and leprosy. The students would also learn the mechanisms of resistance to antibiotics and role of vaccines in controlling bacterial diseases. | The students are assessed by interactive group discussions on the topics which were taught and are asked several MCQs. |

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| 2 | CO2: Will have gained insight on important human diseases caused by fungi (Mycoses); host defences & control against fungi. | The students study and get knowledge on important human diseases caused by fungi. Students are taught to identify the reasons responsible for host defences and control against fungi. | The learning of the students is evaluated by asking them to mycoses related knowledge gained in classroom study using power point presentation. |
| 3 | CO3: Will be able to understand the classification and nomenclature of animal viruses. Identification, serological assay and control of viruses. | Learn about general account of viral diseases. Providing students with the depth concepts about cultivation of viruses identification and serological assay of viruses. | Learning assessment by assignment written by the student on various animal virus infections. |
| 4 | CO4: Will be able to understand the medical importance of protozoan diseases, classification, structure and physiology. | Discussion about the various types of protozoan diseases and their in depth knowledge of epidemiology, diagnosis and treatment. | Student power point presentation and home assignment. |
| 5 | CO5: Will be able to apply the knowledge gained to understand serological methods in disease diagnosis as well as prophylaxis and chemotherapy of bacterial, viral and fungal diseases. | Students are introduced to the concept of immunodiagnostics, *in-vitro* antigen-antibody reactions, prophylaxis and chemotherapy | Students are asked to write on assignment topic of immunodiagnostics which is assessed by the teacher. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **III** | **MIC CC 323** | **Microbial Genetics & Molecular Biology (Theory)** | **Mid Sem 40 End Sem 60** | **04** |

**Course Objectives:**
The course will introduce the student to the variety of microorganisms can be used as tools to understand genetics phenomenon and molecular biology. The student will become familiar with different methods of mutation, structure of different types of RNA and will understand regulation of gene expression and drug targeting. The student will receive knowledge about genetic recombination in bacteria. *In vitro* manipulation of DNA and applications of genetic engineering.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:
CO1: Will have learnt about genome structure, cellular mechanism of DNA replication, damage and repair system.
CO2: Can be able to discuss the molecular importance of mutation.
CO3: Is able to describe types of RNA and different steps involved in DNA replication, transcription and translation processes.
CO4: Is able to describe genetic recombination mechanism and regulation of gene expression. Will have learnt about drug targeting sites. Can list the outcomes of sequencing, blotting and various applications of PCR, RT-PCR.
CO5: Will be able to describe the *In vitro* manipulation of DNA, and know how to make and screen genomic and construct genomic libraries. Can list the outcomes of sequencing, blotting and genetic engineering.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will have learnt about genome structure, cellular mechanism of DNA replication, damage and repair system. | Using blackboard and Power Point presentation the students will be provided keen knowledge of genome structure and C-value paradox of microbial forms. Lecture on DNA replication. DNA damage and DNA repair system. Targeting DNA replication for controlling microbial infections and applications of genome structure using visual aids. | The student will have to discuss different aspects of targeting DNA replication for controlling microbial infections using various methods. |

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| 2 | CO2: Can be able to discuss the molecular importance of mutation. | The student will learned the importance type and analysis of mutants with the help of specific mutagenesis. The student will learn how to correlate between mutagenicity and carcinogenesis as well as mutagens as a tool in biology. to solve problems on deletion-based mapping of point mutations | The student will be asked to solve problems based on mutagenesis and recombination tests. Using slideshow as well as a powerpoint presentation the students will be taught the bases of mutation. |
| 3 | CO3: Is able to describe types of RNA and different steps involved in DNA replication, transcription and translation processes. | Learn about RNA and DNA polymerases for synthesis in RNA and DNA, respectively. replication, host polymerases, transcription regulation in viruses | True/False questions to know knowledge about central dogma. |
| 4 | CO4: Is able to describe genetic recombination mechanism and regulation of gene expression. Will have learnt about drug targeting sites. Can list the outcomes of sequencing, blotting and various applications of PCR, RT-PCR. | The analysis of genetic recombination. Students will be taught the concepts of sequencing, blotting. Various applications of PCR, RT-PCR. | Group activity will include students presenting case studies. |
| 5 | CO5: Will be able to describe the *In vitro* manipulation of DNA, and know how to make and screen genomic and construct genomic libraries. | The student will be initiated into the site directed mutagenesis and applications of genetic engineering. | Mock test and regular hands on training for manipulation of DNA molecules. |

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **III** | **MIC EC 321** | **Food and Dairy Microbiology (Theory)** | **Mid Sem 40<br>End Sem 60** | **03** |

**Course Objectives:**
The major objective of this paper is to introduce the role of microbes in the food processing and spoilage. Also to introduce the role of microbes in dairy products and their applications in Industrial level. Finally to impart knowledge about the distinction between infection and intoxication.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:
CO1: Will get an in-depth understanding about the about the micro-flora important in food and their mechanism of food spoilage and methods for food preservation.
CO2: Will get an in-depth knowledge about the importance and modification of pathways of Lactic Acid Bacteria in terms of industrial application like production of ethanol, sweetener and aroma and their role in dairy processing.
CO3: Will be introduced to the microbiology, method of production and its importance of non-dairy products like Rice, Fruits and Soybean based foods.
CO4: Will have gathered detailed information about the phenotypic and genotypic methods and the challenges faced by such techniques for the identification of microbes especially in the food industry. They will also know the concept of technical methods like PCR and LCR and advance methods for the enumeration of microbes.
CO5: Will get detailed understanding about the distinction of food borne infections and intoxication by bacterial, fungal and viral microbes.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will get an in-depth understanding about the about the micro-flora important in food and their mechanism of food spoilage and methods for food preservation. | Use of Black/White board for sharing important technical details about diagrams and role of bacterial, fungal and yeast based microbes responsible for food spoilage. Use of audio-visual presentation as teaching aid and board notes showing the mechanism of food spoilage and their methods of food preservation using aspesis, physical and chemical alterations. Class notes, discussion, extended Q&A sessions on these topics. | Student presentation and group discussion on the topic. Objective type, short and long questions. |

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| 2 | CO2: Will get an in-depth knowledge about the importance and modification of pathways of Lactic Acid Bacteria in terms of industrial application like production of ethanol, sweetener and aroma and their role in dairy processing. | Black/White board based teaching with notes and drawing diagrams to explain the concept of metabolic engineering of LABs for ethanol, alanine and Diacetyl production. Extended Q&A to involve each student in the classroom. Use of audio-visual presentation to aid the teaching to know the reasoning behind the metabolic engineering of LABs. | Home Assignments, presentation and group discussion on the topic. Objective type, short and long questions. |
| 3 | CO3: Will be introduced to the microbiology, method of production and its importance of non-dairy products like Rice, Fruits and Soybean based foods. | Thought provoking questions, Board teaching and use of computer driven presentation to show and teach about the role of microbes used in fermentation of non-dairy products. | Home Assignments, presentation and group discussion. Objective type, short and long questions. |
| 4 | CO4: Will have gathered detailed information about the phenotypic and genotypic methods and the challenges faced by such techniques for the identification of microbes especially in the food industry. They will also know the concept of technical methods like PCR and LCR and advance methods for the enumeration of microbes. | Phenotypic methods are slow methods for identification of microbes, therefore, genomic methods are used for microbial identification. Will discuss about the development and limitations of these methods using the class notes, books, board based teaching, and the use of computer ppt. Will also talk about the concept of PCR, LCR and suntractive hybridization. The students will be asked several questions during and after the completion of topics related to the methods of enumeration of microbes like MRBT, microscopic etc | Student presentation and group discussion Objective type, short and long questions. |
| 5 | CO5: Will get detailed understanding about the distinction of food borne infections and intoxication by bacterial, fungal and viral microbes. | Infection and intoxication are very related words and they will be discussed in the class using internet, computer, board based teaching. The students will take part in extended Q&A sessions during and after each topic like mycotoxin, poisonous mushrooms etc | Poster and ppt presentation. Objective type, short and long questions. |

*Assessment tasks listed here are indicative, and may vary.

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| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **III** | **MIC EC 323** | **Principles of Bioimaging (Theory)** | **Mid Sem 40<br>End Sem 60** | **03** |

**Course Objectives:**

The major objective of this paper is to introduce the concept of light and its application in imaging. Also to introduce about the types and the role of membrane proteins called ion-channels and the light activated molecules and proteins and their biomedical applications. Finally, to give an understanding about the concept of fluorescence, its measurement and application in bioimaging.

**Course Learning Outcomes:**

Upon successful completion of the course, the student:

CO1: Will get an in-depth understanding about the nature of light as electromagnetic rediation and its application in photolabeling method using carbene, nitrene and benzophenone based functional groups to solve biomedical problems related to structure-function studies of proteins. The use of special bulb called HBO for the same purpose.

CO2: Will get an in-depth knowledge about the structure-function and classification of various ion channels like voltage and ligand gated ion channels. The use of novel technologies like optogenetics will also be introduced.

CO3: Will be introduced to the concept and mechanism of fluorescence. The distinction between spectrophotometer and spectrofluorometer.

CO4: Will have gathered detailed information about the fundamental aspects of bioimaging and various components and concepts like lens, refractive index, NA, resolving power. Also the students will get to know the importance and types of optical chambers used for bioimaging.

CO5: Will get detailed understanding about the application of fluorescence technology like FRET and its concept in biosensors to study structure-function relationship.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks* |
|---|---|---|---|
| 1 | CO1: Will get an in-depth understanding about the nature of light as electromagnetic rediation and its application in photolabeling method using carbene, nitrene and benzophenone based functional groups to solve biomedical problems related to structure-function studies of proteins. The use of special bulb called HBO for the same purpose. | Use of Black/White board for sharing important technical details about diagrams and electromagnetic spectrum of light, HBO lamp and its spectra. The role and mechanism of activation of different functional groups used in the method called photolabeling. Use of audio-visual presentation as teaching aid and board notes will be used throughout along with the extended Q&A sessions on these topics. | Student presentation and group discussion on the topic. Objective type, short and long questions. |

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| 2 | CO2: Will get an in-depth knowledge about the structure-function and classification of various ion channels like voltage and ligand gated ion channels. The use of novel technologies like optogenetics will also be introduced. | Black/White board based teaching with notes and drawing diagrams to explain the classification and structure of VGIC and LGICs. Their distinctions and their role in biomedical diseases. Extended Q&A to involve each student in the classroom. Use of audio-visual presentation to aid the teaching to know the novel field called optogenetics. | Home Assignments, presentation and group discussion on the topic. Objective type, short and long questions. |
| 3 | CO3: Will be introduced to the concept and mechanism of fluorescence. The distinction between spectrophotometer and spectrofluorometer. | Thought provoking questions, Board teaching and use of computer driven presentation to show and teach about the fundamental concept of fluorescence and its distinction to phosphorescence and the two tools like spectrophotometer and fluorometer. | Home Assignments, presentation and group discussion. Objective type, short and long questions. |
| 4 | CO4: Will have gathered detailed information about the fundamental aspects of bioimaging and various components and concepts like lens, refractive index, NA, resolving power. Also the students will get to know the importance and types of optical chambers used for bioimaging. | Bioimaging depends on the use of optical tools like microscopes. There are various parts of microscope. Objective lens is one of the important components. In the class, using computer driven ppt, the knowledge about the refractive index, resolving power, chromatic aberration and its correction will be done. Using the ppt to teach the types and application of various optical chambers as sample holders used in bioimaging. The students will be asked several questions during and after the completion of such topics. | Student presentation and group discussion Objective type, short and long questions. |
| 5 | CO5: Will get detailed understanding about the application of fluorescence technology like FRET and its concept in biosensors to study structure-function relationship. | FRET and its application in the form of biosensors is growing in research. This concept will be taken up and will be discussed among students using internet, computer, board based teaching. The students will take part in extended Q&A sessions during and after each topic. | Poster and ppt presentation. Objective type, short and long questions. |

*Assessment tasks listed here are indicative, and may vary.

| Department of Microbiology | | | | | | |
|---|---|---|---|---|---|---|
| **Class** | **Subject** | **Semester** | **Course Code** | **Course Title** | **Marks** | **Credit** |
| **M.Sc.** | **Microbiology** | **III** | **MIC-OE-321** | **Microbial Diagnosis in Health Clinic** | **Mid Sem 40<br>End Sem 60** | **02** |

**Course Objectives:**
The course covers the novel microbial diagnosis approaches used in health clinic of human diseases caused by bacterial, virus, fungi and protozoan. The major objective of this paper is to introduce the concept of serological, microscopic and rapid kits used in detection of pathogens.

**Course Learning Outcomes:**
Upon successful completion of the course, the student:
CO1: Will have gathered detailed information about importance of diagnosis of various diseases.
CO2: Will get detailed understanding about how to collect clinical samples and to take major precautions during transportation and storage.
CO3: Will get an in-depth knowledge about examination of clinical sample using staining and preparation of culture media.
CO4: Will get an in-depth understanding about serological and molecular methods of microbial diagnosis.
CO5: Attains knowledge about kits for rapid detection of pathogens detection in clinical samples.

**Facilitating the achievement of Course Learning Outcomes**

| Unit | Course Learning Outcomes | Teaching and learning Activity | Assessment Tasks |
|---|---|---|---|
| 1 | CO1: Will have gathered detailed information about importance of diagnosis of various diseases. | Students are introduced to the concept of bacterial, viral, fungal and protozoan diseases of various human body systems. | Mock test and quiz competition. |
| 2 | CO2: Will get detailed understanding about how to collect clinical samples and to take major precautions during transportation and storage. | Learn about sample preparation and how to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required during collection. Also to know about method used for transport and storage of clinical samples. | A group discussion on pros and students are asked to prepare detailed report on this topic. |
| 3 | CO3: Will get an in-depth knowledge about examination of clinical sample using staining and preparation of culture media. | Students are introduced to the concepts of developing various direct Microscopic and cultural examination of sample. How to use culture media (Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar) to distinct colonial properties of pathogens. | Preparation of a report on examination of clinical sample of microbial disease. . |
| 4 | CO4: Will get an in-depth | Students will get deep knowledge | Student power point |

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| | understanding about serological and molecular methods of microbial diagnosis. | about how to use Serological (agglutination, ELISA, immunofluorescence) and molecular diagnostic technology (Nucleic acid based methods - PCR, Nucleic acid probes) to identify pathogenic forms in clinical samples. | presentation and mock test on clinical diagnosis. |
| 5 | CO5: Attains knowledge about kits for rapid detection of pathogens detection in clinical samples. | Familiarizing students with the kits for rapid detection of pathogens (Typhoid, Dengue & Blood group). The students get information about resistance/sensitivity of bacteria using disc diffusion method, Minimal inhibitory concentration (MIC) of an antibiotic. | The learning of the students about diagnostic tests and automatic instruments used for diagnosis. Poster and powerpoint presentation based learning. |