

St. Xavier's College (Autonomous),  
Mumbai



Syllabus of the courses offered by the  
Department of Microbiology  
(2015 onwards)

**F.Y.B.Sc SYLLABUS UNDER AUTONOMY  
MICROBIOLOGY 2013- 2014**

**MICROBIAL CELL STRUCTURE & FUNCTION 45 LECTURES S.MIC.1.01**

**LEARNING OBJECTIVES:**

- Learn the fundamental aspects of Prokaryotic and Eukaryotic Cell structure and function, and the differences between these cells
  - Learn and understand the principles of working of the light microscope and other modified microscopes and to know the differences between them. To be able to apply this knowledge in the laboratory.
  - Develop analytical skills
  - Think in a critical & creative manner
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**UNIT 1: PROCARYOTIC CELL STRUCTURE, FUNCTION AND STAINING  
15 LECTURES**

**1. Members of the Microbial World 3L**

- The universal Phylogenetic tree
- Discovery of Micro-organisms
- Overview of Prokaryotic Cell Structure: Size, Shape, Arrangement, Micrometry
- Diagram of Prokaryotic cell organization

**2. Cell Wall Structure and Gram Stain 3L**

**3. Cell Membrane: Bacterial and Archaeal 2L**

**4. Cytoplasmic Matrix 3L**

- Cytoskeleton, Nucleoid, Plasmids, Ribosome
- Inclusion granules: Composition, Function and Staining

**5. Components External to Cell Wall 3L**

- Capsule, Slime, S-layer, Demonstration
- Pili, Fimbriae
- Flagella: Structure, Motility, Chemotaxis, Staining

**6. Bacterial Endospores 1L**

- Examples of spore forming organisms, habitats, function, staining
- Formation and Germination

**ACTIVITY: Draw Table to include: names, morphology, arrangement, Gram nature with diagrams and kind of motility for each of 15 common microbes**

## **UNIT 2: EUKARYOTIC CELL STRUCTURE AND FUNCTION 15 LECTURES**

**1. Overview of eukaryotic cell structure: General structure and types of cells 1L**

**2. External Cell coverings and Cell Membrane: Structure and Function 2L**

**3. Cytoplasmic Matrix 9L**

- Cytoskeleton: Structure and Function
- Single Membrane Organelles - Endoplasmic reticulum, Golgi complex, Lysosomes, Vesicles, and Ribosomes: Structure and Function and the Endocytic, Biosynthetic and Secretory pathways involved
- Double Membrane Organelles – Nucleus, Mitochondrion and Chloroplast: Structure and Function
- Peroxisomes : Structure and Function

**4. Organelles of motility – Structure and movement of flagella and cilia 2L**

**5. Comparison of Prokaryotic and Eukaryotic cells - Structure & Function 1L**

## **UNIT 3: MICROSCOPY 15 LECTURES**

**1. History of the Microscope 1L**

**2. Lenses and bending of Light 1L**

**3. Light Microscopy 5L**

- Bright field Microscopy: Objectives, Eyepiece, Condenser
- Characteristics of lenses: Resolution, Magnification, Numerical Aperture, Focal Length, Working distance, Depth of Focus.
- Specimen Preparation and Principles of Bacterial cell staining.

**4. Dark Field Microscopy 1L**

**5. Phase Contrast and Differential Interference Contrast Microscopy 1L**

**6. Fluorescence Microscopy 1L**

**7. Electron Microscopy: TEM & SEM and Specimen preparation 3L**

## 8. Newer Techniques in Microscopy 2L

- Confocal Microscope.
- Scanning Probe Microscope

**Student activity:** History of the microscope, different types of light microscopes other than those mentioned above – draw or stick images of microbes using all of the above microscopes

### CIA: Quiz

### References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, , 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. Medical Microbiology, R.Cruickshank, P.Duguid, B.P.Marmion, R.H.A.Swain, 12th ed Vol II., Churchill Livingstone
4. Mackie and McCartney's Practical Medical Microbiology, Eds J. G. Collee, J. P. Duguid, A. G. Fraser & B. P. Marmion, 13th edition, Vol II; Churchill Livingstone
5. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
6. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
7. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.

**ELEMENTS OF MICROBIAL NUTRITION, GROWTH & CONTROL**  
**45 LECTURES** **S.MIC.1.02**

**LEARNING OBJECTIVES:**

- Understand the basic concepts of microbial nutrition, growth and control
  - Gain knowledge of the principles and basic methods involved in the study and control of microbes
  - Develop analytical and problem solving skills
  - Think in a critical & analytical manner
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**UNIT 1: MICROBIAL NUTRITION, CULTIVATION, ISOLATION AND PRESERVATION** **15 LECTURES**

1. **Scope and Relevance of Microbiology** 2L
2. **Nutritional requirements- Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth factors** 1L
3. **Nutritional types of microorganisms** 2L
4. **Nutrient uptake mechanisms** 2L
5. **Types of culture media with examples** 3L
6. **Isolation of microorganisms and pure culture techniques** 3L
7. **Preservation of microorganisms** 2L

**UNIT 2: MICROBIAL GROWTH** **15 LECTURES**

1. **Definition of growth, Mathematical expression, Growth curve** 3L
2. **Measurement of Growth** 7L
  - Direct Microscopic count- Breeds, Petroff-Hausser counting chamber, Haemocytometer
  - Viable count- Spread plate and Pour plate technique, Membrane filtration
  - Electronic Counting
  - Measurement of cell mass
  - Turbidity measurements- Nephelometer and spectrophotometer techniques
  - Measurements of cell constituents.

- 3. Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth, Growth Yield (definition of terms) 1L**
- 4. Influence of environmental factors on growth 3 L**
- 5. Microbial growth in natural environments, viable non-culturable organisms, Quorum sensing 1L**

### **UNIT 3: CONTROL OF MICROORGANISMS**

**15 LECTURES**

- 1. Definitions of frequently used terms 1L**
- 2. Pattern/Rate of Microbial Death 1L**
- 3. Conditions influencing the effectiveness of Antimicrobial agents 1L**
- 4. Physical Methods of Microbial Control 5L**
  - Heat: Moist and Dry
  - Low temperature
  - Filtration
  - High pressure
  - Desiccation
  - Osmotic pressure
  - Radiations
- 5. Chemical methods of Microbial Control 5L**
  - Phenolics
  - Biguanides - chlorhexidine
  - Alcohols
  - Halogens
  - Heavy Metals
  - Quaternary ammonium compounds
  - Surface active agents
  - Aldehydes
  - Sterilizing gases
  - Peroxygens
  - Chemotherapeutic agents
- 6. Evaluation of effectiveness of Antimicrobial agent 2L**

**C.I.A – Quiz /Problem solving**

## References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, , 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
- 3 Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
4. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
5. Microbiology- Concepts and Applications, Pelczar Jr,Chan, Krieg, International ed, McGraw Hill

## **PRACTICALS**

### **SEMESTER I**

**COURSE: S.MIC.1.PR**

#### **LEARNING OBJECTIVES:**

- To learn, understand and practice Safety rules when in the Microbiology Laboratory and become proficient in Aseptic techniques
  - To gain proficiency in the use of Micropipettes
  - To learn principles of Microscopy, to gain proficiency in the use and care of the Compound Microscope and to successfully stain bacteria
  - To gain proficiency in the techniques of cultivation, isolation and preservation of bacteria
  - To use physical and chemical methods to control the growth of micro-organisms.
  - To learn the techniques of enumeration of micro-organisms.
  - To learn to critically observe and record the observation of all experimentation.
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#### **PRACTICAL 1**

1. Biosafety in the Microbiology Laboratory- practices and rules involved with a short experimental study
  
2. Assignments –
  - a) Contributions of one Scientist of the Golden Era
  - b) Experiments that refuted the belief in Spontaneous Generation
  
3. The Light Microscope –
  - a) Diagram of Path of Light through Compound Microscope
  - b) Working Rules
4. Monochrome staining of bacteria
5. Negative staining and Micrometry
6. Gram staining of bacteria
7. Staining of Cell components – Cell wall, Capsule, Metachromatic & Lipid granules, Endospores
8. Staining of Flagella and Spirochaetes
9. Motility by Hanging drop technique
10. Staining of Yeasts
11. Wet mount of Hay Infusion and Pond water for observing bacterial, algal and protozoan forms.

#### **C.I.A – Quiz/Staining technique**

## **PRACTICAL 2**

### 1. Preparation of culture medium:

- a) Liquid medium (Nutrient broth)
- b) Solid media (Nutrient agar, Sabouraud agar)
- c) Preparation of slants, butts and plates

### 2. Inoculation Techniques:

- a) Aseptic Transfer techniques using glass and micro pipettes
- b) Liquid medium
- c) Solid media (slants, butts and plates)

### 3. Cultivation of bacteria:

- a) Study of Colony Characteristics on Nutrient agar
- b) Study of Motility using Motility agar
- c) Use of differential, selective and enriched media
  - (i) MacConkey's agar
  - (ii) Superimposed blood agar

### 4. Determination of optimum growth conditions (Temperature, pH, aeration)

### 5. Measurement of Microbial growth

- a) Microscopic cell count (Haemocytometer, Breed's Count)
- b) Brown's opacity tubes
- c) Viable count (Pour plate and surface spread)
- d) Growth curve of *E.coli* and determination of generation time (Group Experiment)

### 6. Physical methods of control of microorganisms:

- a) Heat: Autoclaving, Fractional sterilization, Dry heat.
- b) Bacteria proof filtration (Demonstration of Membrane filtration)
- c) Effect of U-V rays
- d) Effect of desiccation.
- e) Effect of high osmotic pressure

### 7. Chemical Methods of Control of microorganisms:

- a) Effect of phenolics (Disc Method) and other disinfectants used at home
- b) Oligodynamic action of Copper foil and Mercurochrome
- c) Effect of Cetrimide
- d) Effect of Dyes (Disc Method)
- e) Effect of Chemotherapeutic agents

## **CIA- Isolation and Motility Techniques**

**F.Y.B.Sc SYLLABUS UNDER AUTONOMY  
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**MICROBIAL DIVERSITY, TAXONOMY AND SIGNIFICANCE**

**45 LECTURES**

**S.MIC.2.01**

**LEARNING OBJECTIVES:**

- Learn about the different Taxonomic Groups of organisms and identify their differences
  - Appreciate the diversity amongst organisms
  - Learn ecological principles and concepts
  - Associate the organisms fundamental cell function with various applied aspects of microbiology and biotechnology
  - Think in a critical & creative manner
  - Study on a comparative basis the various groups
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**UNIT 1: TAXONOMY & PROKARYOTIC DIVERSITY**

**15 LECTURES**

**1. Microbial Evolution and Origins of life 3L**

- Endosymbiotic Theory
- An Introduction to Microbial Classification and Taxonomy
- Taxonomic Ranks.
- List of Techniques used for determination of Microbial Taxonomy & Phylogeny
- Systems of Procaryotic and Eucaryotic Phylogeny.

**2. Classification systems in Prokaryotes 1L**

An Overview - Taxonomy based on

- Bergey's Manual of Systematic Bacteriology
- The Prokaryotes
- Systematic Bacteriology.

**3. Prokaryotic groups with unusual characteristics 3L**

- Photosynthetic Bacteria: Cyanobacteria, Green and Purple sulphur bacteria
- Gliding bacteria
- Rickettsia and Chlamydia
- Actinomycetes

**4. Archaea 2L**

- Classification
- Significance

## **5. Viruses 6L**

- Definitions of Virus , Viroids and Prions
- General Structure of viruses
- Structure of Bacteriophage T<sub>4</sub>
- Reproduction with T<sub>4</sub> bacteriophage as an example
- Lytic and lysogenic cycle concepts only
- Basic Concepts of Virus cultivation
- Classification-criteria involved

**Self Study: Comparison between Bacteria, Archaea and Viruses  
Commercial applications of Archaea.**

## **UNIT 2: EUKARYOTIC DIVERSITY 15 LECTURES**

### **1. Overview of eukaryotic cell diversity 5L**

- Three Domains of Life
- Endosymbiotic theories
- Eukaryotic cell cycle and Cell division – Mitosis and Meiosis

### **2. Types of Eukaryotic cells, Morphological characteristics, Classification, Reproduction and Significance 10L**

- Fungi: Molds and Yeasts
- Algal protists
- Protozoan protists

## **UNIT 3: INTRODUCTION TO MICROBIAL ECOLOGY AND MICROBIAL BIOTECHNOLOGY 15 LECTURES**

### **1. Principles of microbial ecology 12 L**

- Ecological concepts 3L
  - i. Species diversity in habitats
  - ii. Microbial ecosystems and biogeochemical cycling-microorganisms as the beginning and end of every energy pyramid.
  - iii. Biofilms and microbial mats
- Microorganisms on land and in water & extreme environments 2L
- Types of Microbial interactions - 2 L

- i. Mutualism, Cooperation, Commensalism, Predation, Amensalism, Competition
- ii. Mycorrhizae, Rumen symbiosis, legume-*Rhizobium* association

- Microbe-human interactions - Normal flora of humans - 3 L

## **2. Microbial biotechnology 3 L**

- Introduction to applied microbiology and biotechnology
- Microorganisms in food-beneficial effects and detrimental effects.
- Industrial microbiology-products from microorganisms-metabolites, enzymes, pharmaceuticals, fuels, biopolymers - a list
- Microorganisms and agriculture- biopesticides & biofertilizers
- Bioremediation- oil spills and waste water treatment
- Impact of Biotechnology and ethics

## **C.I.A – Quiz**

### **References**

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, , 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.

**BASICS OF METABOLISM & GENETICS      45 LECTURES    S.MIC.2.02**

**LEARNING OBJECTIVES:**

- Learn structure and function of the various chemical cellular molecules
  - Understand the basic concepts of metabolism, genetics and bioinformatics
  - Think in a critical and analytical manner
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**UNIT 1: CHEMISTRY OF CELLULAR COMPONENTS 15 LECTURES**

**1. Atoms, Bonds & Molecules 2L**

- Types of atoms - Elements & their properties
- Bonds & Molecules

**2. Water 3L**

**3. Non- informational macromolecules**

- Carbohydrates – sugars & polysaccharides **5L**
- Lipids – Fats, Phospholipids & Waxes **3L**
- Amino acids & Peptide bonds **2L**

**UNIT 2: INFORMATIONAL MACROMOLECULES & INTRODUCTION TO METABOLISM 15 LECTURES**

**1. The Nucleic acids 5L**

- RNA& types, DNA – Features & forms

**2. Proteins 3L**

- Primary & secondary structures & higher order structures

**3. Biocatalysts 4L**

- i) Definition of enzymes, & ribozymes
- ii) Effect of pH, temperature, enzyme concentration, substrate concentration, and inhibitor
- iii) Cofactors & allosteric enzymes

#### **4. Introduction to metabolism 3L**

- Linking of catabolism & anabolism
- Role of ATP & reducing power
- Mechanism of fermentation, respiration & photosynthesis
- Substrate level, Oxidative and Photophosphorylation

### **UNIT 3: INTRODUCTION TO GENETICS & BIOINFORMATICS 15 LECTURES**

#### **1. Structure of genetic material - Structural characteristics of prokaryotic & eukaryotic chromosomes 10L**

- Experiments involved, Watson & Crick's model of DNA, circularity, supercoiling, topoisomerases
- Gene and its function-Central Dogma of life
- Genetic elements: The chromosome, non-chromosomal genetic elements, viruses and plasmids, transposable elements
- Chromatin structure, euchromatin, heterochromatin, Role of histones and non-histone proteins, Structure of condensed chromatin, nucleosomes, centromere, kinetochores, telomeres
- Differences in the chromosomal structure of prokaryotes, eukaryotes and viruses

#### **2. Replication of DNA 1L**

#### **3. Genetic code, Central dogma of molecular biology 3L**

#### **4. Introduction to bioinformatics 1L**

- Definitions of bioinformatics, genomics, proteomics, metabolomics

#### **C.I.A – Quiz**

#### **References**

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, , 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. Principles of Biochemistry, Lehninger, 4th edition. D. Nelson & M. Cox. W.H.Freeman & Co. New York 2005
4. Outlines of Biochemistry, E. Conn, P. Stumpf, G.Bruening & R. Doi, 5th edition. John Wiley & Sons. New York. 1999

5. Introduction to bioinformatics, Attwood T.K., Parry- Smith D.J., Phukan Samiron, Pearson Education 2007
6. iGenetics – A Molecular Approach, Peter Russell, 3<sup>rd</sup> ed, Pearson Publications
7. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.

## **PRACTICAL**

### **SEMESTER II**

**COURSE: S.MIC.2.PR**

### **LEARNING OBJECTIVES:**

- To practice Safety rules when in the Microbiology Laboratory
- To examine living prokaryotic and eukaryotic organisms using different techniques like differential staining, wet mounts and other procedures.
- To cultivate eukaryotic cells.
- To study of organisms from various habitats.
- To apply learnt techniques for the laboratory scale production of biotechnological products.
- To study microbial enzyme producers.
- To use qualitative chemical tests to identify biomolecules.
- To isolate genomic DNA and perform Agarose gel electrophoresis
- To learn to critically observe and record the observation of all experimentation.

### **PRACTICAL 1**

1. Gram stain and isolation of Actinomycetes – *Nocardia* and *Streptomyces*
2. Permanent slides of Cyanobacteria
3. Wet Mount of *Aspergillus*, *Penicillium*, *Mucor* & *Rhizopus*
4. Permanent slides of *Spirogyra*, *Spirulina*, *Euglena*, *Diatoms*
5. Observations of Plaques on a lawn of host cells - Demonstration.
6. Setting up Winogradsky's column- study of different types of microorganisms
7. Study of microorganisms in soil and water
8. Study of extremophiles- isolation of halophiles from sea water/ dried fish
9. Study of *Rhizobium* –legume symbiosis, isolation of *Rhizobium* from nodules of methi plants
10. Study of normal flora from skin, URT and GIT
11. Study of microorganisms in fermented food by Gram Stain (curd and idli batter)
12. Wine production
13. Bread making
14. Mushroom cultivation – demonstration

### **Assignment on Diversity of Micro-organisms**

Students will record in the pages of the journal a list of all microbes studied in Theory and Practicals. These organisms will be grouped according to classification

studied in theory. The record will include a representative well labeled color diagram and the function of each of the chosen organisms in ecology.

### **TABLE ACTIVITY: Small exhibition on FERMENTED FOODS**

#### **CIA- Wet Mount of Fungi**

### **PRACTICAL 2**

1. Qualitative tests for Proteins, Amino Acids Carbohydrates, Nucleic Acids & Lipids
2. Study of Bacterial Enzymes -  
Study of Amylase, Casease, Urease, Catalase & Lipase Producers
3. To isolate genomic DNA from onion or cauliflower and perform Agarose gel electrophoresis.

#### **CIA- Isolation technique / Viable count by the pour plate technique**

#### **References:**

1. Practical Microbiology, R.Vasanthakumari, BI Publications 2009.
2. Microbiology, A Laboratory Manual, 7th ed, Cappucino and Sherman, Pearson Education
3. An Introduction to Practical Biochemistry, 3rd edition, David Plummer, Tata McGraw Hill
4. Microbiological Applications, A Laboratory Manual in General Microbiology, 5th edition, Harold Benson.

**S.Y.B.Sc SYLLABUS UNDER AUTONOMY  
MICROBIOLOGY 2013- 2014**

**CELL BIOLOGY, MICROBIAL VIRULENCE, INNATE IMMUNITY  
45 LECTURES S.MIC.3.01**

**OVERALL LEARNING OBJECTIVES**

- Understand structure of cell, cellular organelles and their functions
  - Understand basic concepts involved in cell regulation
  - Understand pathogenesis of infectious diseases
  - Understand the fundamental mechanisms underlying protective innate immunity
- 

**UNIT 1: CELL BIOLOGY 15 LECTURES**

**LEARNING OBJECTIVES**

- Relate the structure and activities of cell components to their functions
  - Understand the basic events of the cell cycle
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**1. Cell structure and function 12L**

- Revision of FY concepts
- Nucleus-traffic between the nucleus and the cytoplasm, nucleolus and rRNA processing
- Protein sorting and Transport-ER, Golgi apparatus, Lysosomes
- Cytoskeleton
- Plasma membrane-Fluid mosaic model, membrane fluidity, functions
- Cell walls, the extracellular matrix and cell interactions

**2. Introduction to Cell Regulation 3L**

- Cell signaling-an introduction to signaling molecules and their receptors, functions of cell surface receptors
- Cell cycle-regulators of eukaryotic cell cycle progression
- Cell Death-programmed cell death- events of apoptosis, caspases, central regulators of apoptosis

## UNIT 2: MICROBIAL VIRULENCE

### LEARNING OBJECTIVES

- Understand various determinants of infections
  - Understand the pathogenesis of infectious diseases including-pathogen entry, microbe spread through the body, microbial strategies in relation to immune response, mechanisms of cell and tissue damage.
- 

#### 1. Human microbial interactions 1L

- Beneficial interactions-normal flora(revision)
- Harmful microbial interactions

#### 2. Infection and Disease

- **Etiology of Infectious Diseases 1L**
  - Koch's Postulates
  - Exception's to Koch's Postulates
- **Classifying Infectious diseases 1L**
  - Occurrence of a Disease
  - Severity or duration of a disease
  - Extent of Host involvement
- **Patterns of Disease 1L**
  - Predisposing factors
  - Development of Disease
- **The Spread of Infection 1L**
  - Reservoirs of Infection
  - Transmission of Disease
- **Entry of Microorganisms in a host 1L**
  - Portals of entry
  - The Preferred portal of entry
  - Numbers of invading microbes
  - Adherence
- **Penetration of host defenses by bacterial pathogens 2L**
  - Capsules
  - Components of cell wall
  - Enzymes
  - Antigenic variation
  - Penetration into the host cell cytoskeleton
- **Damage of host cells by bacterial pathogens 3L**
  - Using the host's nutrients
  - Direct damage
  - The production of toxins
- **Microbial virulence factors 2L**
  - Pathogenicity Islands
  - Virulence factors of *Salmonella*

- **Microbial mechanisms for escaping host defenses 1L**  
Evading the Complement System  
Resisting Phagocytosis  
Survival inside Phagocytic cells  
Evading the specific Immune response
- **Bacterial, Viral and Fungal diseases 1L**  
Some examples

## **UNIT 3: INNATE IMMUNITY 15 LECTURES**

### **LEARNING OBJECTIVES**

- Describe the cells and organs of the immune system
  - Describe the physical and chemical barriers used by the human body to prevent infection.
  - Describe the process of phagocytosis and list the major types of cells that carry it out.
  - Describe the process of inflammation including its symptoms , its purpose
  - Describe the role of acute phase proteins and fever in innate immunity
- 

#### **1. Overview of the Immune system 1L**

- Innate and adaptive immunity, Major differences between innate and adaptive immunity

#### **2. Cells and Organs of the immune system 5L**

- Haematopoiesis – overview
- Cells- lymphocytes- T cells, B cells, NK cells
- Monocytes, macrophages
- Granulocytic cells -neutrophils, eosinophils, basophils
- Mast cells, dendritic cells, Follicular dendritic cells
- Organs- primary lymphoid organs-thymus, bone marrow
- Secondary lymphoid organs- lymph nodes, spleen, MALT

#### **3. First line of defense- 2L**

- Anatomic - Skin, Mucous membranes
- Physiologic- pH, chemical factors- lactic acid, lysozyme, pepsin

#### **4. Second line of defense 5L**

- Phagocytosis- Cells involved, Mechanisms-opsonin dependent and opsonin independent
- Self and non self recognition by phagocytes- pattern recognition receptors
- Inflammation- Signs of inflammation, Functions of inflammatory response, Major physiological events during an inflammatory response, chemical mediators of inflammation
- Acute phase proteins
- Chemical mediators- IFN, Complement, Cytokines
- Fever

#### **5. Defense mechanisms – Self study 1L**

- Gastrointestinal tract, Respiratory Tract, Genitourinary tract, Conjunctiva-Assignment

#### **6. Connection between innate immunity and adaptive immunity 1L**

#### **CIA: Quiz and Presentations**

#### **References: -**

1. Prescott, Harley, Klein's Microbiology, 7<sup>th</sup> edition, Wiley, Sherwood, Woolverton, Mc Graw Hill
2. The Cell: A Molecular Approach, Geoffrey Cooper, Robert Hausman, 5<sup>th</sup> edition, ASM Press
3. Kuby Immunology, Thomas Kindt, Richard Goldsby, Barbara Osborne, 6<sup>th</sup> edition, W.H. Freeman & Co
4. Foundations in Microbiology, Kathleen Park Talaro, 7<sup>th</sup> edition, McGraw Hill
5. Microbiology, an introduction, Tortora, Funke, Case, 10<sup>th</sup> edition, Pearson Education Brock

**INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATS**  
**45 LECTURES**

**S.MIC. 3.02**

**OVERALL LEARNING OBJECTIVES**

- Gain an insight into microbial metabolic diversity
  - Understand the working and concepts of enzymology
  - Understand the principles of metabolism
  - Get familiar with basic Biostatistical concepts and methods
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**UNIT 1: BIOENERGETICS AND INTRODUCTION TO BIostatISTICS**  
**15 LECTURES**

**LEARNING OBJECTIVES**

- Understand the principles involved in Bioenergetics
  - Gain knowledge of treatment and presentation of Analytical Data and Sampling
- 

**1. Bioenergetics 10 L**

- Scope of thermodynamics
- Concept of free energy, Enthalpy, Delta G, Standard Free Energy change of reaction, Entropy
- First and Second law of Thermodynamics
- Open and Closed system
- Structure and properties of ATP, Standard Free energy change of hydrolysis of ATP and other high energy compounds
- Biological oxidation-reduction reactions
- Structure and Function of NAD and FAD
- Problems for calculation of free energy, standard free energy, equilibrium constant, oxidation reduction potential

**2. Introduction to Biostatistics 5 L**

- Sample and population
- Data presentation-Dot diagram, bar diagram, Histogram, frequency curve
- Central Tendency-Mean, Median, Mode Summation notations
- Standard Deviation, Variation, Q-test, T-test, F-test

## **UNIT 2: ENZYMOLOGY 15 LECTURES**

### **LEARNING OBJECTIVES**

- Gain knowledge of concepts related to enzymes- activity, inhibition, regulation
- 
- Concept checking ( includes revision of FY concepts) **3 L**  
Definition and Mechanism of an enzyme reaction, Effect of enzyme concentration, substrate concentration, pH, temperature on enzyme activity, exo/ endoenzymes, constitutive/ induced enzymes, isozymes, ribozymes, enzyme unit, specific activity, Monomeric, Oligomeric and Multimeric enzymes, Zymogens
  - Important structural features **1 L**
  - Michaelis-Menton equation-Derivation, Lineweaver - Burk equation and plot **2 L**
  - Inhibitors of enzymes: Irreversible, Reversible -competitive, Non-competitive, Uncompetitive **2L**
  - Cofactors : Coenzymes, Prosthetic groups, Metallic cofactors –important examples **1L**
  - Multisubstrate reactions -Ordered, Random, Ping-pong (schematic with example) **1 L**
  - Classification of Enzymes **1L**
  - Allosteric enzymes -Properties and mechanism **1 L**  
- Koshland Nemethy and Filmer model  
- Monod Wyman and Changeux model
  - Control of enzyme activity : Allosteric Regulation, Covalent Modification, Feedback Inhibition **2 L**
  - Principles underlying enzyme purification **1 L**

## **UNIT 3: INTRODUCTION TO MICROBIAL METABOLISM 15 LECTURES**

### **LEARNING OBJECTIVES**

- Understand the link between fueling and biosynthetic pathways
  - Gain knowledge of the principles underlying catabolism and anabolism
- 

#### **1. Overview of Metabolism – Revision 1 L**

#### **2. Energy Release and Conservation 12 L**

- Chemoorganotrophic Fueling Processes
- Fermentation, Substrate level Phosphorylation

- Aerobic Respiration - Breakdown of Glucose to Pyruvate , The Tricarboxylic Acid Cycle, Electron Transport and Oxidative Phosphorylation, Amphibolic Pathway, Anaplerotic Reactions
- Anaerobic Respiration
- Chemolithotrophy
- Phototrophy, Photophosphorylation

### **3. Principles Governing Biosynthesis 2 L**

#### **CIA: Quiz, Problem Solving**

#### **References: -**

1. Lehninger's Principles of Biochemistry, Nelson & Cox, 5<sup>th</sup> edition, Macmillan Worth Publications
2. Outlines Of Biochemistry, 5th edition, Eric E Conn , Paul K Stumpf ,George Bruening, Roy H. Doi John Wiley & Sons
3. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, , 7th International, edition 2008, McGraw Hill.
4. Biochemistry Berg JM, Tymoczko JL, Stryer L. 6th edition, New York: W H Freeman
5. A biologist's physical chemistry, J. Gareth Morris, Hodder Arnold Publications
6. Biochemical Calculations, Irwin H. Segel, 2nd Edition John Wiley & Sons

**BASICS OF GENETICS & INTRODUCTION TO BIOINFORMATICS**  
**45 LECTURES**

**COURSE: S.MIC.3.03**

**OVERALL LEARNING OBJECTIVES**

- Basic understanding of concepts of genetics
  - Develop analytical skills, problem solving & critical thinking
  - Think in an innovative & creative manner
- 

**UNIT 1: DNA REPLICATION 15 LECTURES**

**LEARNING OBJECTIVES**

- Understand basics of DNA replication
  - List the differences between prokaryotic & eukaryotic DNA replication
  - Understand the principles of related instrumentation
- 

**1. Revision of FY concepts – 1L**

**2. Historical perspective 4L**

- Meselson & Stahl experiment (with principle of density gradient centrifugation)
- J. Cairns experiment (with DNA radiolabeling)
- Agarose gel electrophoresis

**3. Prokaryotic DNA replication 10L**

- Details of molecular mechanisms & enzymes involved in Initiation, Elongation and Termination
- Theta & sigma modes of replication

**UNIT 2: TRANSCRIPTION & TRANSLATION 15 LECTURES**

**LEARNING OBJECTIVES**

- Understand the mechanisms of transcription & translation
  - Compare prokaryotic & eukaryotic transcription & translation
  - Application & analysis based on concepts taught
-

## **1. RNA Synthesis (Transcription) 6 L**

- Revision of concepts studied in FY
- Types of RNA (mRNA, tRNA, rRNA), DNA dependent RNA polymerase, promoter, operator, positive & negative regulators of transcription
- Process of RNA synthesis in prokaryotes – Initiation, Elongation & Termination

## **2. Protein Synthesis (Translation) 9 L**

- Revision of concepts studied in FY- amino acids and proteins
- Genetic code, ORF, CDS, constitutive & inducible proteins
- Stages of protein synthesis in prokaryotes – Activation of amino acids, Initiation, Elongation, Termination and Release, Folding and posttranslational processing
- Exercises on transcription & translation using on-line software

## **UNIT 3: EUKARYOTIC GENETICS & BIOINFORMATICS 15 LECTURES**

### **LEARNING OBJECTIVES**

- Compare prokaryotic & eukaryotic replication, transcription & translation
  - Application & analysis based on concepts taught in Mendelian genetics
  - Introduction to real time methods in bioinformatics
  - Knowledge of available on-line software & their applications
- 

### **1. Eukaryotic genetics**

- **DNA replication in Eukaryotes 2L**
  - i. Molecular details of DNA synthesis, enzymes involved, replication of telomeres, assembly of replicated DNA into nucleosomes
  - ii. Differences between prokaryotic & eukaryotic DNA replication
- **Transcription in Eukaryotes 2L**
  - i. Process of RNA synthesis in eukaryotes – In comparison with prokaryotic transcription
  - ii. RNA dependent DNA polymerase – Diagrammatic representation of reverse transcription
- **Translation in Eukaryotes 2L**

Process of protein synthesis in eukaryotes – In comparison with prokaryotic translation

- **Mendelian Genetics 2L**
  - i. Mendel's laws
  - ii. Monohybrid, Dihybrid & Trihybrid Crosses
  - iii. Problem solving

## **2. Bioinformatics 7 L**

- **Introduction**
  - i. Genomics - structural, functional and comparative genomics
  - ii. Proteomics- structural and functional proteomics,
  - iii. Annotation, Transcriptomics, Metabolomics, Pharmacogenomics,
  - iv. Sequence alignment & all related terms in bioinformatics
- **Database, tools and their uses**
  - i. NCBI, ExPASy proteomics server, EBI
  - ii. Importance, Types and classification of databases
  - iii. Nucleic acid sequence databases- EMBL, DDBJ, GenBank, CMR
  - iv. Protein sequence databases-PIR, SWISS-PROT
  - v. Metabolic Databases - KEGG, METACYC
  - v. BLAST with one example

### **CIA: Quiz, Problem solving**

### **References: -**

1. Lehninger's Principles of Biochemistry, D. Nelson & M. Cox, 5<sup>th</sup> edition, Macmillan Worth Publications
2. Molecular Biology of the gene, JD Watson, Baker, Bell, 4<sup>th</sup> / 5<sup>th</sup> edition, Pearson Education Publications
3. Concepts of Genetics 7<sup>th</sup> edition, Klug & Cummings, Pearson Education Publications
4. Genes IX, Lewin, Oxford Publications
5. Genetics – a molecular approach, Peter Russell, 3<sup>rd</sup> edition, Pearson Publications
6. Introduction to Bioinformatics, Arthur Lesk, 3<sup>rd</sup> edition, Oxford University Publications
7. Introduction to Bioinformatics, T. K. Attwood & D. J. Parry-Smith, (2003), Pearson Education Publications
8. Fundamental bacterial genetics, Nancy Trun & Janine Trempy, (2004), Blackwell Publications
9. Bioinformatics, David Mount, 2<sup>nd</sup> edition, Cold Spring Harbor Laboratory Press
10. A Biologist's Guide to Principles & Techniques of Practical Biochemistry, 2<sup>nd</sup> edition, Williams & Wilson, E. Arnold Publications

**MICROBIOLOGICAL TECHNIQUES**

1. Biosafety in the microbiology laboratory – Recording, pathogen handling, use of laminar flow, laboratory disinfection
2. Role of fomites in spread of diseases
3. Microbial Counts using Haemocytometer
4. Breed's Count
5. Viable Count Pour plate and Spread plate methods
6. Isolation
7. Gram Stain
8. Motility – hanging / stab culture
9. Multiple tube fermentation
10. MIC and Tolerance
11. Preservation of cultures
12. Cultivation of Anaerobes
13. Study of psoriacin
14. Blood Staining
15. Study of virulence factors of *S. aureus*

**CIA:** Viable Count

**MICROBIAL BIOCHEMISTRY AND BIOSTATISTICS**

1. Determination of dry and wet weight of microbes (yeast/fungi)
2. Verification of Beer-Lambert's Law Linear range, extinction coefficient and Molar extinction coefficient.
3. Estimation of Proteins by Biuret method, UV absorbance method & Robinson – Hogden method
4. Determination of Nitrogen & protein content by Microkjeldahl method (Demonstration)
5. Estimation of reducing sugar (DNSA method)
6. Estimation of DNA - DPA method & UV absorbance method
7. Estimation of RNA (Orcinol method)
8. Effect of variables on enzyme activity (amylase)
  - a. Temperature
  - b. pH
  - c. substrate concentration
  - d. Enzyme concentration
  - e. Determination of  $K_m$  of amylase (Lineweaver-Burke plot; Michaelis-Menton graph)
11. Problems based on biostatistics & bioenergetics

**References: -**

1. Biochemical Calculations, Irwin H. Segel, 2nd Edition John Wiley & Sons
2. Methods in Microbiology, Norris & Ribbons Volume VB, Academic Press

**CIA:** Chemical Assay

**BASICS OF GENETICS AND INTRODUCTION TO BIOINFORMATICS**

1. Isolation of genomic DNA from *E. coli*
2. Plasmid Isolation
3. Agarose gel electrophoresis – horizontal gel electrophoresis
4. Problem solving on Mendelian Genetics
5. Bioinformatics (ORF finder, 6 frame translations, nucleotide & protein BLAST, restriction fragment analysis, protein structure, KEGG)

**CIA:** Problem Solving

**S.Y.B.Sc SYLLABUS UNDER AUTONOMY  
MICROBIOLOGY 2013- 2014**

**VIROLOGY AND IMMUNOLOGY**

**45 LECTURES**

**S.MIC.4.01**

**OVERALL LEARNING OBJECTIVES**

- Understand viral structure, replication, cultivation, purification & enumeration
  - Understand important functional properties of antigens and antibodies
- 

**UNIT 1: ANTIGENS AND ANTIBODIES 15 LECTURES**

**LEARNING OBJECTIVES**

- Understanding the terms-antigen, epitope, immunogenicity, antigenicity, antibody, monoclonal antibodies
  - Understand important functional properties of antigens
  - Describe basic structure and valence of human antibodies, classes of antibodies, functions of antibodies
- 

**1. Immunogenicity versus antigenicity, haptens 1L**

**2. Properties of the immunogen contributing to immunogenicity 2L**

Foreignness, molecular size, chemical composition and heterogeneity, susceptibility to antigen processing and presentation

**3. Other factors contributing to immunogenicity 2L**

- Properties of biological system that contribute to immunogenicity- genotype, immunogen dosage, route of administration
- Adjuvants

**4. Epitopes- Tcell epitopes and B cell epitopes 2L**

**5. Antibodies 8L**

- Basic structure of antibodies
- Antibody binding site
- Antibody mediated effector functions
- Antibody classes and biological activities
- Antigenic determinants on immunoglobulins
- Immunoglobulin superfamily

- Monoclonal antibodies-an introduction

## **UNIT 2: VIRAL ARCHITECTURE, REPLICATION & CLASSIFICATION 15 LECTURES**

### **LEARNING OBJECTIVE**

- Knowledge of viral morphology, classification and replication
- 

#### **1. Viral Architecture 4L**

- Morphology of viruses
- Structure of TMV, Influenza virus, HIV

#### **2. Viral classification 1L**

- Baltimore classification
- International Committee on Taxonomy of Viruses

#### **3. Viral replication cycle 10L**

- Attachment, penetration, uncoating, replication, assembly, maturation and release
- Life cycle of TMV, Influenza virus, HIV & T4 phage
- Prions and viroids

## **UNIT 3 : VIRAL CULTIVATION, PURIFICATION & ENUMERATION 15 LECTURES**

### **LEARNING OBJECTIVE**

- Understand principles underlying methods used for cultivation, purification and enumeration of viruses
- 

#### **1. Cultivation of viruses- 6L**

- Laboratory animals, embryonated egg, cell culture techniques

#### **2. Purification of viruses 2L**

- Methods used with their principles

### **3. Visualization and enumeration of virus particles 7L**

- Measurement of infectious units
  - i. Plaque assay, Pock assay
  - ii. Fluorescent focus assay
  - iii. Infectious center assay
  - iv. Transformation assay
  - v. Endpoint dilution assay
  
- Measurement of virus particles and their components
  - i. Electron microscopy
  - ii. Atomic force microscopy
  - iii. Haemagglutination
  - iv. Measurement of viral enzyme activity
  
- Fate of the cells following virus infection

#### **CIA: Quiz**

#### **References: -**

1. Understanding Viruses, Teri Shors, 2009, Jones and Bartlett Publishers
2. Basic Virology, Edward Wagner and Martinez Hewlett, 2nd edition, Blackwell Publishing
3. Principles of Virology, Flint, Enquist, Racanillo and Skalka, 2nd edition. ASM press
4. Prescott, Harley, Klein's Microbiology, 7<sup>th</sup> edition, Wiley, Sherwood, Woolverton, Mc Graw Hill
5. Kuby Immunology, Thomas Kindt, Richard Goldsby, Barbara Osborne, 6<sup>th</sup> edition, W.H. Freeman & Co

**ENVIRONMENTAL MICROBIOLOGY**  
**45 LECTURES**

**S.MIC.4.02**

**OVERALL LEARNING OBJECTIVES**

- Understand behavior & activities of microorganisms in their natural environments
  - Gain awareness of the microbial processes that occur in different environments
  - Learn important tools & techniques in Microbial Ecology
  - Understand Microbial Diversity
- 

**UNIT 1: MICROBIAL BIODIVERSITY AND TAXONOMY**      **15 LECTURES**

**LEARNING OBJECTIVES**

- Understand the principles involved in Microbial Taxonomy
  - Gain knowledge of the principles & methods involved in studying microbial ecology
- 

**1. Microbial Taxonomy and Diversity 5L**

- Introduction to Microbial Taxonomy and Classification -
- Taxonomic Ranks
- Bergey's Manual of Systematic Bacteriology, The Prokaryotes, Systematic Bacteriology
- Survey of Prokaryotic Phylogeny and Diversity

**2. Methods of study - microbial taxonomy and phylogeny 10L**

- Techniques for Determining Microbial Taxonomy and Phylogeny based on classical & molecular characteristics

**UNIT 2: WATER MICROBIOLOGY 15 LECTURES**

**LEARNING OBJECTIVES**

- Describe aquatic habitats of microorganisms & microbial diversity therein
  - Describe water purification processes & bacteriological analysis of water
  - Gain knowledge of the significance of waste water treatment and the processes involved
-

### **1. Aquatic Environments 2L**

- Microbial Habitats in the Aquatic Environments- Planktonic, Benthic, Microbial Mats, Biofilms
- Aquatic Environments – Freshwater Environments, Brackish Water, Marine Water, Subterranean Water
- Micro-organisms in Marine Environments
- Micro-organisms in Fresh Water Environments

### **2. Microbiology of Potable Water – Sanitary Analysis and Water Purification 8 L**

- Definition of potable water
- Standards for potability
- Microorganisms as bio-indicators of fecal pollution
- Routine analysis of water
- Municipal water purification process
- Domestic water purification processes

### **3. Microbiology of Waste Water 5 L**

- Types of waste water and Characteristics
- Measuring Waste Water Quality
- Waste Water Treatment Processes-domestic and industrial
- Home Treatment Systems
- Impact on environment

## **UNIT 3: AEROMICROBIOLOGY AND TERRESTRIAL MICROBIOLOGY 15 LECTURES**

### **LEARNING OBJECTIVES**

- Describe microorganisms in air & terrestrial environments & their significance
- Understand principles involved in sampling microorganisms from air & terrestrial environments
- Gain knowledge of significant environment management processes

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### **1. Aeromicrobiology 5 L**

- Distribution of microorganisms in air
- Aeromicrobiological Pathway- launching, transport and deposition of aerosols
- Survival of microorganisms in air

- Significance of microorganisms in air (extramural and intramural)- agriculture, waste disposal, germ warfare, buildings, spaceflight, public health, hospital and laboratories.
- Methods to study airborne microorganisms -Sampling, qualitative and quantitative methods
- Bioaerosol control (ventilation, filtration, biocidal control -uv, gaseous, quarantine)
- Biosafety in the laboratory

## **2. Microorganisms in Terrestrial Environments 6L**

- Soil as an Environment for Microorganisms
- Soils, Plants and Nutrients
- Microorganisms in the soil environment and Significance
- Microorganisms & Formation of Soil
- Microorganisms and Vascular Plants
- Soil Microorganisms and the Atmosphere, Subsurface Biosphere
- Soil Microorganisms and Human Health
- Methods in study of microbial ecology - Culture dependent & independent analyses of microbial communities, measuring microbial activities in nature

## **3. Environment Management 4L**

- Bioremediation
- Solid waste management : Landfills, Composting, Production of Biomass, Production of Fuels

### **CIA: Quiz**

#### **References: -**

1. Brock Biology of Microorganisms Michael.T.Madigan, John.M.Martinko, Paul V. Dunlap, David P. Clark, 12th edition, Pearson International edition 2009
2. Prescott, Harley, Klein's Microbiology, 7<sup>th</sup> edition, Wiley, Sherwood, Woolverton, Mc Graw Hill
3. Fundamental principles of Bacteriology 7<sup>th</sup> edition, Salle A. J. ,Tata McGraw Hill
4. Bergey's Manual of Systematic Bacteriology. 2nd edition
5. Microbial Ecology-Fundamentals and Application, Atlas and Bartha Pearson Education
6. Environmental Microbiology, Maier, Pepper, Gerba, 2<sup>nd</sup> edition, Academic Press
7. Foundations in Microbiology 7<sup>th</sup> edition, Kathleen Talaro, McGraw Hill
8. The Prokaryotes, Falkow S, Rosenberg E, Schleifer, K.H, Stackerbrandt E, 3<sup>rd</sup> edition, Volumes 1 – 7, Springer Publication

# **FOOD MICROBIOLOGY & BIOPROCESS TECHNOLOGY**

**45 LECTURES**

**COURSE: S.MIC. 4.03**

## **OVERALL LEARNING OBJECTIVES**

- Understand the principles of Food Microbiology & Microbial Biotechnology
  - Develop critical thinking & presentation skills
  - Independent study & planning of projects
- 

## **UNIT 1: FOOD & DAIRY MICROBIOLOGY 15 LECTURES**

### **LEARNING OBJECTIVES**

- Understand the principles & methods involved in food & dairy fermentation
  - Understand preservation as an important field for a microbiologist
  - Knowledge of recent trends in Food & Dairy Microbiology
- 

### **1. Introduction – Scope of food microbiology & role of a microbiologist 1L**

### **2. Food Spoilage 1L**

- Microbial flora of food & milk – normal – self study
- Food/milk as substrate for microbes (spoilage) – self study
- Other causes of spoilage – environmental, mechanical, pests
- Types of spoilage – fermentation, putrefaction, rancidity
- Spoilage by molds

### **3. Preservation of foods & dairy products 6L**

- Asepsis, removal of microbes – filtration & centrifugation
- Hindrance to microbial growth – Use of low temperatures, drying, food additives, anaerobiosis – canning
- Food additives other than preservatives – antioxidants, sweeteners, coloring agents, nutraceuticals, fortified foods
- Killing of microbes – Use of heat, radiations, gaseous sterilants
- Mechanical destruction – grinding, use of high pressure
- Combination of methods: examples of foods preserved

#### **4. Beneficial microbes & food fermentation processes 7L**

- Cheese fermentation
- Butter making
- Yogurt fermentation
- Bread fermentation
- Wine fermentation
- Mushroom fermentation
- Probiotics & Nutraceuticals

### **UNIT 2: FOOD SAFETY & METHODS IN FOOD MICROBIOLOGY 15 LECTURES**

#### **LEARNING OBJECTIVES**

- Gain knowledge of Food Safety & its scope in Quality Control of Foods
  - Understand basic techniques involved in ensuring food quality
- 

#### **1. Contamination of foods & milk – Sources & prevention - self study 1L**

#### **2. Food & milk borne diseases 1L**

- Food borne infections – bacterial & viral pathogens
- Food intoxications – bacterial & fungal toxins

#### **3. Methods in Food Microbiology 10L**

- Physical methods – Impedance, microcalorimetry, flow cytometry
- Chemical methods – Detection of thermostable nuclease, endotoxins, ATP, radiometry, chromogenic substrates
- Molecular methods - phage typing, PCR, PAGE, DNA probes, RFLP
- Immunological methods – serotyping, FAT, RIA, ELISA
- Bioassay methods – suckling mouse, ligated loop technique, cell cultures (HeLa and human fetal cells)

#### **4. Food sanitation & control of food safety 3L**

- Microbiological standards of foods – criteria, purpose & difficulties & Sanitary quality of foods – indicator microbes & total microbial load
- HACCP/ISO – definitions, principles of HACCP, guidelines for application of HACCP system

## UNIT 3: UPSTREAM BIOPROCESS TECHNOLOGY 15 LECTURES

### LEARNING OBJECTIVES

- Gain knowledge of Fermenter design & basic concepts of microbial biotechnology
  - Understand basic application of fermentation technology
- 

### 1. Introduction 7L

- Historical Aspects
- Scope, concept & range of Fermentation technology
- Design of a typical aerobic fermentor
- Parameters to be considered in designing a typical fermentor

### 2. Overview of a fermentation process 8L

- Development of Industrial Process Upstream Processing of typical aerobic, submerged batch fermentation – requirements & scale –up
- Fermentation media
- Screening of industrially useful microbes – ideal characteristics, primary & secondary screening
- Stock cultures – primary & working stock cultures, preservation & inoculum preparation & scale-up of culture for a fermentation process

### CIA: Assignment

#### References: -

1. Food Microbiology, Frazier & Westhoff, 4<sup>th</sup> edition, Tata McGraw Hill Publications
2. Modern Food Microbiology, James Jay, 7<sup>th</sup> edition, Springer Publications
3. Food Microbiology by Adams & Moss, 3<sup>rd</sup> edition, The Royal Society of Chemistry
4. Advances in Biotechnology, S. N. Jogdand, Himalaya Publishing House
5. Milk & Milk Products, C. Eckles, 4<sup>th</sup> edition, Tata McGraw Hill Publications
6. Brock Biology of Microorganisms Michael.T.Madigan, John.M.Martinko, Paul V. Dunlap, David P. Clark, 12th edition, Pearson International edition 2009
7. Industrial Microbiology” 2009 Reprint, Casida L. E., New Age International (P) Ltd, Publishers, New Delhi
8. Principles of Fermentation Technology Stanbury P. F., Whitaker A. & Hall--S. J., 1997, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
9. A Textbook of Industrial Microbiology Crueger W. and Crueger A. 2000 Biotechnology, 2nd Edition, Panima Publishing Corporation, New Delhi.
10. Industrial Microbiology 1982, Prescott and Dunn's, 4th Edition, McMillan Publishers

11. Industrial Microbiology, A. H. Patel, Macmillan Publishers India Limited
12. Fermentation Technology, H. A. Modi, 2009, Vols 1 & 2, Pointer Publications, India
13. Microbial Technology, Pepler, H. J. and Perlman, D. (1979), Vol 1 & 2, Academic Press

## SEMESTER 4

## COURSE: S.MIC.4.PR

### VIROLOGY AND IMMUNOLOGY

1. Agarose gel and polyacrylamide gel electrophoresis of serum
2. Lymphocyte separation, staining, checking viability
3. Phage assay

**CIA:** Phage Assay

### ENVIRONMENTAL MICROBIOLOGY

1. Study of air flora: Qualitative and quantitative, Liquid impingement and Gravity sedimentation methods
2. Study of aquatic flora: Qualitative and quantitative, isolation of agar digesters, isolation of haloduric and halophilic bacteria
4. Study of soil flora isolation - qualitative & quantitative (bacteria, fungi and actinomycetes), enrichment/ isolation of – cellulose degraders, starch hydrolysers, ureolytic, saccharolytic organisms, nitrosifiers, nitrifiers and sulphate reducers, Cultivation of anaerobes.
3. Isolation of *Azotobacter* and *Rhizobium*
4. Analysis of potable water: SPC Presumptive, confirmed and completed test, detection of fecal enterococci and *Clostridium* species, determination of coliform count in water by MPN, Membrane filtration technique
5. Waste water analysis: Physical (TDS), Chemical (COD), Biological (BOD), Microbiological study of raw and treated sewage
6. Isolation and identification of a bacterial isolate

**CIA:** Project in Environmental Microbiology

### FOOD MICROBIOLOGY AND UPSTREAM BIOPROCESS TECHNOLOGY

1. Study of food spoilage organisms
2. Study of organisms causing food borne infections
3. TDP and TDT determination
4. Food preservation - MIC & tolerance of sugar and salt
5. Microbiological analysis of milk - DMC, SPC, coliform, psychrophilic & thermophilic counts, RRT, MBRT, phosphatase test
6. Isolation of an antibiotic producer
7. Study of antibacterial spectrum of antibiotic producers
8. Isolation of amino acid producers

**CIA:** MIC of an antimicrobial agent

**VISITS:** Educational visits relevant to Environmental Microbiology

# SYLLABUS UNDER AUTONOMY

## TYBSc MICROBIOLOGY (2013-14)

**INDUSTRIAL BIOTECHNOLOGY AND GENETICS**

**S.MIC. 5.01**

### OVERALL LEARNING OBJECTIVES

- Understand the basic concepts of downstream processing in fermentation technology
  - Study various microbial biotechnological processes
  - Understand basic concepts of mutations and DNA repair
  - Understand the regulatory mechanisms of gene expression in prokaryotes, eukaryotes and bacteriophages
- 

### UNIT – 1 DOWNSTREAM PROCESSING OF FERMENTATION PRODUCTS 15 LECTURES

#### LEARNING OBJECTIVES

- Understand the principles involved in downstream processing
  - Understand the steps of fermentation product recovery
  - Understand the principles underlying detection of the recovered products
  - Apply learnt concepts to study different fermentation processes
- 

1. Overview of fermentation process **1L**
2. General overview & Principles of - Criteria for choice of recovery process **1L**
3. Biomass separation from fermentation media (Biomass as a fermentation product – Bakers yeast) **1L**
4. Cell Disruption for intracellular products (Growth factors or dietary supplements as a fermentation product - Vitamin B<sub>12</sub>) **1L**
5. Whole broth processing **1L**
6. Solvent extraction (Penicillin fermentation) **1L**
7. Detection & Assay methods of the fermentation products **1L**
8. Microbiological assay of penicillin & vitamin B<sub>12</sub> **3L**
9. Fermentation Process (Flow charts) **5L**
  - Penicillin fermentation
  - Vitamin B<sub>12</sub>
  - Amylase production
  - Beer making
  - Acetone Butanol Fermentation

**UNIT – 2 MICROBIAL BIOTECHNOLOGY**  
**LEARNING OBJECTIVES**

**15 LECTURES**

- Understand significance of biosensors and nanotechnology
  - Understand applied biotechnological processes
  - Introduce concepts of Intellectual property rights & Good manufacturing practices
- 

1. Introduction to biosensors, biochips & nanotechnology **2L**
  - Definitions, Examples, Applications
2. Biofuel production from biomass **3L**
  - Bioethanol, Biogas, Biohydrogen
3. Microbial enhanced oil recovery (MEOR) process **1L**
4. Microbial ore leaching **2L**
5. Biopesticides & Biofertilizers **3L**
6. Social & ethical issues of biotechnology **1L**
7. Biowarfare (self study) **1L**
8. Intellectual property rights - patents, trade secrets, copyrights and trademarks, GMP, Quality Assurance, Biosafety **2L**

**UNIT 3: MUTATIONS & DNA REPAIR IN PROKARYOTES**

**15 LECTURES**

**LEARNING OBJECTIVES**

- Understand the basic concept of forward & reverse mutations
  - Understand the consequences of mutations
  - Understand the various DNA repair mechanisms
- 

**MUTATIONS IN PROKARYOTES**

**10 LECTURES**

**1. Forward Mutations:**

- **Types of mutations:** macrolesions, microlesions
- a. Genotypic consequences of point mutations
    - i. Base pair substitutions – transitions & transversions
    - ii. Insertions & deletions
  - b. Phenotypic consequences of point mutations
    - i. missense mutations, nonsense mutations, silent mutations, neutral mutations
    - ii. frameshift mutations
    - iii. pleiotropic mutations, cryptic mutations
- Definitions - alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, prototrophs & auxotrophs

- **Causes of Mutations:**

- i. Natural/spontaneous mutation - replication error, depurination, deamination, oxidative damage, hotspots, Fluctuation test
- ii. Induced mutation: principle and mechanism with illustrative diagrams for
  - a. Chemical mutagens- base analogues, base modifying agents like nitrous acid, hydroxyl amine, alkylating agents and intercalating agents
  - b. Physical mutagen – ultra violet radiations, X- rays
  - c. Biological mutagen – plasmids & transposons

## **2. Reverse Mutations:**

Suppressor mutation types – intragenic & extragenic, conditional remedial mutations  
Ames test

## **3. Detection of mutants:**

- i. Selection based on relative growth – direct selection
- ii. Selection based on relative survival - indirect selection – penicillin enrichment, phenotypic lag, sib selection
- iii. Selection based on visual detection

## **4. Mutations in bacteriophages**

- i. Complementation test – intergenic & intragenic
- ii. Phenotypic mixing of phages

## **DNA REPAIR IN PROKARYOTES**

## **5 LECTURES**

**1. Light repair** – direct reversal of DNA damage - Photoreactivation

**2. Dark repair**

- a. Excision repair
  - Mismatch repair
  - Base excision repair
  - Nucleotide excision repair
- b. Tolerance to DNA damage
  - Recombination repair – Post dimer synthesis
  - Error Prone / SOS repair – Trans dimer synthesis
- c. Repair of alkylated DNA – direct reversal

## **UNIT 4: REGULATION OF GENE EXPRESSION 15 LECTURES**

### **LEARNING OBJECTIVES**

- Understand the basic concept of regulation
  - Understand the significance of regulation in prokaryotes, eukaryotes and bacteriophages
-

## **Regulation of gene expression in prokaryotes, eukaryotes and bacteriophages**

### **15 LECTURES**

#### **1. Prokaryotes**

i. Operon model – criteria for negative /positive types & inducible / repressible types

ii. Examples

- Lac operon regulation, types of lac mutants, isolation of lac mutants, Positive control: Catabolite repression of lac operon
- Trp operon regulation - repressor control & attenuator control

#### **2. Phages**

Regulation of lytic & lysogenic life cycle in bacteriophage  $\lambda$

#### **3. Eukaryotes**

- Cell signaling-an introduction to signaling molecules and their receptors, functions of cell surface receptors, pathways of intracellular signal transduction, signaling networks
- Cell cycle-regulators of eukaryotic cell cycle progression
- Cell Death-programmed cell death- events of apoptosis, caspases, central regulators of apoptosis
- Molecular mechanisms of activation of proto-oncogenes

#### **CIA: Quiz and Assignment**

#### **References: -**

1. Industrial Microbiology 2009 Reprint, Casida L. E., New Age International (P) Ltd, Publishers, New Delhi
2. Principles of Fermentation Technology Stanbury P. F., Whitaker A. & HaII--S. J., 1997, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Industrial Microbiology, A. H. Patel, Macmillan Publishers India Limited
4. A Textbook of Biotechnology, R.C. Dubey, 2010, S. Chand and Co Ltd.
5. Advances in Biotechnology, S. N. Jogdand, 2007, 2<sup>nd</sup> edition
6. Genetics – a molecular approach, Peter Russell, 3<sup>rd</sup> edition, Pearson Publications
7. Molecular Biology of the gene, JD Watson, Baker, Bell, 4<sup>th</sup> / 5<sup>th</sup> edition, Pearson Education Publications
8. Concepts of Genetics 7<sup>th</sup> edition, Klug & Cummings, Pearson Education Publications
9. Genes IX, Lewin, Oxford Publications
10. Lehninger's Principles of Biochemistry, D. Nelson & M. Cox, 5<sup>th</sup> edition, Macmillan Worth Publications
11. Brock Biology of microorganisms, M. Madigan, J. Martinko, J. Parkar, (2009), 12<sup>th</sup> ed., Pearson Education International
12. The Cell: A Molecular Approach, Geoffrey Cooper, Robert Hausman, 5<sup>th</sup> edition, ASM Press

**MEDICAL MICROBIOLOGY AND IMMUNOLOGY: I**  
**60 LECTURES**

**COURSE: S.MIC.5.02**

**OVERALL LEARNING OBJECTIVES**

- Understand the principles underlying the field of chemotherapy
  - Get an overview of clinical microbiology
  - Study significant microbial pathogens with respect to the respiratory tract and the infections caused by them
  - To understand basic principles of Immunology
- 

**UNIT 1: CLINICAL MICROBIOLOGY (DIAGNOSTICS) AND RESPIRATORY TRACT INFECTIONS**  
**15 LECTURES**

**LEARNING OBJECTIVES:**

- Get an overview of the diagnostic methods used in a Clinical Microbiology lab and understand the principles underlying them
  - Understand with respect to the respiratory tract :
    - The anatomy and function of the system and its defenses against microorganisms
    - The clinical syndromes that characterize the tract related infections
    - The modes of transmission, pathogenesis, diagnosis, prophylaxis and treatment with respect to some significant microbial pathogens that infect the system
- 

**Note:** All infections labeled **ii.** to be covered with respect to all details - emphasis on Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis, Treatment.

All infections labeled **iii.** to be covered with respect to General Aspects

**1. Introduction to Medical Microbiology 1L**

**2. Clinical Microbiology (Diagnostics) 2L**

- Specimens : Collection, Handling, Transport
- Identification of Microorganisms from Specimens:
- Microscopy
- Growth and Biochemical Characteristics
- Rapid Methods of Identification
- Immunologic Techniques
- Bacteriophage Typing
- Molecular Methods and Analysis of Metabolic Products

- Computers in Clinical Microbiology
- Concepts of Quality Assurance in Diagnostics

### **3. Respiratory tract Infections 12L**

- Upper respiratory tract:
  - i The anatomy and function of the upper respiratory tract and host defenses
  - ii Streptococcal Pharyngitis, Diphtheria
  - iii Common Cold , Oral Candidiasis , Measles- Rubeola, Rubella, Mumps , Chicken pox, Shingles
- Lower Respiratory tract:
  - i The anatomy and function of the lower respiratory tract and host defenses
  - ii. Tuberculosis , Influenza , H1N1, Avian Influenza
  - iii Bacterial pneumonia , Whooping cough , SARS

## **UNIT 2: ANTIMICROBIAL CHEMOTHERAPY**

**15 LECTURES**

### **LEARNING OBJECTIVES**

- Understand the characteristics of an ideal chemotherapeutic agent
  - Get an overview of the principal groups of antibacterial agents, their modes of action and examples
  - Get familiar with the range of antimicrobial agents
  - Understand drug resistance
  - Know the methods of testing presently being used
- 

### **1. Basics of Chemotherapy 3L**

- History and Development of Chemotherapy
- General Properties of antimicrobial agents
- Attributes of an ideal antimicrobial agent

### **2. Drug Resistance: Origin, Mechanisms and Transmission 3L**

### **3. Selection & Testing 2L**

### **4. Principal Groups of Antibacterial Agents and Mechanism of Action 4L**

- Cell Wall Inhibitors
- Inhibitors of Protein Synthesis
- Inhibitors of Nucleic Acid Synthesis
- Cell Membrane Disruptors
- Antimetabolites

**5. Anti-mycobacterial, Antifungal, Antiviral, Antiprotozoal drugs 1L**

- Tabulation of Examples

**6. Principles of Ayurveda & other forms of alternative medicine 1L**

**7. Concepts of Drug Design, Clinical Research & Pharmacogenomics 1L**

**UNIT 3: FUNDAMENTALS OF IMMUNOLOGY**

**15 LECTURES**

**LEARNING OBJECTIVES**

- Understand processes involved in immune cell development
  - Understand structure and function of MHC molecules
  - Understand Complement activation pathways, their significance and regulation
- 

**1. Overview of the immune system 1L**

**2. Cells of the immune system- T-cells, B-cells, NK-cells 6L**

- Development and Maturation of T cells- Receptors, structure and organization, positive and negative selection
- Development and Maturation of B cells -Receptors----structure & organization

**3. Major Histocompatibility Complex 4L**

- Organization of MHC genes
- Structure of class I and class II molecules
- Polymorphism and Polygenism
- T cell antigen receptors and MHC molecules.
- Tests for MHC specificity.

**4. Complement system 4L**

- Complement components and notations
- Complement activation (classical pathway, Alternate pathway, Lectin pathway)
- Biological consequences of complement activation.
- Regulation of complement pathways.

**UNIT 4: ADAPTIVE IMMUNE RESPONSE**

**15 LECTURES**

**LEARNING OBJECTIVES**

- Understand the significance of antigen presenting cells

- Understand cellular interactions and activation of immune cells in response to foreign antigen
- 

### **1. Antigen Presenting Cells 1L**

### **2. Antigen presentation and processing pathways 2L**

- Cytosolic pathway
- Endocytic pathway

### **3. Cytokines 2L**

- Properties and Functions
- Cytokines secreted by Th1 and Th2 cells

### **4. T cell activation and differentiation 2L**

- Generation of effector and memory cells.
- Cell death and T cell population.
- Functions of peripheral  $\alpha\beta$  and  $\gamma\delta$  cells

### **5. B cell activation & differentiation 2L**

- Thymus dependent and independent antigens.
- B cell activating signals
- Role of T<sub>H</sub> cells in humoral response, formation of T&B conjugates
- CD40/CD40L interaction, T<sub>H</sub> cell cytokine signals.

### **6. Humoral response 3L**

- Induction of Humoral response, Primary and secondary responses,
- Germinal centers and antigen induced B cell differentiation
- Affinity maturation and somatic hyper mutation, class switching
- Generation of plasma cells and memory cells, synthesis, assembly and secretion of immunoglobulins.
- Evaluation of humoral response.

### **7. Cell mediated effector response 3L**

- Generation and target destruction by Cytotoxic T cells.
- Killing mechanism of NK cells.
- Antibody dependent cell cytotoxicity (ADCC)
- Experimental assessment of CM cytotoxicity.

**CIA: Quiz**

## References:-

1. Textbook of Microbiology, Ananthanarayan and Paniker, (2009), 8th Edition. Universal Press
2. Medical Microbiology, Cedric Mims et al, 3rd Edition Mosby
3. Microbiology, Prescott, Harley, Klein, 6th Edition McGraw Hill
4. Diagnostic Microbiology, Koneman, 5th and 6th Edition. Lippincott
5. Understanding Viruses, Teri Shors Jones, Bartlett Publishers
6. Introduction to Microbiology, Ingraham and Ingraham, 2<sup>nd</sup> Edition, Thomas Learning Inc
7. Immunology, Richard A. Goldsby, Janis Kuby, 6th Edition. W. H. Freeman and Company.
8. The elements of Immunology, Fahim Halim Khan, Pearson Education.
9. Immunology, An Introduction Ian R. Tizard, 4th - Edition, Saunders College Publishing
10. Immunobiology, Janeway, C, 6th edition, Garland Science Publishers

**SEMESTER 5**

**COURSE: S.MIC.5.PR**

**INDUSTRIAL MICROBIOLOGY AND GENETICS**

1. UV survival curve and repair– determination of exposure time leading to 90% reduction
2. Isolation of mutants using UV mutagenesis-Viable Count
3. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant
4. Study of Diauxy
5. Paper chromatography, TLC & Column Chromatography
6. Bioassay of Penicillin & Vitamin B<sub>12</sub>
7. Study of biofertilizers

**CIA:** Projects based on Industrial Microbiology

**MEDICAL AND IMMUNOLOGY PART I**

1. Kirby-Bauer method (antibacterial & antifungal activity) and Stokes method for AST
2. Study of antimicrobial effects of natural products
3. Synergistic activity of antibiotics.
4. Detection of  $\beta$ -lactamase producer by Acidometric/Iodometric method
5. Schematic /diagrammatic representation of Respiratory tract
6. Diagnostic Cycle of any one infection of the above system (viz., in upper respiratory tract: Pharyngitis)
7. Case study and problem solving for identification of the pathogen and antibiotic sensitivity with reference to each of the infections
8. Quality control tests of media, reagents, strains and equipment used in the syllabus.

**CIA:** Technique – Medical

# SYLLABUS UNDER AUTONOMY

## TYBSc MICROBIOLOGY (2013-14)

### GENETICS, MOLECULAR BIOLOGY & BIOINFORMATICS

60 LECTURES

COURSE: S.MIC. 6.01

#### OVERALL LEARNING OBJECTIVES

- Basic understanding of recombination in bacteria
  - Understand and apply tools and techniques involved in Genetic Engineering and Bioinformatics
  - Develop analytical skills, problem solving & critical thinking
- 

#### UNIT 1: TYPES OF GENETIC EXCHANGE

15 LECTURES

#### LEARNING OBJECTIVES

- Understand the basic concept of genetic exchange -transformation, transduction & conjugation
- 

#### 1. Transformation 5L

- Introduction and History
- Types of transformation in prokaryotes
  - i. Natural transformation in *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Bacillus subtilis*,
  - ii. Artificial transformation in *E. coli*
- Mapping of bacterial genes using transformation
- Problems based on transformation

#### 2. Conjugation 5L

- Discovery of conjugation in bacteria
- The conjugation machinery
- Hfr strains, their formation and mechanism of conjugation
- F' factor, origin and behavior of F' strains, Sexduction
- Mapping of bacterial genes using conjugation (Wolman and Jacob experiment)
- Problems based on conjugation

### 3. Transduction 5L

- Introduction and discovery
- Generalized transduction, Use of Generalized transduction for mapping genes
- Specialized transduction – HFT & LFT
- Problems based on transduction

## UNIT 2: GENETIC RECOMBINATION & PLASMIDS 15 LECTURES

### LEARNING OBJECTIVES

- Understand the consequences of recombination in bacteria
  - Understand transposition in bacteria
  - Knowledge of different plasmids
- 

### 1. Types of recombination 5L

- Legitimate -
  - i. Homologous or general recombination - Holliday model, recombination enzyme system
  - ii. Site specific recombination –  $\lambda$  phage integration & Hin inversion
- Illegitimate Recombination

### 2. Transposition 5L

- Types - Insertion sequence (IS) element & Composite & complex transposons (Tn) in prokaryotes
- Structure and properties
- Mechanism of transposition – Replicative & Non-replicative
- Demonstration of transposition
- Ty elements of yeast

### 3. Plasmids 5L

- Properties of plasmids
- Detection and isolation of plasmids
- Plasmid incompatibility
- Plasmid curing
- Cell to cell transfer of plasmids
- Types of plasmids
  - i. F factor
  - ii. Resistance Plasmids,
  - iii. Plasmids encoding Toxins and other Virulence Characteristics

- iv. Col factor
- v. Degradative plasmids
- vi. Ti plasmid

### **UNIT 3: BASIC TECHNIQUES IN RECOMBINANT DNA TECHNOLOGY 15 LECTURES**

#### **LEARNING OBJECTIVES:**

- Understand the basic steps involved in gene cloning
- 

#### **1. Model Organisms 1L**

- Characteristics of a model organism
- Examples of model organisms used in study

#### **2. Restriction & Modification in bacteria 2L**

- Restriction endonucleases – Type 1, 2 & 3
- Modification enzymes – methylation by methylase enzyme

#### **3. DNA techniques and Gene Cloning**

- PFGE, 2-d electrophoresis
- Southern, Northern & Western blotting
- DNA sequencing – Sanger's manual & automated methods
- Vectors – cloning & expression vectors (plasmids, phages, cosmids, shuttle vectors, YAC, BAC)
- Restriction enzymes, ligases, adaptors and linkers
- Basic PCR and different types of PCR (RT-PCR, qPCR, LA-PCR)
- Genomic and cDNA libraries, DNA synthesizer
- Overview of the steps involved in gene cloning
- Screening methods for identification and isolation of recombinant clones and products

### **UNIT 4: APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY & BIOINFORMATICS - PROTEIN SEQUENCE ANALYSIS 15 LECTURES**

#### **LEARNING OBJECTIVES:**

- Understand the applications of gene cloning
  - Understand the applications of bioinformatics in genomic and proteomic studies
-

## **1. Applications of Recombinant DNA Technology 7L**

- Strain Improvement to increase fermentation yield
- Transgenic plants - Bt cotton, Golden rice
- Animal Pharming
- Insulin production
- Metagenomics
- Gene therapy
- DNA fingerprinting

## **B. Bioinformatics 10 LECTURES**

1. Pair-wise sequence alignment – Revise Retrieval of sequences & tools used to analyze nucleotide and protein sequences
2. 16SrRNA analysis
3. Multiple sequence alignment - PIR - CLUSTAL W, T-COFFEE
4. Phylogenetic analysis - Phylogenetic tree
5. PDB
6. Use of Bioedit and Spdbv software

## **CIA: Problem Solving & Quiz**

### **References: -**

1. Genetics – a molecular approach, Peter Russell, 3<sup>rd</sup> edition, Pearson Publications
2. Molecular Biology of the gene, JD Watson, Baker, Bell, 4<sup>th</sup> / 5<sup>th</sup> edition, Pearson Education Publications
3. Concepts of Genetics 7<sup>th</sup> edition, Klug & Cummings, Pearson Education Publications
4. Genes IX, Lewin, Oxford Publications
5. Genetics a conceptual approach, Benjamin A. Pierce (2008), 3rd ed., W. H. Freeman and company
6. Lehninger's Principles of Biochemistry, D. Nelson & M. Cox, 5<sup>th</sup> edition, Macmillan Worth Publications
7. Advanced Molecular Biology, R. M. Twyman, Viva Books Private Limited
8. Brock Biology of microorganisms, M. Madigan, J. Martinko, J. Parkar, (2009), 12<sup>th</sup> ed., Pearson Education International
9. Genetics, Fairbanks and Anderson, (1999), Wadsworth Publishing Company
10. Principles of genetics, R. H. Tamarin, (2004), Tata McGraw Hill
11. Introduction to Bioinformatics, Arthur Lesk, 3<sup>rd</sup> edition, Oxford University Publications
12. Introduction to Bioinformatics, T. K. Attwood & D. J. Parry-Smith, (2003), Pearson Education Publications

13. Bioinformatics, David Mount, 2<sup>nd</sup> edition, Cold Spring Harbor Laboratory Press

## **MEDICAL MICROBIOLOGY AND IMMUNOLOGY: II**

**60 LECTURES**

**COURSE: S.MIC.6.02**

### **OVERALL LEARNING OBJECTIVES**

- Study significant microbial pathogens with respect to the various systems of the human body ( except respiratory tract) and the infections caused by them
  - Understand the significance of Nosocomial infections, their modes of spread and control
  - Understand basic principles and concepts of immunization and transplantation
  - Understand concepts of clinical immunology and immunohematology
  - Knowledge of antigen antibody reactions and their applications
- 

### **UNIT 1: GASTRO INTESTINAL AND CNS INFECTIONS (15 LECTURES)**

#### **LEARNING OBJECTIVES**

- Understand with respect to the gastro-intestinal and central nervous systems:
    - The anatomy and function of the system and its defenses against microorganisms
    - The clinical syndromes that characterize the tract related infections
    - The modes of transmission, pathogenesis, diagnosis, prophylaxis and treatment with respect to some significant etiological microbial pathogens that infect the system
- 

**Note:** All infections labeled **ii.** to be covered with respect to all details - emphasis on Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis, Treatment.

All infections labeled **iii.** to be covered with respect to General aspects

#### **1. Gastro – Intestinal Infections 9L**

- i. The anatomy and function of the gastro intestinal tract and its host defenses
- ii Infectious diseases caused by *Salmonella*, *Shigella* , *Vibrio*  
Food Poisoning: Staphylococcal, Botulism
- iii Infectious diseases caused by *E.coli*, *Helicobacter pylori*, *Campylobacter*, Rota virus, *Hepatitis A & E*, *E.histolytica*

#### **2. Central Nervous System Infections 6L**

- i. The anatomy and function of the central nervous system and its host defenses

- ii. Tetanus, Polio, Rabies
- iii. Meningitis: viral, bacterial -Meningococcal, Pneumococcal and *Haemophilus*

## **UNIT 2: SEXUALLY TRANSMITTED, HOSPITAL & URINARY TRACT INFECTIONS AND INFECTIONS WITH SKIN AS THE PORTAL OF ENTRY**

### **15 LECTURES**

#### **LEARNING OBJECTIVES**

- Understand with respect to the genitourinary tract and skin :
    - The anatomy and function of the system/ skin and its defenses against microorganisms
    - The clinical syndromes that characterize the tract/skin related infections
    - The modes of transmission, pathogenesis, diagnosis, prophylaxis and treatment with respect to some significant microbial pathogens that infect the system
  - Understand the significance of nosocomial infections, the pathogens involved, modes of spread, methods of control and hospital waste management.
- 

**Note:** All infections labeled **ii.** to be covered with respect to all details - emphasis on Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis, Treatment

All infections labeled **iii.** to be covered with respect to General aspects

#### **1. Sexually transmitted Infections 5L**

- i. The anatomy and function of the genitourinary system and its host defenses
- ii. HIV infection, Syphilis
- iii. Gonorrhoea, Herpes, Hepatitis B

#### **2. Hospital Infections 2L**

- Nosocomial Infections
- Modes of Transmission
- Methods of Control
- Hospital waste management

#### **3. Urinary Tract Infections 3L**

- The anatomy and function of the urinary tract and host defenses
- Pathogens & Factors Involved
- Diagnosis, Prevention, Treatment

#### **4. Infections with skin as the portal of entry 5L**

- i The anatomy and function of the skin and its host defenses
- ii. Pyogenic Staphylococcal, Streptococcal infections, Leprosy, Malaria
- iii. Candidiasis, Dermatophytosis, Pseudomonas infections, Leptospirosis, Dengue

### **UNIT 3: IMMUNE SYSTEM IN HEALTH AND DISEASE – PART -I**

#### **15 LECTURES**

#### **LEARNING OBJECTIVES**

- Knowledge of monoclonal antibodies and their applications
  - Knowledge of types of vaccines
  - Basic knowledge of transplantation immunology
- 

#### **1. Monoclonal antibodies 2L**

- Preparation
- Applications
- Engineered antibodies.

#### **2. Vaccines 10L**

- Active and passive immunization
- Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant vector vaccines, DNA vaccines, anti-idiotypic vaccines
- Use of adjuvants in vaccines
- New vaccine strategies
- Ideal vaccine
- Routes of vaccine administration, Vaccination schedule, Failures in vaccination.

#### **3. Transplantation immunology 3L**

- Immunological basis of graft rejection,
- Types of graft rejection, Clinical manifestation of graft rejection,
- General and specific immunosuppressive therapy

### **UNIT 4: IMMUNE SYSTEM IN HEALTH AND DISEASE – PART -II**

#### **15 LECTURES**

#### **LEARNING OBJECTIVES**

- Understand the principles and uses of a range of immunological techniques in current use.

- Understand basic concepts of transfusion medicine
  - Knowledge of autoimmune disorders and hypersensitivity reactions.
- 

### **1. Antigen- Antibody reactions 5L**

- Precipitation,
- Agglutination, passive agglutination, agglutination inhibition,
- Complement Fixation,
- Radioimmunoassays (RIA),
- Enzyme immunoassays (EIA),
- Immunofluorescence,
- Flow cytometry,
- Western blot technique,
- Immunoelectron microscopy,
- Toxin antitoxin assays.

### **2. Immunohematology 4L**

- Human blood group systems, ABO, secretors and non secretors, Bombay Blood group. Rhesus system and list of other blood group systems.
- Haemolytic disease of new born, Coombs test.
- Blood Transfusion, Major and Minor Cross matching, transfusion reactions

### **3. Hypersensitivity – 4L**

- Coombs and Gells classification
- Type I to Type IV hypersensitivity- Mechanism and manifestation.

### **4. Autoimmunity 2L**

- Definition of immune tolerance,
- Immune suppression and autoimmunity
- Spectrum of autoimmune diseases,
- Mechanism and treatment of autoimmune diseases.

### **CIA: Quiz, Assignment**

#### **References:-**

1. Textbook of Microbiology, Ananthanarayan and Paniker, (2009), 8th Edition. Universal Press
2. Medical Microbiology, Cedric Mims et al, 3rd Edition Mosby
3. Microbiology, Prescott, Harley, Klein, 6th Edition McGraw Hill
4. Diagnostic Microbiology, Koneman, 5th and 6th Edition. Lippincott

5. Understanding Viruses, Teri Shors Jones, Bartlett Publishers
6. Introduction to Microbiology, Ingraham and Ingraham, 2<sup>nd</sup> Edition, Thomas Learning Inc
7. Immunology, Richard A. Goldsby, Janis Kuby, 6th Edition. W. H. Freeman and Company.
8. The elements of Immunology, Fahim Halim Khan, Pearson Education.
9. Immunology, An Introduction Ian R. Tizard, 4th - Edition, Saunders College Publishing
10. Immunobiology, Janeway, C, 6th edition, Garland Science Publishers

## **SEMESTER 6**

## **COURSE: S.MIC.6.PR**

### **CLASSICAL GENETICS, MOLECULAR BIOLOGY & BIOINFORMATICS**

1. Preparation of competent cells and transformation
2. Restriction analysis
3. PCR (Demo)
4. Western Blot (Demo)
5. Conjugation (Demo)
6. Genetics problems
7. Bioinformatics
  - A. Off Line
    - i. Sequence Alignment, dot plot, exercises using Bioedit
    - ii. Visualizing and manipulating Protein structure database files using SPDBV
  - B. On Line
    - i. Visiting NCBI and EMBL - Retrieving nucleotide and protein sequences, sequence alignment, use of BLAST and FASTA for sequence analysis
    - ii. Multiple sequence alignment – CLUSTAL W, phylogenetic tree
    - iii. Understand every item mentioned in the report generated its significance and use in interpretation of results as well as limitations of the results.

### **CIA: Bioinformatics**

### **MEDICAL AND IMMUNOLOGY II**

1. Schematic /diagrammatic representation of Urinary tract, Gastro-intestinal tract, Central Nervous System, Skin

2. Diagnostic Cycle of any one infection of the above systems
3. Case study and problem solving for identification of the pathogen and antibiotic sensitivity with reference to each of the infections
4. Blood Grouping, Direct & Reverse Typing
5. Determination of Isoagglutinin titre
6. Coombs test – direct & indirect method
7. Compatibility test – cross matching.
8. Preparation of Typhoid vaccine and sterility checking
9. Antigen – Antibody Reactions: Agglutination – Widal (Demonstration); RPR Qualitative and Quantitative (Demonstration); Immuno diffusion - Ouchterlony; SRID
10. Pregnancy test – ELISA (Demonstration)
11. Rheumatoid arthritis test (Demonstration)

**CIA:** Immunohaematology/Antigen antibody reactions

**Educational Visits/ Blood bank internship**

**DEPARTMENT OF MICROBIOLOGY  
CROSS FACULTY COURSE  
SYLLABUS 2015**

**SEMESTER IV**

**COURSE: SPC0401**

**INFECTIOUS DISEASES: STAYING AHEAD**

**45 LECTURES**

**LEARNING OBJECTIVES:**

- Understand the basic principles and practices involved in the study of Infectious Diseases
- Understand the fundamental mechanisms underlying protective innate immunity

**UNIT 1: INTRODUCTION TO INFECTIOUS DISEASES - 15 lectures**

- History of infectious diseases
- Introduction to the microscopic world
- Microbe human interactions-  
Human as a habitat-resident and indigenous flora of new born and specific regions of the human body
- Infectious disease cycle- an overview
- The causative agent, source or reservoir of the pathogen, modes of transmission, portals of entry, infectious dose, adherence and portals of exit

**UNIT 2: INNATE IMMUNITY, VACCINES AND CHEMOTHERAPY -15 lectures**

- Host defenses –overview and nonspecific defenses  
Innate and adaptive immunity  
First line of defense  
Second line of defense
- Vaccines  
Passive and active immunization  
Principles and effects of vaccination
- Antimicrobial Chemotherapy  
Principles of antimicrobial therapy  
Mechanisms of drug action  
Factors influencing antimicrobial drug effectiveness  
Drug resistance and its significance

**UNIT 3: STUDY OF INFECTIOUS DISEASES -15 lectures**

- Classifying Infectious Diseases  
Occurrence- sporadic, endemic, epidemic, pandemic  
Severity or duration of disease- acute, chronic, sub acute, latent  
Extent of host involvement-local infection, systemic infection, focal infection etc

- Development of Disease  
Stages of Disease- incubation period, prodromal period, period of illness, period of decline, period of convalescence
- Germ theory of disease –Koch's postulates
- Microbial mechanisms of pathogenicity- penetration of host defenses, damage to host cells.
- Study of some infectious diseases- Influenza, TB
- Emerging and re-emerging infections
- Nosocomial infections

**References: -**

1. Foundations in Microbiology, Kathleen Park Talaro, 7<sup>th</sup> edition, McGraw Hill
2. Prescott, Harley, Klein's Microbiology, Wiley, Sherwood, Woolverton, 7<sup>th</sup> edition, McGraw Hill
3. Microbiology, an Introduction, Tortora, Funke, Case, 10<sup>th</sup> edition, Pearson Education