



# St. Xavier's College (Autonomous) Mumbai

## M.Sc. Syllabus For 1<sup>st</sup> Semester Courses in **Microbiology** (June 2018 onwards)

### Contents:

Theory Syllabus for Courses:

SMIC0701 - **VIROLOGY**

SMIC0702 - **GENETICS**

SMIC0703 - **MICROBIAL BIOCHEMISTRY I**

SMIC0704 - **IMMUNOLOGY**

SMIC07PR Practical Syllabus for the following Courses:

**LABORATORY AND SCIENTIFIC COMMUNICATION SKILLS**

**GENETICS**

**VIROLOGY**

**MICROBIAL BIOCHEMISTRY**

**IMMUNOLOGY**

**Title: VIROLOGY**

**Course: SMIC0701**

**LEARNING OBJECTIVES**

1. Understand the structure and replication of bacteriophages, plant and animal viruses
2. Understand prions as infectious agents
3. Understand the methods of study of viruses
4. Understand viral evolution and related consequences such as viral emergence

**Number of lectures: 60**

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**UNIT 1: INTRODUCTION TO VIROLOGY, TECHNIQUES IN VIROLOGY AND STUDY OF BACTERIOPHAGES** **15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand the architecture and classification of viruses
2. Understand the replication of bacteriophages.
3. Understand the techniques used in virology

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|---|-----------|
| <b>1. Introduction to Virology</b>                                    | <b>2L</b> |
| • Virus architecture and nomenclature                                 |           |
| • Classification of viruses   |           |
| <b>2. Techniques in virology</b>                                      | <b>5L</b> |
| • Measurement of biological activity                                  |           |
| • Viral structural proteins   |           |
| • Analysis of genome  |           |
| • <i>In situ</i> hybridization, Microarray-based methods              |           |
| <b>3. Single/double-stranded DNA and RNA phages of <i>E. coli</i></b> | <b>8L</b> |
| • Structure, gene organization and replication of                     |           |
| i. T4 phage   |           |
| ii. T7 phage  |           |
| iii. $\lambda$ Phage  |           |

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**UNIT 2: STUDY OF PLANT VIRUSES, VIROIDS, AND INSECT VIRUSES** **15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand the structure and replication of plant viruses and viroids.
2. Understand the structure and significance of insect viruses.

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| <b>1. Impact of plant viruses</b>  | <b>2L</b> |
| • Symptoms of plant viral diseases: macroscopic, histological, cytological |           |
| • Economic impact with the help of one recent example                      |           |
| • Strategies of plant virus control  |           |

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| <b>2. Replication strategies of plant viruses</b>  | <b>7L</b> |
| • Strategies to overcome eukaryotic translational constraints                                      |           |
| • Replication strategies of plant viruses with different nucleic acid types with relevant examples |           |
| <b>4. Plant-virus interactions</b>   | <b>2L</b> |
| • Movement of the virus within plants  |           |
| • RNA silencing  |           |
| <b>5. Agents that resemble plant viruses</b>   | <b>2L</b> |
| • Viroids  |           |
| • Satellite viruses and satellite RNAs   |           |
| <b>6. Baculoviruses (Insect viruses)</b>   | <b>2L</b> |
| • Significance   |           |
| • Viral structure  |           |
| • Genome   |           |
| • Host range   |           |
| • Transmission   |           |

### **UNIT 3: PATHOGENIC ANIMAL RNA VIRUSES AND PRIONS 15 LECTURES**

#### **LEARNING OBJECTIVES**

1. Understand the structure and replication of RNA viruses causing significant diseases in animals.
2. Understand prions and prion mediated pathogenesis in humans.

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|--|-----------|
| <b>1. Introduction to RNA viruses-</b>   | <b>4L</b> |
| • Constraints faced by RNA viruses in eukaryotic hosts   |           |
| • General strategies used by animal RNA viruses  |           |
| <b>2. Double stranded RNA viruses- Reoviruses- e.g. Rotavirus</b>  | <b>2L</b> |
| <b>3. Single-stranded RNA viruses with negative sense –Orthomyxoviruses- e.g. Influenza viruses</b>          | <b>2L</b> |
| <b>4. Single-stranded RNA viruses with positive sense-Picornaviruses- e.g. Polio Virus</b>                   | <b>2L</b> |
| <b>5. Single-stranded RNA viruses with reverse transcriptase- Retroviruses- Human Immunodeficiency Virus</b> | <b>3L</b> |

- 6. Prions** **2L**
- History
  - Proteins involved and “Protein only” Hypothesis
  - Diseases
    - i. CJD
    - ii. BSE

**UNIT 4: PATHOGENIC ANIMAL DNA VIRUSES, VIRUS EVOLUTION, EMERGING VIRUSES AND ANTIVIRALS** **15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand the structure and replication of DNA viruses causing significant diseases in animals.
2. Study virus evolution and the emergence of new and re-emerging animal viruses affecting human health.
3. Study antiviral drugs used to treat/prevent viral diseases

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- 1. Double-stranded DNA viruses-** Herpes viruses- e.g. HSV, EBV **2L**
- 2. Double-stranded DNA-RT viruses-**Hepadna viruses- e.g. Hepatitis B virus **3L**
- 3. Single-stranded DNA virus-** Parvoviruses **1L**
- 4. Viral evolution** **4L**
- Host-parasite theory
  - r and k replication strategies.
  - Quasispecies concept
  - Error threshold, lethal mutagenesis, and extinction
  - Genetic bottlenecks
  - Origin of viruses
- 5. New and re-emerging animal viruses** **2L**
- Evolution, Emergence, and adaptation
  - Sources and causes of emergent viruses
    - i. Ecological factors
    - ii. Climate variability
    - iii. Human factors- social behavior
    - iv. Exposure to zoonotic diseases
    - v. Human movement
  - Example: one recent example of an outbreak of an emerging virus
- 6. Anti viral Drugs** **3L**
- Screening for Antiviral Compounds
  - Designer antivirals and computer-based searching
  - Examples of approved drugs and resistance

- Searching for new targets
- Antiviral Gene Therapy

### **CIA: Test, Model making**

#### **References:-**

##### Unit 1

1. Basic Virology, Wagner E, K, Hewlett, M.J, Bloom, D.C., Camerini, D, 3<sup>rd</sup> ed., 2008, Blackwell Publishing.
2. Freifelder's Essentials of Molecular Biology, 4<sup>th</sup> ed., 2015, Malacinski GM
3. Microbial Genetics, Maloy, S.R.; Cronan, J.E.; Freifelder, David; 2<sup>nd</sup> ed., 1994, Jones and Bartlett Publishers.
4. Microbiology – Davis, B.D, Dulbecco, R, Eisen, H.N., and Ginsberg, H.S., 4<sup>th</sup> ed., 1990, Lippincott, Philadelphia
5. Molecular Biology, Freifelder, D.; 2<sup>nd</sup> ed., 1987, Narosa Publishing H.
6. The Biology of Viruses, Voyles B. A., 2<sup>nd</sup> ed., 2002, McGraw-Hill higher education.

##### Unit 2

1. Comparative Plant Virology, Hull, R., 2<sup>nd</sup> ed., 2013, Academic Press.

##### Unit 3

1. Basic Virology, Wagner E, K; Hewlett, M.J, Bloom, D.C., Camerini, D, 3<sup>rd</sup> ed., 2008, Blackwell Publishing.
2. Principles of Virology, Flint,S.J.; Enquist, L.M.; Racaniello, V.R; and Skalka, A.M. 3<sup>rd</sup> ed., 2009, Vol I and II, ASM.
3. Understanding Viruses –Shors, T., 3<sup>rd</sup> ed., 2017, Jones and Bartlett Publishers.

##### Unit 4

1. Basic Virology, Wagner E, K, Hewlett, M.J, Bloom, D.C., Camerini, D, 3<sup>rd</sup> ed., 2008, Blackwell Publishing.
2. Principles of Virology - Flint,S.J., Enquist, L.M.; Racaniello V.R; and Skalka, A.M. 3<sup>rd</sup> ed., 2009, Vol I and II, ASM.
3. Understanding Viruses - Shors,T., 3<sup>rd</sup> ed., 2017, Jones and Bartlett Publishers.

**Title: GENETICS**

**Course: SMIC0702**

**LEARNING OBJECTIVES**

1. Understand concepts involved in recombination, mutations, repair and regulation of gene expression in bacteria and eukaryotes
2. Understand concepts of cytoplasmic inheritance and transposable elements in eukaryotes
3. Understand viral genetics and study applications based on gene transfer
4. Study the genetic basis of cancer

**Number of lectures: 60**

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**UNIT 1: GENE EXPRESSION AND ITS REGULATION**

**15 LECTURES**

**LEARNING OBJECTIVES**

Understand gene expression and its regulation in prokaryotes and eukaryotes

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**A. GENE EXPRESSION IN EUKARYOTES**

**5L**

**1. Transcription**

- Transcription process
- Post transcriptional processing- structure of mRNA, pre-mRNA processing, addition of 5' cap, addition of Poly (A) tail, RNA splicing, RNA editing.
- Small RNA molecules- RNA interference, types, processing and function of microRNAs

**2. Translation**

- Mechanism of translation, mRNA surveillance.
- Post translational modification of proteins

**B. REGULATION OF GENE EXPRESSION**

**10L**

**1. Control of gene expression in prokaryotes**

- Genes and regulatory element
- Levels of gene regulation
- DNA binding proteins
- Operons
- Antisense RNA molecules
- Riboswitches

**2. Control of gene expression in eukaryotes**

- Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation.
- Regulation through transcriptional activators, Co-activators and repressors, enhancers and insulators
- Regulation through RNA processing and degradation
- Regulation through RNA interference

## **UNIT 2: RECOMBINATION, MUTATION AND DNA REPAIR**

**15 LECTURES**

### **LEARNING OBJECTIVES**

1. Understand the significance of homologous recombination in bacteria and eukaryotes
2. Understand the molecular basis of mutations and DNA repair mechanisms in prokaryotes and eukaryotes

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|--|-----------|
| <b>1. Recombination</b>  | <b>4L</b> |
| <ul style="list-style-type: none"><li>• Homologous recombination in eukaryotes</li><li>• Mating type switching</li></ul>   |           |
| <b>2. Mutations</b>  | <b>5L</b> |
| <ul style="list-style-type: none"><li>• Molecular basis of mutation - Types, mutations induced by chemicals, radiation and transposable genetic elements; expanding trinucleotide repeats and inherited human diseases</li></ul>   |           |
| <b>3. DNA repair mechanisms</b>  | <b>6L</b> |
| <ul style="list-style-type: none"><li>• Excision repair in eukaryotic cells</li><li>• Mismatch repair in eukaryotic cells</li><li>• Recombination repair in eukaryotic cells</li><li>• Conserved repair systems in eukaryotic cells</li><li>• Non-homologous end joining (NHEJ) pathway for repairing double-stranded breaks</li><li>• Inherited human diseases with defects in DNA repair</li></ul> |           |

## **UNIT 3: CYTOPLASMIC INHERITANCE and TRANSPOSABLE GENETIC ELEMENTS**

**15 LECTURES**

### **LEARNING OBJECTIVES**

1. Understand cytoplasmic inheritance
2. Understand the mechanisms of chromosomal rearrangements and its effects on gene expression

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|--|-----------|
| <b>1. Cytoplasmic inheritance</b>  | <b>8L</b> |
| <ul style="list-style-type: none"><li>• Mitochondrial DNA-<br/>Genome structure, replication, transcription and translation, analysis for the study of evolutionary relationships</li><li>• Chloroplast DNA -<br/>Gene structure and organization, replication, transcription, and translation</li><li>• Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA</li><li>• Examples of extranuclear inheritance</li></ul> |           |

- i. Poky mutant of *Neurospora*
- ii. Yeast petite mutant

## 2. Transposable genetic elements

7L

- Transposable Elements in Eukaryotes
  - i. Ac and Ds Elements in Maize
  - ii. P Elements and Hybrid Dysgenesis in *Drosophila*
  - iii. Mariner, an ancient and widespread Transposon
- Retrotransposons
  - i. Retrovirus-like elements
  - ii. Retroposons
- The Genetic and Evolutionary Significance of Transposable Elements
  - i. Transposons and Genome Organization
  - ii. Transposons and Mutation
  - iii. Rearrangement of Immunoglobulin Genes
  - iv. Evolutionary Issues Concerning Transposable Elements

## UNIT 4: VIRAL GENETICS AND GENETICS OF CANCER

15 LECTURES

### LEARNING OBJECTIVES

1. Understand the significance of recombination and mapping of the bacteriophage genome
2. Study of the application and analysis based on concepts of gene transfer
3. Understand the genetic basis of cancer

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### 1. Viral genetics

5L

- Mapping the Bacteriophage genome
  - i. Genetic fine structure mapping
  - ii. Deletion mapping
- Overlapping genes: Bacteriophage  $\Phi$  X174
- Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons

### 2. Genetic basis of cancer

10L

- Cancer: A Genetic Disease
  - i. Forms of Cancer
  - ii. Cancer and the Cell Cycle
- Oncogenes
  - i. Tumor-inducing retroviruses and viral oncogenes
  - ii. Proto-oncogenes
  - iii. Chromosome rearrangement and cancer
- Tumor Suppressor Genes
  - i. Inherited cancers and Knudson's two-hit hypothesis
  - ii. Cellular roles of tumor suppressor proteins
- Genetic Pathways to Cancer



## **CIA: Open book test, Test**

### **References: -**

#### Unit 1

1. Genetics: A Conceptual Approach, Benjamin Pierce, 6<sup>th</sup> ed., 2016, W. H. Freeman and Co.
2. Molecular Biology, R. F. Weaver, 5<sup>th</sup> ed., 2011 McGraw-Hill
3. Molecular Cell Biology - Lodish, H; Berk, A.; Kaiser, C.A. Krieger, M.; Scott, M.; Bretscher, A; Ploegh, H.; and Matsudaira, P; 6<sup>th</sup> ed., W.H Freeman and Company
4. Molecular Cell Biology, 8<sup>th</sup> ed., 2016, Lodish et al
5. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5<sup>th</sup> edition, 2007, Pearson Education
6. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, 7<sup>th</sup> ed., 2013, Benjamin-Cummings Pub Co

#### Unit 2

1. Genes IX, Lewin B., 2006, Jones and Bartlett Publishers
2. Genes X, Lewin B., 2008, Jones and Bartlett Publishers
3. Genes XII, Lewin B., 2018
4. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, 7<sup>th</sup> ed., 2013, Benjamin-Cummings Pub Co
5. Principles of Genetics, Snustad and Simmons, 6<sup>th</sup> ed., 2012, John Wiley and Sons Inc

#### Unit 3

1. Fundamental Bacterial Genetics, Turn, Trempy, 1<sup>st</sup> ed., 2004, Blackwell Publishing
2. Genes X, Lewin, B., 2008, Jones and Bartlett Publishers
3. Genetics: A Conceptual Approach, Benjamin Pierce 5<sup>th</sup> ed., 2013, W. H. Freeman and Co
4. iGenetics- A Molecular Approach, Russell, P.J., 3<sup>rd</sup> ed., 2010, Pearson International edition
5. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5<sup>th</sup> ed., 2007, Pearson Education

#### Unit 4

1. Concepts of Genetics, Klug, Cummings, Spencer, Palladino 11<sup>th</sup> ed., 2016, Pearson Education Ltd
2. Concepts of Genetics, Klug, Cummings, Spencer, Palladino, Killian 12<sup>th</sup> ed., 2018, Pearson Education Ltd
3. Genetics: A Conceptual Approach, Benjamin Pierce 6<sup>th</sup> ed., 2017, W. H. Freeman and Co
4. iGenetics, A Molecular Approach, Russell, P.J., 3<sup>rd</sup> ed., 2010, Pearson International Edition

5. Molecular Biology, R. F. Weaver, 5<sup>th</sup> ed., 2011 McGraw-Hill
6. Molecular Biology of the Cell, Alberts, B.; Johnson, A.; Lewis, J.; Raff, M.; Roberts K. and Walter P.; 5<sup>th</sup> ed., 2008, Garland Science, Taylor and Francis Group
7. Molecular Biology of the Cell, Alberts, B.; Johnson, A.; Lewis, J.; Raff, M.; Roberts K. and Walter P.; 6<sup>th</sup> ed., 2014, Garland Science, Taylor and Francis Group
8. Principles of Genetics, Snustad and Simmons, 6<sup>th</sup> ed., 2012, John Wiley and Sons Inc
9. The Biology of Cancer, Weinberg, R., 2<sup>nd</sup> ed., 2013, Garland science.

**Title: MICROBIAL BIOCHEMISTRY I**

**Course: SMIC0703**

**LEARNING OBJECTIVES**

1. Understand the molecular details of bioorganic molecules
2. Understand protein structure, folding and structural bioinformatics
3. Understand bacterial photosynthesis, nitrogen fixation and extracellular transport
4. Understand signalling systems and stress responses in bacteria

**Number of lectures: 60**

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**UNIT 1: BIOMOLECULES**

**15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand the structure and function of carbohydrates and lipids.
  2. Understand the structural details of nucleic acids and factors involved.
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**1. Carbohydrates**

**5L**

- Carbohydrates and stability of the glycosidic bond
- Glycoconjugates, proteoglycans, glycoproteins, and glycolipids
- Homopolysaccharide folding
- Functions of oligosaccharides and polysaccharides

**2. Lipids**

**5L**

- Lipid classification
- Structure of lipids in membranes- glycerolipids, ether lipids, galactolipids, sulfolipids, lipids in archaebacteria
- Sphingolipids, terpenes, isoprenoids
- Functions of lipids-signals, cofactors, pigments

**3. Nucleic Acids**

**5L**

- The factors that determine the structure of DNA- denaturation and melting curve, Hydrogen bonds and hydrophobic interactions, Base stacking, Ionic strength.
- Renaturation Kinetics - C<sub>0</sub>t curve analysis.
- Forms of DNA and circular superhelical DNA.
- Special base sequences and Structural consequences- direct and inverted repeats
- Cruciform, hairpin and stem-loop structures.

**UNIT 2: AMINO ACIDS AND PROTEINS**

**15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand the structures and functions of amino acids and proteins.
  2. Understand protein folding and misfolding.
  3. Understand structural bioinformatics.
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**1. Amino acids and primary structure of Proteins**

**4L**

- Classification and stereochemistry
- Derivative and ionization
- Structure of peptide bond and its stability
- Protein sequencing

**2. Secondary, Tertiary and Quaternary Structure of Proteins** **9L**

- Ramachandran plot
- Secondary structures-  $\alpha$  helix and other helices,  $\beta$  structures, non-repetitive structures
- Example fibrous protein: Collagen
- Tertiary structure- Globular proteins
- super secondary motifs
- Thermodynamics of folding and protein stability- Electrostatic forces, Van der Waals forces, Hydrogen bonding forces, Disulfide bonds, Protein Denaturation and stability of the thermostable protein.
- Chaperonins and prion motifs and domains
- Quaternary Structure- subunit interactions and symmetry in protein

**3. Structural Bioinformatics** **2L**

- Protein databases- NCBI, Swiss-Prot (ExPasy) PDB, PIR
- Protein Structure visualization- SPDBV, Jmol, Rasmol
- Structural Classification- CATH, SCOP, Pfam, CE and VAST.

**UNIT 3: EXPORT SYSTEMS, PHOTOSYNTHESIS AND NITROGEN FIXATION  
IN BACTERIA** **15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand cellular export systems
2. Understand bacterial photosynthesis.
3. Understand biological nitrogen fixation.

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**1. Cellular export systems** **5L**

- Extracellular protein secretion
- Drug export system

**2. Bacterial Photosynthesis** **5L**

- Phototropic bacterial families
- Photosynthetic Apparatus and its Reactions
- Carbon metabolism

**3. Biological Nitrogen Fixation** **5L**

- Nitrogen Fixing organisms
- Biochemistry of nitrogen fixation
- Regulation of nitrogen fixation

## UNIT 4: SIGNAL TRANSDUCTION IN BACTERIA

15 LECTURES

### LEARNING OBJECTIVES

1. Understand signalling systems in bacteria in response to physical and chemical factors
2. Understand bacterial development and quorum sensing

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1. General themes in bacterial signal transduction- (basic principles) one component signalling, two-component signalling, quorum sensing, global control networks **2L**

2. Mechanisms of signal transduction **13L**

- Response by facultative anaerobes to
  - i. Anaerobiosis
  - ii. Nitrate and nitrite
  - iii. Nitrogen supply
- Effect of oxygen and light on the expression of photosynthetic genes in purple photosynthetic bacteria
- Response to osmotic pressure
- Chemotaxis
- Bacterial response to environmental stress
  - i. Heat-shock response
  - ii. Oxidative stress
  - iii. Expression of virulence genes/factors
- Quorum sensing
- *Caulobacter* differentiation

### CIA: Test, Problem-solving

#### References: -

##### Unit 1

1. Biochemistry, Voet D. and Voet J.G., 4<sup>th</sup> ed., 1995, John Willey and Sons Inc.
2. Lehninger Principles of Biochemistry, Nelson DL, Cox MM, 6<sup>th</sup> ed., 2013, Macmillan publishers
3. Lehninger Principles of Biochemistry, Nelson DL, Cox MM, 7<sup>th</sup> ed., 2017, W H Freeman
4. Principles of Biochemistry, Zubay, G., 4<sup>th</sup> ed., 1998, Wm. C. Brown Publishers
5. Principles Biochemistry, Mathew, Van Holde and Ahern, 3<sup>rd</sup> ed., 1999, Pearson Education

##### Unit 2

1. Biochemistry, Voet D. and Voet J.G., 4<sup>th</sup> ed., 1995, John Willey and Sons Inc.
2. Lehninger Principles of Biochemistry, Cox and Nelson, 7<sup>th</sup> ed., 2017, WH Freeman and company, NY.

##### Unit 3

1. Bacterial Metabolism, Gottschalk, G., 2<sup>nd</sup> ed., 1985, Springer-Verlag

2. Biochemistry, Voet D. and Voet J.G., 4<sup>th</sup> ed., 1995, John Willey and Sons Inc.
3. Brock Biology of Microorganisms, Michael Madigan, John Martinko, Kelly Bender, Daniel Buckley, David Stahl, 14<sup>th</sup> ed., 2015, Pearson
4. The physiology and biochemistry of prokaryotes, White D., Drummond, T. J., and Fuqua C., 4<sup>th</sup> ed., 2007, Oxford University Press

#### Unit 4

1. Brock Biology of Microorganisms, Michael Madigan, John Martinko, Kelly Bender, Daniel Buckley, David Stahl, 14<sup>th</sup> ed., 2015, Pearson
2. The Physiology and Biochemistry of prokaryotes, White D., Drummond, T. J., and Fuqua C., 4<sup>th</sup> ed., 2007, Oxford University Press

**Title: IMMUNOLOGY**

**Course: SMIC0704**

**LEARNING OBJECTIVES**

1. Understand maturation and activation of T/B cells
2. Understand immune response to infectious agents and in turn the immune evasion mediated by these agents
3. Know advances in innate immunity, immune tolerance, autoimmunity, vaccine, transplantation immunology, immunodeficiency diseases and cancer immunology

**Number of lectures: 60**

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**UNIT 1: T/B CELL DEVELOPMENT, MATURATION AND ACTIVATION**

**15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand the maturation, activation and memory generation for T and B cells.
2. Understand the concept of Immune tolerance.

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**1. T/B cell development**

**8L**

- Site of development
- Lineage Commitment
- Mechanisms of generation of TCR/BCR diversity
- Central and Peripheral Tolerance
- T<sub>reg</sub> Cells

**2. T/B cell activation and memory generation**

**5L**

- T/B cell activation and differentiation
- T/B cell memory generation

**3. Use of Fluorescence-activated cell sorting in development and activation of lymphocytes**

**2L**

**UNIT 2: ADVANCES IN INNATE IMMUNITY AND IMMUNE RESPONSE TO INFECTIOUS DISEASES**

**15 LECTURES**

**LEARNING OBJECTIVES**

1. Know advances in innate immunity
2. Know the immune response to prion, viral, bacterial and parasite infections
3. Understand the microbial mechanisms of evading the immune system

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**1. Recent advances in Non-specific immunity**

**9L**

- Physiological and immunological barriers.
- Induced Cellular Innate Responses
  - i. TLRs
  - ii. NLRs
  - iii. CLR
  - iv. Antimicrobial Peptides
  - v. Interferon
  - vi. Cytokines

- Phagocytosis
- Inflammation
- Interaction between Innate and Adaptive Immune system
- Autophagy

**2. Immune response to Infectious agents** **4L**

- Prions
- Viruses
- Bacteria
- Parasites

**3. Microbial mechanisms of evading the immune system** **2L**

**UNIT 3: IMMUNE SYSTEM AND HEALTH**

**15 LECTURES**

**LEARNING OBJECTIVES**

1. Understand the concept of autoimmunity
2. Know the advances in the fields of vaccines

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**1. Autoimmunity** **5L**

- Interplaying Factors
- Triggering Factors
- Mechanisms of Damage
- Organ Specific Autoimmune Diseases
- Systemic Autoimmune Diseases
- Animal Models for Autoimmune Diseases
- Proposed Mechanisms for Induction of Autoimmunity
- Treatment of Autoimmune Diseases

**2. Advances in Immunization** **10L**

- Overview
- Passive immunization and Antibody engineering
- Active Immunization
  - i. Malaria vaccine
  - ii. HIV vaccine
  - iii. Pertussis vaccine
  - iv. HPV vaccine
  - v. Tuberculosis vaccine



## UNIT 4: CHALLENGES IN IMMUNOLOGY

15 LECTURES

### LEARNING OBJECTIVES

Know the advances in the fields of transplantation immunology, immunodeficiency diseases and cancer immunology

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#### 1. Transplantation and Transfusion Immunology 5L

- Antigen Involved in Graft Rejection
- Allorecognition
- Graft Rejection-Role of APCs and Effector Cells
- Graft v/s Host Diseases
- Immunosuppressive Therapies
- Blood Transfusion
  - i. ABO and Rh Blood Groups (revision)
  - ii. Potential Transfusion Hazards
  - iii. Transfusion Alternatives

#### 2. Immunodeficiency diseases 5L

- Primary Immunodeficiency
- Defects in the Complement System
- Treatment Approaches for Immunodeficiency
- Animal Models of Primary Immunodeficiency
- Secondary Immunodeficiency and AIDS

#### 3. Cancer immunology 5L

- The Immune Response to Cancer
- Cancer Immunotherapy

### CIA: Test, Presentation

### References:-

#### Unit 1

1. Immunology – Essential and Fundamental, Pathak, S. and Palan, U., 3<sup>rd</sup> ed., 2011, Capital publishing company.
2. Janeway's Immunobiology - The immune system in health and disease, Murphy, M. K., Travers, P., Walport, M. and Janeway, C., 9<sup>th</sup> ed., 2017, Garland Science, 2011
3. The Immune Response to Infection, Kauffman, S. H. E., Rouse B.T., and Sacks D.L., 2011, ASM Press, Washington, USA
4. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6<sup>th</sup> ed., 2006, W.H. Freeman and company.
5. Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7<sup>th</sup> ed., 2013, International Edition, Macmillan Higher Education.
6. Mims' Pathogenesis of Infectious Disease, Mims, A. C., Nash, A. and Stephen, J., 5<sup>th</sup> ed., 2000, Academic Press.

7. Mims' Pathogenesis of Infectious Disease, Mims et al., 6<sup>th</sup> ed., 2015, Academic Press.
8. Current published papers/ reviews

#### Unit 2

1. Janeway's Immunobiology –the immune system in health and disease, Murphy, M. K., Travers, P., Walport, M. and Janeway, C., 6<sup>th</sup> ed., 2011, Garland Science.
2. The Immune Response to Infection, Kauffman, S. H. E., Rouse B.T., and Sacks D.L., 2011, ASM Press, Washington, US
3. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6<sup>th</sup> ed., 2006, W. H. Freeman and company.
4. Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7<sup>th</sup> ed., 2013, International Edition, Macmillan higher education.
5. Takeuchi, O. and Akira, S., Pattern recognition receptors and inflammation, 2010, Cell, 140: 805-820
6. Current published papers/ reviews

#### Unit 3

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3. Kim, K.S., Park, S.A., Ko, K., Yi, S., Cho, Y.J., Current status of human papillomavirus vaccines, 2014, Clin Exp Vaccine Res;3:168-175
4. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6<sup>th</sup> ed., 2006, W. H. Freeman and company.
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6. Rosalind Rowland1 and Helen McShane, Tuberculosis vaccines in clinical trials, Expert Rev Vaccines, 2011 May; 10(5): 645–658
7. Current published papers/ reviews

#### Unit 4

1. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6<sup>th</sup> ed., 2006, W. H. Freeman and company.
2. Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7<sup>th</sup> ed., 2013, International Edition, Macmillan higher education.
3. Roitt's Essential Immunology, Delves, J. P., Martin, J. S., Burton, R. D. and Roitt, . I., 12<sup>th</sup> ed., 2011, John Wiley and Sons.
4. Roitt's Essential Immunology, Delves et al, 13<sup>th</sup> ed., 2017
5. Current published papers/ reviews

## **MICROBIOLOGY**

**SMIC07PR**

### **Semester 1 practical**

#### **LABORATORY SKILLS**

1. Lab safety –
  - Hand washing and hygiene
  - Effectiveness of disinfectants
  - Burner versus Biosafety cabinet
  - How to dispose off ethidium bromide, blood products, media components
  - Safety in handling chemicals (eg: acrylamide, ethidium bromide)
  - PPE
2. The principle of lab instruments, care, and handling.
  - Autoclave, hot air oven, incubator
  - Shaker, centrifuge, microscopes,
  - Biosafety cabinets, colorimeter, automated pipettes
3. Preparation of solutions and lab media
  - Molarity and Normality
  - Liquid and solid media, with and without indicators
  - Media with components to be separately sterilized, such as antibiotics
  - Preparation of slants, butts, and plates
4. Preparation of buffers
5. Determination of pK and pI value for an amino acid
6. Sterilization of heat sensitive material, Sterility check - Efficiency of sterilization
7. Sub-culturing, lyophilization, glycerol-stock preparation
8. Industrial visit

#### **SCIENTIFIC COMMUNICATION SKILLS**

Referencing, Oral and poster presentation, Concept of plagiarism, summary writing

#### **GENETICS**

1. UV mutagenesis
2. Acridine orange mutagenesis
3. Penicillin enrichment technique and mutant isolation by replica plating (grid plate)
4. Ames test
5. Conjugation in bacteria
6. Problems on gene transfer mechanisms

#### **VIROLOGY**

1. Isolation and purification of coliphages from sewage
2. Study of One Step Growth Curve of Lambda phage / T4 Phage.
3. Isolation of host range mutants
4. Egg inoculation and cultivating animal virus in embryonated egg - Demonstration
5. Problems on viral genetics

## **MICROBIAL BIOCHEMISTRY**

1. Isolation of cholesterol and lecithin from egg yolk
2. Identification of fatty acids and other lipids by TLC/GC
3. Determination of degree of unsaturation of fats and oils
4. Identification of an unknown carbohydrate
5. Isolation of lactose from bovine milk
6. Estimation of total sugars by the phenol-sulphuric acid method
7. Isolation of glutamic acid from gluten
8. Determination of molar absorption coefficient ( $\epsilon$ ) of l-tyrosine
9. Determination of the isoelectric point of the given protein
10. Estimation of polyphenols/ tannins by Folin- Denis method
11. Diffusion studies of molecules across sheep RBCs
12. Adaptation of *E. coli* to anaerobiosis
13. Chemotaxis of *Pseudomonas*

## **IMMUNOLOGY**

1. Separation of mononuclear cells from blood by Ficoll-Hypaque density gradient centrifugation, counting of viable cells by trypan blue.
2. Staining of blood smear
3. Study of virulence factors-Phagocytosis and Phagocytic index.
4. Horizontal electrophoresis of proteins – Human serum
5. Immunoelectrophoresis
6. Determination of Rh – Antibody titre
7. Major and Minor cross-matching of blood.
8. SRID: For detection of immune deficiency and Complement deficiency.
9. ELISA- qualitative and quantitative

## **CIA: Experimental, Primary research paper presentation, Instrument maintenance with SOP writing**

### **References:**

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3. Biosafety manual of the college
4. Textbook of Microbiology –Ananthnarayan and Paniker-10th ed.,2017, University Press
5. Microbial Genetics, Maloy, S.R.; Cronan, J.E.; Freifelder, David 2nd ed., 1994, Jones and Bartlett Publishers.
6. Molecular Cloning: A Laboratory Manual (3 Volume Set), J. Sambrook, E. F. Fritsch, T. Maniatis, 2nd ed., 1989, Cold Spring Harbor Laboratory Pr.
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8. Principles of Genetics, Snustad and Simmons, 6th ed., 2012, John Wiley and Sons Inc

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12. Laboratory manual in biochemistry by Jayaraman J., 1981, New Age International Publishers
13. An introduction to practical biochemistry 3<sup>rd</sup> ed., 1998, David T Plummer, Tata McGraw Hill ed.
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