



St. Xavier's College (Autonomous) Mumbai

Syllabus For 9th Semester Courses in **M.Sc. Life Science** (June 2019 onwards)

Contents:

Syllabus (Theory and Practical) for Courses:

SLSC0901	Human Physiology II
SLSC0902	Molecular Biology and Recombinant DNA Technology
SLSC0903	Bioinformatics and Routine Diagnostics
SLSC0904	Clinical Microbiology and Public Health
SLSC09PR	Practicals

Template for theory and practical question paper
Evaluation and Assessment Grid

Percent revision:

2015-16: No revision
2016-17: No revision
2017-18: No revision
2018-19: 50% (0903) and 40-50% revision in practicals
2019-20: No revision
2020-21: No revision

LIFE SCIENCE

M.Sc.

Course No.: SLSC0901

Title: Human Physiology II

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)

Nervous system:

1. Neurons and Glia – structural and functional features. (2)
2. Nerve Impulse transmission; Channels and Transporters. (3)
3. Synapse: Types of synapses, Synaptic Transmission, Synaptic Potentials, Synaptic Plasticity and long-term potentiation. (4)
4. Structural and functional organization of the Nervous system: CNS and PNS (2)
5. Understanding brain anatomy & function, Anomalous examples of behavior, Brain imaging techniques – CT, PET, MRI (2)
6. The Autonomic Nervous system. (1)
7. Organization: The sensorimotor pathways (1)

UNIT II

(15 lectures)

1. Neurotransmitters: Acetylcholine, Catecholamines (Norepinephrine, Dopamine), Glutamate, GABA: mode of actions, receptor types and functional diversity. (5)
2. Neuronal signal transduction process and related disorders:
 - a. Phototransduction: Structural organization of the retina, photoreceptors, mechanism of phototransduction
 - b. Chemotransduction: olfaction and gustation: receptors, structure and mechanism of transduction
 - c. Mechanotransduction: Auditory system: cochlea and organ of Corti, receptors and mechanism of transduction, auditory pathway (6)
3. Neurological disorders: Parkinson's, Alzheimer's, Schizophrenia, Bipolar disorder (4)

UNIT III

(15 lectures)

Endocrine system:

1. Concept of cell signaling: Endocrine, autocrine, paracrine. Chemical nature of hormones, general mode of action on target cells. (2)
2. The Hypothalamus and Pituitary – Structural and Functional relationship; Hormones of the Anterior and Posterior Pituitary; Growth hormone: function and disorders (3)
3. Target Tissues of the Tropins and their Hormones: Thyroid (Thyroid disorders), Parathyroid, Adrenals, Pancreas (insulin, glucagon; Disorder: Diabetes mellitus). (7)
4. Homeostasis and Hormonal regulation –Water, electrolytes and acid-base balance; Thermoregulation; Blood volume control. (3)

UNIT IV

(15 lectures)

A) Reproductive System:

1. Differentiation of sex and development of male and female reproductive systems; Oogenesis and Spermatogenesis. (2)
2. Overview of the reproductive systems; The Hypothalamus-Pituitary-Gonadal axis; Cellular and molecular interactions in ovary and testis; Menstrual Cycle – Cyclic changes at Ovarian and Uterine level. (3)
3. Hormonal Regulation of Fertilization and Implantation. (2)
4. Hormonal Changes during Pregnancy, Parturition and Lactation. (2)

B) Male and Female Fertility Management:

1. Common causes of male and female infertility – anatomical, hormonal, genetic. (1)
2. Disorders of Folliculogenesis and ovulation: Polycystic Ovary Syndrome; Abnormal spermatogenesis. (2)
3. Assisted Reproductive Technologies (ARTs) – IVF-ET, ICSI, GIFT, ZIFT; Preimplantation Genetic Diagnosis; Researchable areas and Ethical issues in ARTs (1)
4. Contraception and Family Planning (1)
5. Menopause and Hormone Replacement Therapy; Synthetic Estrogens and Phytoestrogens. (1)

References:

1. Guyton AC and Hall JE (2006) "Textbook of Medical Physiology" *Elsevier Saunders*.
2. Saladin K (2003) "Anatomy & Physiology: The Unity of Form and Function" *The McGraw–Hill Companies*.
3. Seeley R, Stephens T and Tate P "Anatomy and Physiology" *The McGraw–Hill Companies*.
4. Fox S (2003) "Human Physiology" *The McGraw–Hill Companies*.
5. Rhodes R and Tanner G (2003) "Medical Physiology" *Lippincott Williams & Wilkins*.

LIFE SCIENCE

M.Sc.

Course No.: SLSC0902

Title: Molecular Biology and Recombinant DNA Technology

Learning Objectives:

This course aims to provide a molecular understanding of the information processing pathways in the cell that lead to the expression of the genetic information in DNA.

1. To understand the molecular processes of DNA replication, transcription, and translation, and how they are managed in cells.
2. To understand protein and nucleic acid structure and function, and the relationship between them, both in vitro and in vivo.
3. To understand the principles of gene expression and its regulation in prokaryotes and eukaryotes.
4. To understand the principles and application of gene cloning in industry and medicine

Number of lectures: 60

UNIT I (15 lectures)

1. DNA topology: Supercoiling, denaturation and renaturation kinetics, C-value paradox (2)
2. DNA replication: DNA replication in *E. coli* (guided self study), Eukaryotic DNA replication (guided self study), and Viral DNA replication (Rolling circle model) (3)
3. DNA damage and repair: UV/chemicals, Repair systems (mismatch, nucleotide excision, base excision, recombination lesion, photoreactivation, SOS) (4)
4. DNA recombination: homologous, and site-specific (4)
5. Mobile Genetic Elements: Prokaryotic and eukaryotic Transposons one eg each. (2)

UNIT II (15 lectures)

1. Concept of a gene (self study) (2)
2. Transcription: prokaryotic and eukaryotic transcription (3)
3. Post-transcriptional processing: capping, splicing, polyA tail addition of mRNA; self splicing. (5)
4. Genetic code: universality, mitochondrial codon usage, wobble hypothesis (self study) (1)
5. Translation: protein synthesis in prokaryotes and eukaryotes (3)
6. Post-translational modifications (self study) (1)

UNIT III (15 lectures)

1. Protein-nucleic acid interactions: eg transcription factors; types of DNA binding motifs, interactions with DNA, gel-mobility shift assay, chromatin immunoprecipitation (6)
2. Regulation of gene expression in prokaryotes: (1)
 - a. The Lactose Operon in *E. coli* (self study)
 - b. The Tryptophan/ arabinose Operon in *E. coli* (guided self study)
3. Regulation of gene expression in eukaryotes: (8)
 - a. Gene rearrangement in immunoglobulin genes
 - b. Maternal gene expression in drosophila development

UNIT IV **(15 lectures)**

1. Restriction endonucleases: Type II R.E and its mechanism of cleavage (self study) **(1)**
2. Vectors: plasmid, phage, transcription vectors, expression vectors (pGLO, lacZ), eukaryotic vectors **(1)**
3. Selection methods: antibiotic resistance, lacZ, GFP (self study) **(1)**
4. Cloning of genes: using genomic DNA libraries, cDNA cloning, PCR cloning **(1)**
5. Screening of cloned genes: nucleic acid hybridization, immunochemical method, Southern blots **(1)**
6. DNA sequencing: **(4)**
Chain termination method, pyrosequencing, whole genome sequencing, contig mapping
7. Applications of gene cloning: **(6)**
RFLPs, DNA fingerprinting, production of useful molecules, transgenic animals, transgenic plants, whole animal cloning, gene therapy, knock outs, knock down, knock-ins.

References:

1. Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A. (2016) 'Molecular Cell Biology' *W H Freeman*.
2. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. (2014) *Molecular Biology of the Gene*. 7th Ed. *Pearson*.
3. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. (2014) *Molecular Biology of the Cell*. 7th Ed. *Garland Science*.
4. Pierce BA. (2013) *Genetics – A Conceptual Approach*. 5th Ed. *Barnes and Noble*.
5. Hartl DL, Ruvolo M. (2011) *Genetics – Analysis of Genes & Genomes*. 8th Student Ed. *Jones and Bartlett*.
6. Snustad DP, Simmons MJ. (2009) *Principles of Genetics*. 5th International Student Ed. *Wiley Publishing Ltd*.
7. Wessler SR, Lewontin RC, Gelbart WM, Suzuki DT, Miller JH (2004) *Introduction to Genetic analysis*. 8th Ed. *W H Freeman & Company*.
8. Atherly AG, Girton JR, McDonald JF. (1999) *The Science of Genetics*. *Daine Pub. Co*.
9. Weaver RF, Hedrik PW. (1997) *Genetics*. 3rd Ed. *Barnes and Noble*.

LIFE SCIENCE

M.Sc.

Course No.: SLSC0903

Course title: Bioinformatics and Routine Diagnostics

Learning Objectives:

1. Introduce students to the interdisciplinary field of bioinformatics and computational biology that integrates the use of computational power to organize, manage, analyze and interpret the voluminous biological data in the post-genomic era.
2. Make students adept at using basic bioinformatics tools available online to analyze sequence, structure and evolutionary data and give an overview of the fast developing fields of systems biology and big data analyses.
3. Help students understand routine analysis of biological fluids and specific organ function tests, and their clinical significance.
4. Introduce students to non-invasive methods for diagnosis.

UNIT I: Computers in Biology (15 lectures)

1. Introduction to Bioinformatics and Computational Biology (1)
(Overview of the field, need, applications, types of biological data)
2. IT basics
Types of computers and their construction, Hardware and software, (1)
Types of operating systems (1)
Computer programming and programming languages (C++, Bioperl) (2)
Unix fundamentals and its use in data presentation (2)
3. Databases & Annotation – Relational, Object-oriented db (2)
(Literature – PubMed, PubChem, PharmaWiki (2)
Sequence - NCBI GenBank, DDBJ, EMBL
Structure – PDB, PROSITE, PFAM, ExPASy, RFAM
Metabolic Pathways – KEGG
Genome databases – SGD, XBASE, MYCOB)
4. Sequence Analysis (7)
(Sequence input formats- GenPept, FASTA; Sequence alignments - Pairwise and Multiple, Dot Matrix and FASTA methods of sequence alignment, NCBI BLAST, different BLAST programs and their use, Scoring an alignment: Scoring Matrices – BLOSUM, PAM, Score, E value, Query coverage)

UNIT II: Basic Bioinformatics & Computational Biology (15 lectures)

1. Phylogenetic Analysis (6)
(Rooted and unrooted trees, Tree construction – UPGMA, Neighbour joining, Maximum Parsimony, Maximum Likelihood, Validation – Boot strapping, Jack-knifing, Software: CLUSTAL OMEGA, MEGA, PHYLIP)
2. Structure Prediction and Modelling – Proteins, Nucleic Acids (6)
(Comparative modelling, HMM, Fold recognition/ threading, Ab-initio predictions, Structure visualization using RASMOL, PYMOL)
3. Molecular Modelling and Dynamics (2)
(Molecular interactions: Small molecule – protein, Nucleic acid – protein,

protein – protein. Energy minimization. Basics of Molecular Docking and Drug design

4. Emerging areas in Bioinformatics: Systems Biology and Big Data Analysis: (1)
Guest Lecture (Applications of Bioinformatics in Agriculture, Human Health, Environment, Molecular Biology and Biotechnology, Neuroscience, Drug design)

UNIT III: Routine Diagnostics (15 lectures)

1. Cardiac profile tests (3)
2. Routine Blood tests (2)
 - a. Complete Blood Count and Hematological Indices.
 - b. PCV, ESR
 - c. Reticulocyte count
3. Variants of hemoglobin and abnormal hemoglobin identification. (1)
4. Erythrocyte disorders (at least two) (1)
5. Hemostasis, coagulation and routine coagulation tests (2)
 - a. Mechanism of coagulation
 - b. Congenital deficiencies of hemostatic factors (self study)
 - c. Routine coagulation tests
 - d. Bleeding disorders
 - e. Bleeding time, clotting time, prothrombin time, Partial Thromboplastin time and Activated PTT
6. Basic principles of blood banking. (1)
7. Liver function tests (3)
8. Histopathological approaches to diagnosis (2)
 - a. Fixation and fixative tissue processing
 - b. Immunostaining
 - c. PAP smear

UNIT IV: Routine Diagnostics (15 lectures)

1. Kidney function tests (2)
2. Routine analysis of body fluids; urine, sputum, CSF, semen, cavity fluids: pericardial, peritoneal and synovial. (4)
3. Parasitology and routine examination of feces. (2)
4. Thyroid function tests (2)
5. Pulmonary function tests (3)
6. Non-invasive imaging techniques-MRI, CT scan, PET scan, fdg-PET (2)

References:

1. Jonathan Pevsner (2015) "Bioinformatics and Functional Genomics" 3rd Ed. *Wiley*.
2. Arthur M. Lesk. (2013) Introduction to Bioinformatics. 4th Ed. *Oxford University Press*.
3. Zhumur Ghosh, Bibekanand Mallick. (2008). Bioinformatics: Principles and Applications *Oxford University Press*.
4. David W. Mount. (2004) Bioinformatics: Sequence and Genome Analysis. 2nd Ed. *Cold Spring Harbor Laboratory Press, New York*.
5. S C Rastogi, N Mendiratta, P Rastogi. Bioinformatics: Methods and Applications – Genomics, Proteomics and Drug Discovery. 3rd Ed. *PHI Learning Pvt. Ltd., New Delhi*.
6. University websites (Online).
7. Burtis C.A and Bruns D.E (2015) 'Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics' 7th Edition, *Elsevier Saunders*.
8. Hammer G.D and Mc Phee S.J (2019) 'Pathophysiology of Disease – An Introduction to Clinical Medicine' 8th Edition, *McGraw Hill Education*
9. Baynes J.W and Dominiczak M.H (2019) 'Medical Biochemistry' 5th Edition *Elsevier*.

LIFE SCIENCE

M.Sc.

Course No.: SLSC0904

Title: Clinical Microbiology and Public Health

Learning Objectives:

This course will

1. Introduce and explain the principles of various diagnostic methods used in Clinical Microbiology.
2. Provide an elaborate overview of antimicrobials, their mechanisms of action, drug resistance and use of vaccines in controlling and prevention of infectious diseases.
3. Explain the concepts of epidemiology of infectious diseases and public health measures used to analyze and determine the spread of a disease and its eradication.
4. Introduce the concept of emerging infectious disease; discuss the factors affecting its spread and the methods to control them.

Number of lectures: 60

UNIT I: Diagnostic methods in Clinical Microbiology (15 lectures)

1. Common staining procedures in Clinical Microbiology: Ziel Neelson Stain (2)
Spore stain
2. Invitro culture principles and applications: (5)
Culture media for inoculation of specimens, recommended procedure for inoculation of specimens, tests for distinguishing Gram positive organisms, tests for distinguishing Gram negative bacteria.
3. Serological diagnosis - Western blot, ELISA- types and applications (3)
4. Developments in diagnostic techniques (5)
 - a. Immunohistologic techniques
 - b. Molecular biology techniques
 - c. In situ hybridization
 - d. PCR
 - e. Microarrays.

UNIT II: Control and Prevention of Microbial Growth (15 lectures)

1. **Antimicrobials:** (two examples of each) (5)
 - a. Antibacterial agents – chemistry, category, mode of action, mechanism of resistance
 - b. and side effects of Cell wall inhibitors, inhibitors of protein synthesis, inhibitors of membrane function, DNA inhibitors, inhibitors with other modes of action, antituberculous agents
 - c. Antifungal antimicrobics
 - d. Antiprotozoan antimicrobics
 - e. Antiviral agents
 - f. Antiparasitic agents

2. **Antibiotic Use and Misuse: Mechanisms of Resistance: Transfer and Expression**
 - a. Natural Resistance (4)
 - b. Acquired Resistance eg. Tuberculosis
 - c. Physiologic Mechanisms of Drug Resistance
3. **Vaccines** (6)
 - a. Aims of Vaccination, Requirements of a good vaccine. Active and Passive
 - b. Immunisation
 - c. Designing vaccines for active immunization – Live, Attenuated vaccines, “Inactivated” or “killed” vaccines, Subunit vaccines, Conjugate vaccines, DNA vaccines.
 - d. Current vaccine practices- Recombinant vector vaccines (any two)
 - e. New and experimental vaccines (any two)
 - f. Monoclonal Antibodies
 - g. Phage display libraries.

UNIT III: Epidemiology and Public Health (15 lectures)

1. Definition, scope and uses of epidemiology (1)
2. Epidemiology and Public health – Cause of disease, Natural history, health status of populations, evaluating interventions (2)
3. Achievements in epidemiology (4)
 - a. Small pox
 - b. Iodine deficiency diseases
 - c. HIV/ AIDS
 - d. SARS
4. Measuring health and disease (3)
5. Public health surveillance: purpose and characteristics , identifying health problems for surveillance, collecting data for surveillance, analyzing and interpreting data, disseminating data and interpretation, evaluating and improving surveillance (5)

UNIT IV: Emerging Infectious Diseases (15 lectures)

1. Emerging disease patterns
2. Determinants of Emerging disease: (2)
 - a. Host- change in demographics
 - b. Pathogen- origins, adaptation, change (genotypic and phenotypic)
 - c. Environment- climatologic, geographic, topographic, ecologic.
3. Prevention goals (CDC, OIE, USDA: APHIS and others). (1)
4. Emerging viral diseases (6)
 - a. Severe Acute Respiratory Syndrome
 - b. H1N1 Influenza
 - c. Avian Influenza
5. Emerging Bacterial Infections (4)
 - a. Multi-drug resistant tuberculosis
 - b. MRSA
 - c. E. coli 0157:H7
6. Emerging Zoonotic Bacterial Pathogens (2)
Helicobacter species

References:

1. Ewald PW (1994) "Evolution of Infectious Disease" *Oxford University Press*.
2. Scheld WM, Armstrong D and Hughes JM (1998) "Emerging Infections 1" *ASM Press*.
3. Scheld WM, Craig WA and Hughes JM (1998) "Emerging Infections 2" *ASM Press*.
4. Horsburgh, CR Jr and Nelson AM (1997) "Pathology of Emerging Infections" *ASM Press*.
5. Morse SS (1993) "Emerging Viruses" *Oxford University Press*.
6. Hantavirus Herper DR and Meyer AS (1999) "Of Mice, Men, and Microbes" *Academic Press*.
7. Klenk HD (1999) "Marburg and Ebola Viruses. Current Topics in Microbiology and Immunology" *Springer*.
8. Schlesinger RW (1977) "Dengue Viruses" *Springer*.
9. Tortora, Funk and Case (1998) "Microbiology: An Introduction" *Benjamin/Cummings Publishing Company*.
10. Godkar, Praful B (1998) "Textbook of Medical Laboratory Technology Reprint" *Bhalani Publishing House*.
11. Goldsby, Richard, S. Kindt, Thomas J., Osborne, Barbara A(2000) "Immunology" *W.H. Freeman and Company*.
12. Greenwood, David, Slack, Richard C.B., Peutherer, John F (1992) "Medical Microbiology: A Guide to Microbial Infections, Pathogenesis, Immunity, Laboratory Diagnosis and Control" *English Language Book Society*.
13. Isenberg, Henry D (1998) "Essential Procedures for Clinical Microbiology" *ASM Press*.
14. Janeway, Charles A., Jr. Travers, Paul (1994) "Immunobiology: The Immune System in Health and Disease" *Blackwell Scientific Publications, Oxford*.
15. Jawetz, Melnick, Adelberg, Edward (1998) "Medical Microbiology" *Prentice Hall International Inc*.
16. Kuby and Janice (1991) "Immunology" *W.H. Freeman and Company*.
17. Mackie T J., McCartney, J.E. (1989) "Practical Medical Microbiology" *Churchill Livingstone*.
18. Koneman, Elrner W. Allen, Stephen D., Janda, William M. Schreckenberge, Paul C (1997) "Color Atlas and Textbook of Diagnostic Microbiology" *Lippincott-Raven Publishers*.
19. Mukherjee, Kanai L. (1988) "Medical Laboratory Technology" *Tata MacGraw Hill Publishing Co. Ltd*.

Practical Semester 9:

Course: SLSC09PR

*Cell Culture Techniques, Molecular Biology, Physiology and Medical Laboratory
Diagnostics*

1. Preparation of single cell suspension and viability count (dye exclusion/fluorescence)
2. Setting up Primary fibroblast cultures of chick embryo/ chicken liver
3. Trypsinization of monolayer and subculturing
4. MTT assay for cell viability
5. Cryopreservation of cultured cells
6. Preparation of paraffin blocks and tissue sectioning (microtomy) as a demonstration experiment
7. Histological studies of vertebrate tissue using HE staining (mouse/chick)
8. Isolation of DNA from *E. coli*.
 - a. Determination of purity of DNA using UV absorbance 260:280
 - b. Separation of DNA using agarose gel electrophoresis.
9. Isolation of plasmid DNA by the Alkali lysis method.
10. PCR amplification of a desired gene
11. RE digestion and insertion of DNA
12. Preparation of competent cells and transformation.
13. Selection and Screening of transformed cells.
14. Expression of recombinant protein-induced v/s un-induced state
15. Construction of a restriction map of plasmid DNA
16. Cognitive function tests (COG LAB): Tests for Attention, working and Memory span.
17. Neuronal enzyme assays: AChE/Na-K ATPase
18. Basic Hematology
 - a. CBC, platelet count, PCV, ESR.
 - b. Bleeding time, Clotting time.
19. Biochemistry of body fluids
 - a. Serum glucose by GOD-POD method and GTT
 - b. SGPT, SGOT and Bilirubin
 - c. Total protein and albumin
 - d. Serum cholesterol, Lipid profile: Triglycerides, LDL, HDL
20. Visit to Industry/ Research Institute/ IVF lab. (Optional)

Template of Theory Question paper

M.Sc. LIFE SCIENCE

Courses: 0901, 0902, 0903, 0904

CIA I – 20 marks, 45 mins.

Objectives/Short questions

CIA II – 20 marks

Test (*45 mins.*)/ Survey/ Assignment/ Presentation/ Poster/ Essay/ Review

End Semester exam – 60 marks, 2 hours

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

M.Sc. Life Science

Practical Evaluation

Course: SLSC09PR

CIA & End Semester Practical Exam

Total marks: 200

CIA

80 marks

ESE

120 marks

For CIA: (20 marks journal + 60 marks experiments/viva etc)

Department of Life Science and Biochemistry

M.Sc. II Life Science Exam Grid Semester 9					
Course	Exam	Knowledge and Information	Understanding	Application and Analysis	Total
0901	CIA	10	5	5	20
	CIA	10	5	5	20
	End semester	30	20	10	60
Course	Exam	Knowledge and Information	Understanding	Application and Analysis	Total
0902	CIA	10	5	5	20
	CIA	10	5	5	20
	End semester	30	20	10	60
Course	Exam	Knowledge and Information	Understanding	Application and Analysis	Total
0903	CIA	10	5	5	20
	CIA	10	5	5	20
	End semester	30	20	10	60
Course	Exam	Knowledge and Information	Understanding	Application and Analysis	Total
0904	CIA	10	5	5	20
	CIA	10	5	5	20
	End semester	20	20	20	60