



St. Xavier's College – Autonomous Mumbai

Syllabus For 2nd Semester Courses in **M.Sc. LIFE SCIENCE** (June 2015 onwards)

Contents:

Syllabus (theory and practical) for Courses:

MS.LSC.2.01	Cell Biology
MS.LSC.2.02	Human Physiology I
MS.LSC.2.03	Immunology
MS.LSC.2.04	Microbial Diseases

Template for theory and practical question paper

LIFE SCIENCE

M.Sc.

Course No. MS.LSC.2.01

Title: Cell Biology

Learning Objectives:

On completion of the course, the student must be able to:

1. Understand the structure and function of components of eukaryotic cells - membranes, organelles and cytoskeleton
2. Describe the various types of cellular transport involved in movement of material into the cell and between various compartments of the cell.
3. Explain the concept of intercellular communication using diffusible solutes and cell membranes
4. Enlist stages of cell cycle and discuss the basis of its regulation
5. Summarize the causes and regulation of programmed cell death
6. Compare & contrast the various methods used to study cellular processes

Number of lectures: 60

UNIT I

(15 lectures)

1. Origin and Evolution of Cells (1)
2. Limits of cellular compartment - The Plasma Membrane (3)
3. Sub-cellular compartmentalization (with reference to evolutionary origin, structure, and function) (Guided self-study) (4)
 - a. The Endomembrane System – ER, Golgi apparatus, Lysosome, Vacuole, Peroxisome
 - b. Mitochondria
 - c. Chloroplast
 - d. Nucleus
4. Cytoskeletal Organization (6)
 - a. Microtubules, Microfilaments & Intermediate filaments : types, structure and function
 - b. The cytoskeleton and cell behaviour : cilia, flagella; cytokinesis
5. Motor proteins – prototype structure & role in cellular cargo transport (1)

UNIT II

(15 lectures)

1. Membrane Transport (6)
 - a. Passive diffusion
 - b. Facilitated diffusion
 - c. Active transport – primary & secondary
 - d. Transport of ions
 - e. Endocytosis, Exocytosis, Bulk transport
2. Vesicular Transport Pathways (6)
 - a. ER to Golgi,
 - b. Golgi to plasma membrane/ secreted out
 - c. Golgi to lysosomes
3. Signal Sequences in Protein Targeting : nuclear, mitochondrial and chloroplast (1)
4. Overview of Protein Degradation Pathways (2)

UNIT III

(15 lectures)

1. Cell signalling (9)
 - a. Concept of signal transduction
 - b. Receptor types –G-protein receptor, enzyme coupled receptors (tyrosine kinase, ser-thr kinase), ionotropic receptors
 - c. Signalling pathways – Adenylate Cyclase-cAMP, IP3-DAG, Calcium/Calmodulin
2. Intercellular interactions (6)
 - a. Cell junctions – need & organization
 - b. Types of junctions – composition & function of occluding & adherens junctions, communicating junctions
 - c. Cell-ECM interactions – Integrins & cell anchoring

UNIT IV

(15 lectures)

1. Cell Cycle and its Regulation (7)
 - a. An overview of Cell Cycle
 - b. Cyclin and Cyclin-dependant kinases, Cdk inhibitor proteins
 - c. Cell Cycle Check points
 - d. Cell Division – Mitosis & Cytokinesis; Meiosis
2. Apoptosis (8)
 - a. Cellular changes underlying apoptosis, Apoptosis-dependent developmental/physiological processes
 - b. Apoptotic pathways : Extrinsic and Intrinsic Pathways
 - c. Caspases as executioners of apoptosis, DNA fragmentation regulators.
 - d. Techniques for apoptosis detection : TUNEL, COMET assay, Flow Cytometry based assays
 - e. Imbalance between proliferation and apoptosis – Endometrial Hyperplasia, neoplasia

References

1. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff.
2. Cell Biology by Gerald Karp
3. Molecular Cell biology By Lodish Berk, Kaiser,Krieger, Scott, Bretscher, Ploegh, Matsudaira
4. Cell: A Molecular Approach, by Cooper
5. Molecular biology of Gene, by J. P. Watson.
6. Lehninger, Nelson and Cox; Principles of Biochemistry
7. Voet and Voet, Biochemistry

LIFE SCIENCE

M.Sc.

Course No. MS.LSC.2.02

Title: Human Physiology I

Learning Objectives:

The course aims at:

1. Imparting knowledge and understanding of the structural organization of the human body and its functional segregation into various systems, and understand the physiological interdependence of various systems.
2. Introducing the students to the physiological and cellular mechanisms underlying disorders of various organ systems.

Number of lectures: 60

UNIT I

(15 lectures)

1. **Introduction to Physiology:** Structural and functional organization of the human body; General characteristics of homeostatic control systems. (3)
2. **Gastrointestinal Physiology:** Overview of digestive process; Secretory functions of the alimentary canal; Cephalic, gastric and intestinal phase of stomach secretion; Digestion and absorption in the G.I. tract; Role of accessory glands – liver, pancreas, gall bladder; Neural and endocrine control of GI function; Overview of the absorptive and Post-absorptive state; Basal Metabolic Rate. (6)
3. **Disorders of the GI system:** Liver Cirrhosis, Obesity, Vitamin deficiencies (6)

UNIT II

(15 lectures)

1. **Cardiovascular system:** Anatomy of the heart; Blood flow through the heart; Cardiac cycle; Rhythmic excitation of the heart. (5)
2. **Circulatory system:** Components of blood; Blood flow and resistance; Functions of the arterial and venous system; Cardiac output and venous return; Humoral and nervous control of circulation; Blood pressure control. (5)
3. **Lymphatics** (1)
4. **Cardiovascular disorders:** Atherosclerosis, Cardiac arrhythmia, Anaemia, Thalassaemia. (4)

UNIT III

(15 lectures)

1. **Urinary system:** Physiologic anatomy of the Kidneys; Overview of the process of urine formation – Glomerular filtration, Tubular reabsorption, Tubular secretion; Micturition reflex; GFR and Renal Blood flow; Neural control and Auto-regulation of GFR and Renal Blood Flow. (7)
2. **Disorders:** Acute and chronic renal failure (2)
3. **Physiology of Muscle Contraction:** Gross anatomy of skeletal, smooth muscles and cardiac muscles; Molecular mechanism of muscle contraction. (4)
4. Neural control of muscle contraction: the Neuromuscular Junction. (2)

UNIT IV

(15 lectures)

1. **Respiratory system:** Overview of the respiratory system; Pulmonary ventilation; Measuring lung function – Lung Compliance, Pulmonary Volumes and Capacities; Principles of gaseous exchange; Relationship between Pulmonary ventilation and Pulmonary capillary blood flow; Transport of gases in the blood - Hemoglobin and oxygen transport; Carbon dioxide and blood pH; Neural and chemical control of ventilation. (7)
2. **Respiratory disorders:** Chronic Obstructive Pulmonary Disorders, Cystic fibrosis (4)
3. **Musculoskeletal disorders:** Osteoporosis, Osteoarthritis, Duchenne's Muscular Dystrophy (4)

References

1. Arthur C. Guyton, John E. Hall, Textbook of Medical Physiology, 11th Edition, Elsevier Saunders, 2006.
2. Ken Saladin: Anatomy & Physiology: The Unity of Form and Function, 3rd Edition, The McGraw–Hill Companies, 2003.
3. Seeley R, Stephens T, Tate P, Anatomy and Physiology, 6th Edition, The McGraw–Hill Companies, 2004.
4. Stuart Fox, Human Physiology, 8th Edition, The McGraw–Hill Companies, 2003.
5. Rhodes R, Tanner G, Medical Physiology, 2nd Edition, Lippincott Williams & Wilkins, 2003.

LIFE SCIENCE

M.Sc.

Course No. MS.LSC.2.03

Title: Immunology

Learning Objectives:

On completion of the course, the student must be able to:

1. To understand the concept of innate and adaptive immunity.
2. Be able to describe the organization and the role of the various cells and organs of the immune system.
3. Be able to understand the role of innate and adaptive immunity and the factors that contribute towards immunity.
4. To understand the role of the immune system in tumour formation, during transplantation and for allergic responses.
5. To understand how the immune system has evolved.

Number of lectures: 60

UNIT I

(15 lectures)

1. Introduction to the Immune System (1)
2. Cells, tissues and organs of the immune system (self study)
3. Mechanisms of Innate Immunity: (5)
 - a. Anatomical barriers,
 - b. Phagocytosis and inflammation,
 - c. Pattern recognition: toll-like receptors, NOD proteins, TLR signaling
 - d. Complement system
 - e. Microbicidal proteins
4. Antigen Recognition by Immune cells: (9)
 - a. Antigen recognition by B cells
 - b. Antigen recognition by T cells
 - c. Immunoglobulin gene rearrangement
 - d. Classical and non-classical MHC molecules
 - e. Antigen presentation to T lymphocytes

UNIT II

(15 lectures)

1. Humoral Immune Response: (5)
 - a. Development of B lymphocytes
 - b. B cell activation and antibody production
 - c. Distribution and function of immunoglobulin isotypes
2. Cell-mediated immunity: (5)
 - a. T cell development in the thymus and the gamma-delta T cells in the gut
 - b. Priming of naive T cells and effector T cells
 - c. T cell-mediated cytotoxicity
 - d. Macrophage activation by TH1 cells
 - e. Role of TH17 cells
3. Mucosal Immune System: (3)
 - a. Organization of the mucosal immune system
 - b. Mucosal response to infections
 - c. Regulation of the mucosal immune response
4. Cytokines and cytokine receptors (2)

UNIT III **(15 lectures)**

1. Immunological Tolerance: (5)
 - a. Tolerance Mechanisms
 - b. Central thymic and Post-thymic tolerance
 - c. B cell tolerance
 - d. Regulatory T cells: CD4 Tregs and CD8 alpha-alpha cells
2. Immunological Memory: (5)
 - a. Memory B cell responses
 - b. Memory T cells responses
 - c. Immunological memory after infection/vaccination
3. Evolution of the Immune System: Innate and Adaptive (5)
 - a. Invertebrate immunity
 - b. Vertebrate Immunity
 - c. Lymphomyeloid tissues in lower vertebrates
 - d. Amphibian model for studying ontogeny of immunity

UNIT IV **(15 lectures)**

1. Cancer and Immunity: (5)
 - a. Malignant transformation of cells
 - b. Immune surveillance
 - c. Tumors of the immune system
 - d. Tumor antigens
 - e. Tumor evasion of the immune system
 - f. Cancer immunotherapy
2. Transplantation and Rejection: (5)
 - a. Barriers to transplantation
 - b. Role of T cells in rejection
 - c. Clinical manifestations of rejection
 - d. Prevention of rejection
 - e. Transplantation of kidney/liver/bone marrow
3. Hypersensitivity: (5)
 - a. IgE-mediated hypersensitivity
 - b. Antibody-mediated hypersensitivity
 - c. Immune complex-mediated hypersensitivity
 - d. Delayed type hypersensitivity

References

1. Kuby Immunology by Kindt, Goldsby, Osborne; 6th edition, W. H. Freeman, 2007
2. Immunology by Roitt, Brostoff, Male; 6th edition, Blackwell Publishing, 2001
3. Immunobiology by Janeway and Travers, et al, 7th edition, Garland Sc. 2005
4. Immunology by Ian Tizard, 4th ed., Saunders College Publishing, 1995.
5. Roitt's Essential Immunology – P.Delves, S. Mastin et al, Blackwell Pub., 11th ed., 2006.
6. Immunology by Kalus Elgert, 2nd ed., Wiley Blackwell, 2010
7. The Immune response to infection by S.Kaufmann et al, ASM Press, 2011
8. Cellular and Molecular Immunology by A.K. Abbas et al, 5th ed, Saunders, 2003.

LIFE SCIENCE

M.Sc.

Course No. MS.LSC.2.04

Title: Microbial Diseases

Learning Objectives:

1. To understand host–parasite interactions by in-depth study of pathogenesis of various microbial parasites and immune response of the host to them
2. To study and understand infectious agents colonizing various organs and systems in human body.
3. To equip the students with a thorough knowledge of not only the clinical features and diagnosis of each of these diseases but also promote a clear understanding of the mechanisms for preventing the disease.

Number of lectures: 60

UNIT I

(15 lectures)

1. Types of infectious diseases (1)
 - a. Reservoirs of Infection
 - b. Sites of entry, exit and transmission, types of transmission between humans, transmission from animals.
2. Pathogenesis of bacterial diseases (5)
 - a. Reservoirs of bacterial pathogens
 - b. Mechanisms of bacterial invasion growth and multiplication of pathogens
 - c. Regulation of bacterial virulence factors
 - d. Bacterial toxins
3. Pathogenesis of viral diseases (3)
 - a. Entry, contact, and primary replication
 - b. Viral spread and cell tropism
 - c. Cell injury and clinical illness
 - d. Recovery from infection
 - e. Virus shedding
4. Interaction of the pathogen with the Innate and Adaptive Immune System (6)
 - a. Immune response to bacterial, viral and fungal diseases.

UNIT II

(15 lectures)

Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment.

1. Respiratory tract infections: (7)
 - a. The common cold
 - b. Influenza virus infection
 - c. Pneumonia- Bacterial & Viral
2. Central nervous system infections: (8)
 - a. Meningitis / Japanese Encephalitis
 - b. Tetanus
 - c. Polio
 - d. CJD, Kuru

UNIT III

(15 lectures)

1. Urinary tract infections: Pathogenesis, clinical features, complications, laboratory diagnosis, treatment, prevention. (4)
2. Gastrointestinal tract infections: (6)
 - a. Diarrheal diseases caused by bacterial or viral infection
 - b. *Helicobacter pylori* and gastric ulcer disease
 - c. Round worm
 - d. Typhoid
3. Sexually transmitted diseases: (5)
 - a. Syphilis
 - b. Human papilloma virus infection
 - c. Human immunodeficiency virus

UNIT IV

(15 lectures)

1. Vector borne infections: (6)
 - a. Malaria
 - b. Dengue
 - c. Filariasis
2. Multi system zoonosis: (4)
 - a. Anthrax
 - b. Plague
3. Infections of skin and soft tissue: (3)
 - a. Fungal infections of skin- Dermatophytosis / Candidiasis
 - b. Bacterial infections of the skin
 - c. Viral infections eg herpes simplex, chicken pox
4. Obstetric and perinatal infections (2)
 - a. Congenital infections – Rubella virus

References

1. Evolution of Infectious Disease. Ewald PW. Oxford University Press, New York. 1994. ISBN 0-19-511139-7.
2. Emerging Infections 1. Scheld WM, Armstrong D and Hughes JM, Editors. ASM Press, Washinton, DC. 1998. ISBN 1-55581-123-3.
3. Emerging Infections 2. Scheld WM, Craig WA and Hughes JM, Editors. ASM Press, Washington, DC. 1998. ISBN 1-55581-141-8.
4. Pathology of Emerging Infections. Horsburgh, CR Jr and Nelson AM, Editors. ASM Press, Washington, DC. 1997. ISBN 1-55581-20-5.
5. Pathology of Emerging Infections 2. Nelson AM and Horsburgh, CR Jr, Editors. ASM Press, Washington, DC. 1998. ISBN 1-55581-140-X.
6. Emerging Viruses. Morse SS, Editor. Oxfor University Press, New York. 1993. ISBN 0-19-510484-6.
7. Of Mice, Men, and Microbes Hantavirus. Herper DR and Meyer AS. Academic Press, New York. 1999. ISBN 0-12-326460-X.
8. Marburg and Ebola Viruses. Current Topics in Microbiology and Immunology, 235. Klenk HD, Editor. Springer, New York. 1999. ISBN 3-540-64729-5.
9. Dengue Viruses. Schlesinger RW. Springer, New York. 1977. ISBN 0-387-81406-X.
10. Tortora, Funk and Case: "Microbiology, an Introduction"; 6th edn. Benjamin/Cummings Publishing company, California (1998)

11. Nester et al, "Microbiology: A Human Perspective",
12. Snustad and Simmons: "Principles of Genetics, 2nd edition"
13. "Schaechter's Mechanisms of Microbial Disease" by N. Cary Engleberg, Terry Dermody, and Victor DiRita. 4th Edition.
14. Godkar, Praful B: Textbook of Medical Laboratory Technology Reprint edn Bhalani Publishing house, (1998).
15. Goldsby, Richard, S. Kindt, Thomas J., Osborne, Barbara A. : Immunology 4th edition. W.H. Freeman and Company, New York (2000)
16. Greenwood, David, Slack, Richard C.B., Peutherer, John F. : Medical Microbiology: A guide to microbial infections, pathogenesis, immunity, laboratory diagnosis and control 14th edn. English Language Book Society, London (1992)
17. Isenberg, Henry D.: Essential Procedures for clinical microbiology, ASM Press Washington, D.C. (1998)
18. Janeway, Charles A., Jr. Travers, Paul: Immunobiology: the immune system in health and disease Blackwell Scientific Publications, Oxford (1994).
19. Jawetz, Melnick, Adelberg, Edward. Medical Microbiology 21st edn. Prentice Hall International Inc, Connecticut (1998).
20. Kuby, Janice : Immunology- 2nd edn. W.H. Freeman and Company, New York (1991)
21. Mackie T J., McCartney, J.E.: Practical Medical Microbiology Vol1 and 2 – 13th edn. Churchill Livingstone, New York (1989)
22. Koneman, Elrner W. Allen, Stephen D., Janda, William M. Schreckenberge, Paul C.: Color Atlas and textbook of diagnostic microbiology 5th edn. Lippincott-Raven Publishers, Philadelphia (1997).
23. Mukherjee, Kanai L.: Medical Laboratory Technology – Reprint edn. Tata MacGraw Hill Publishing Co. Ltd., New Delhi (1988).
24. Tizard, Ian R.: Immunology 4th edn. Saunders College Publishing, Philadelphia
25. Nelson KE and Williams CM. Infectious Disease Epidemiology: Theory and Practice, Jones and Bartlett Publishers, Inc;

Practicals Semester 2:

Course: MS.LSC.2.PR

Microbiology and Immunology

1. GLP, media preparation, sterilization protocols, culturing methods (aerobic and anaerobic)
2. Enumeration methods:
 - a. Opacity Tube method
 - b. Optical Density
 - c. Viable Count (Spread plate/Pour Plate)
3. Staining methods: simple staining, Gram staining, Capsule staining and Spore staining.
4. Preservation of micro-organisms: subculturing, glycerol stocks and lyophilization.
5. Growth curve E. coli
6. U.V. survival curve
7. Isolate auxotrophic mutants after exposure to UV/ chemical mutagen.
8. Antibiotic sensitivity tests –
 - a. Agar Cup method
 - b. Disc Diffusion method: Kirby Bauer method and Stokes method
 - c. Minimum Inhibitory Concentration & Minimum Lethal Concentration of an antibiotic (Agar dilution/Broth dilution/E-MIC strip agar diffusion).
9. Isolation of antibiotic resistant mutants from soil/ sewage/UV exposure using gradient plate technique.
10. Medical Microbiology
 - a. Pure culture Study of Microorganisms on selective media
 - b. Study of Biochemicals for identification of microorganisms: Oxidase, Catalase, Nitrate Reduction, IMViC, TSI, Urease, Sugar Fermentation, Lysine Decarboxylase, Phenylalanine deaminase, Coagulase, Haemolysin
 - c. Identification of microorganism based on cultural characteristics on selective media and biochemical characteristics.
11. Isolation of phage from sewage and determine its host specificity
12. Enumeration of T4 Phage (T4 plaque assay).
13. Agglutination Reactions:
 - a. Study of Blood groups: Forward and reverse typing
 - b. Isohemagglutinin titre in blood
 - c. Quantitative Widal Test
14. Precipitation Reaction:
 - a. Single (Radial) immunodiffusion
 - b. Double immunodiffusion (Ouchterlony)
15. Separation of Mononuclear cells (lymphocytes) using a gradient and the determination of viable count of the same.
16. Purification of IgG from serum.
17. Innate Immunity: Testing the effects of saliva, tears, lysozyme on Staphylococcus, Streptococcus.
18. Bioassay (microbiological assay) for determination of antibiotics and or vitamin(Vit B₁₂)

M.Sc. Life Science
PRACTICAL EVALUATION

<u>Semester 2</u> - CIA – 20 marks x 3	= 60
- 20 marks for lab visits	= 20
ESE - 30 marks x 4	= <u>120</u>
	<u>200</u> marks

For CIA: (20 marks journal + 40marks experiments/viva etc + 20marks lab visits)

M.Sc. LIFE SCIENCE

Courses 2.01, 2.02, 2.03, 2.04

Template of Theory Question paper

CIA I – 20 marks, 45 mins.

Unit I: Objectives/Short questions

CIA II – 20 marks, 45 mins.

Unit II: Short questions/Assignment/Presentation

End Semester exam – 60 marks, 2 hours

Choice is internal- within a unit and could be between 50% to 100%