Syllabus
For 3rd Semester Courses in
M.Sc. Life Science
(June 2015 onwards)

Contents:
Syllabus (Theory and Practical) for Courses:
M.LSC.3.01 Clinical Microbiology and Public Health
M.LSC.3.02 Human Physiology II
M.LSC.3.03 Molecular Biology and Recombinant DNA Technology
M.LSC.3.04 Analytical Techniques

Template for theory and practical question paper
LIFE SCIENCE  

M.Sc. Course No. MS.LSC.3.01

Title: Clinical Microbiology and Public Health

Learning Objectives:
On completion of the course, the student must be able to
1. Understand the principles of the diagnostic methods used in Clinical Microbiology.
2. This course provides an elaborate overview of all the possible mechanisms of controlling microbial growth and disease.
3. This course also aims to allow the students to have an insight into epidemiology of infectious diseases, analysing different public health measures that goes in to understanding the spread of the disease and its eradication.

Number of lectures: 60

UNIT I: Diagnostic methods in Clinical Microbiology (15 lectures)
1. Common staining procedures in Clinical Microbiology: Ziel Neelson Stain Spore stain (2)
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
   d. Antifungal antimicrobics
   e. Antiprotozoan antimicrobics
   f. Antiviral agents
   g. Antiparasitic agents
2. Antibiotic Use and Misuse: Mechanisms of Resistance: Transfer and Expression (4)
   a. Natural Resistance
   b. Acquired Resistance eg. Tuberculosis
   c. Physiologic Mechanisms of Drug Resistance
3. **Vaccines**
   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**

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

**UNIT IV: Emerging Infectious Diseases**

1. Emerging disease patterns
2. Determinants of Emerging disease:
   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).
4. Emerging viral diseases
   a. Severe Acute Respiratory Syndrome
   b. H1N1 Influenza
   c. Avian Influenza
5. Emerging Bacterial Infections
   a. Multi-drug resistant tuberculosis
   b. MRSA
   c. E. coli 0157:H7
6. Emerging Zoonotic Bacterial Pathogens
   Helicobacter species
References:

25. Nelson KE and Williams CM. Infectious Disease Epidemiology: Theory and Practice, Jones and Bartlett Publishers, Inc;
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M.Sc. Course No. MS.LSC.3.02

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:
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
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Course No. MS.LSC.3.03
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 eukaryoptic 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 RE and its mechanism of cleavage (self study) (1)
2. Vectors: plasmid, phage, transcription vectors, expression vectors (pGLO, lacZ), eukaryotic vectors
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:
   - Chain termination method, pyrosequencing, whole genome sequencing, contig mapping
7. Applications of gene cloning:
   - RFLPs, DNA fingerprinting, production of useful molecules, transgenic animals, transgenic plants, whole animal cloning, gene therapy, knock outs, knock down, knock-ins.

References:
2. Molecular Cell Biology - Lodish, Baltimore
4. Genetics – analysis of Genes & Genomes - Daniel L. Hartl & Elizabeth W. Jones
5. The Science of Genetics - Alan G. Atherly, Jack R. Girton & John F. McDonald
6. Genetics – a conceptual approach - Benjamin A. Pierce
7. Principles of Genetics - D. Peter Snustad & Michael J. Simmons
8. Introduction to Genetic analysis - Griffiths, Wessler, Lewontin, Gelbart, Suzuki & Miller
9. Genetics - Weaver et al.
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Course No. MS.LSC.3.04

M.Sc.

Title: Analytical Techniques

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

1. To be aware of the various approached used in the study of biological samples.
2. To understand the principles of separation and investigation applied to analysis of biological samples.
3. To identify current trends in calibrations and certifications association with instrumentation techniques (to be covered in practicals).

Number of lectures: 60

UNIT I: Methods based on separation (15 lectures)

A. Centrifugation (5)

1. Basic principles; Theory (RCF, Sedimentation coefficient, etc)
2. Types of centrifuge - microcentrifuge, clinical, high speed and ultracentrifuges
3. Types of centrifugation: Preparative centrifugation; Analytical centrifugation . [Differential & density gradient centrifugation]
4. Applications: Isolation of cell components , Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

B. Chromatography techniques:
Partition, Thin Layer, Gas, Molecular Exclusion, Ion-exchange , Affinity, Reverse phase, HPLC and FPLC

UNIT II: Methods based on electromagnetic spectrum (15 lectures)

1. Electromagnetic spectrum and Interaction of radiation with matter. (guided study) (1)
2. Measurement of transmission and absorbance- (Beer’s Law derivation). (2)
3. UV and Visible spectrophotometry. (2)
4. IR spectroscopy. (1)
5. Atomic absorption and Atomic emission spectroscopy. (3)
6. Introduction to : ( Principle and application in biology) (6)
   i. NMR spectroscopy.
   ii. ORD and CD spectroscopy.
   iii. X-ray Diffraction
   iv. Fluorescence spectroscopy

UNIT III: Methods based on electrophoresis/ fragmentation techniques/ thermal analysis etc. (15 lectures)

1. Electrophoresis: Discontinuous, Iso-electric focusing, 2D, Capillary electrophoresis, Pulsed field electrophoresis (6)
2. Methods based on fragmentation and hyphenated techniques – (4)
   An introduction to:
   a. Mass spectrometry
   b. LC-MS.
3. Methods based on heat of interaction/thermal analysis/binding constants (5)
   a. Isothermal Calorimetry (ITC)
   b. Surface Plasmon Resonance Spectroscopy (SPR)

UNIT IV: Investigative methods based on Microscopy, Radioactivity (15 lectures)

1. Microscopy (Self-study) (8)
   a. Principles of light microscopy
   b. Phase contrast microscopy
   c. Fluorescence microscopy – Epifluorescence, Confocal
   d. TEM, SEM
   e. Atomic force microscopy/SFM
2. Methods based on Radioactivity: (7)
   a. Radioactive rays and their properties.
   b. Measurement of Radioactivity.
3. Detection of Radioactivity, GM counters and Scintillating counters
4. Application of radioactivity in biology, RIA.

References:

1. Instrumental methods of analysis, D. Skoog
2. Instrumental methods of chemical analysis, G.R. Chatwal
5. Tools of Biochemistry, Terrance Cooper
Practical Semester 3:
Course: MS.LSC.3.PR
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
7. Study of Flow cytometry based assays for apoptosis and interpretation of results : AnnexinV staining, Mitochondrial Membrane Permeability, Caspase assays (any 2)
8. Preparation of paraffin blocks and tissue sectioning (microtomy) as a demonstration experiment
9. Isolation of DNA from plant, animal and microbial sources.
   a. Determination of purity of DNA using UV absorbance 260:280
   b. Separation of DNA using agarose gel electrophoresis.
10. Isolation of plasmid DNA by the Alkali lysis method.
11. PCR amplification of a desired gene
12. RE digestion and insertion of DNA
13. Preparation of competent cells and transformation.
14. Selection and Screening of transformed cells.
15. Expression of recombinant protein-induced v/s un-induced state
16. Construction of a restriction map of plasmid DNA
17. Histological studies of vertebrate tissue using HE staining (mouse/chick)
18. Study of ECG/EEG tracings
20. Neuronal enzyme assays: AChE/Na-K ATPase
21. Basic Hematology
   a. CBC, platelet count, PCV, ESR.
   b. Bleeding time, Clotting time.
22. 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
23. Visit to path lab/hospital for automation. (Optional)
M.Sc. Life Science
Practical Evaluation

Semester 3
- CIA – 20 marks x 3 = 60
- 20 marks for lab visits = 20
  ESE - 30 marks x 4 = 120
  \[\frac{200\text{ marks}}{}\]

For CIA: (20 marks journal + 40 marks experiments/viva etc + 20 marks lab visits)
  Or
  (20 marks journal + 60 marks experiments/viva etc)

M.Sc. LIFE SCIENCE

Courses 3.01, 3.02, 3.03, 3.04
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%