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

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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.

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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

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

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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

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- 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

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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, 5th 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

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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

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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

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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, 5th edition, Macmillan Worth Publications
2. Molecular Biology of the gene, JD Watson, Baker, Bell, 4th / 5th edition, Pearson Education Publications
3. Concepts of Genetics 7th edition, Klug & Cummings, Pearson Education Publications
4. Genes IX, Lewin, Oxford Publications
5. Genetics – a molecular approach, Peter Russell, 3rd edition, Pearson Publications
6. Introduction to Bioinformatics, Arthur Lesk, 3rd 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, 2nd edition, Cold Spring Harbor Laboratory Press
10. A Biologist's Guide to Principles & Techniques of Practical Biochemistry, 2nd edition, Williams & Wilson, E. Arnold Publications

SEMESTER 3 **COURSE: S.MIC.3.PR**

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 Km 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