St. Xavier's College (Autonomous),

Mumbai

Syllabus of the courses offered by the Department of Life Science and Biochemistry (2017-18)

St. Xavier's College – Autonomous Mumbai

Syllabus
For 1st Semester Courses in
M.Sc. Life Science
(June 2015 onwards)

Contents:

LIFE SCIENCE

M.Sc. **Course No. MS.LSC.1.01**

Title: Genetics and Evolution

Learning Objectives:

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

1. To understand the origin of life and the geological eras
2. To describe Darwin's theory of evolution and understand the nature of genetic variation in populations, natural selection, microevolution, reproductive isolation and speciation
3. To understand the inheritance patterns of Mendelian and Non-Mendelian traits
4. To understand how multifactorial conditions defer from the classical Mendelian single gene disorders
5. To understand linkage disequilibrium, its quantification and its relationship to SNP tagging and genetic association studies
6. To explain the Hardy-Weinberg law of equilibrium and to solve a simple Hardy-Weinberg equation to calculate genotype frequencies

Number of lectures: 60

UNIT I – Evolution **(15 lectures)**

1. Origin of life and geological time scale (4)

2. Introduction to Darwinian evolution (3)
   a. Pre Darwinian theories of evolution
   b. Darwinian evolution
   c. Evidences for evolution

3. Speciation and macroevolution (5)
   a. Reproductive isolation
   b. Modes of speciation
   c. Macroevolution

4. Convergent evolution and sexual selection (3)

UNIT II – Transmission genetics **(15 lectures)**

1. Basic Mendelian pedigree patterns and its complications (5)
   Nonpenetrance-failure of a dominant condition to manifest
   Molecular markers in human pedigrees (any two examples)

2. Non-Mendelian ratios: (4)
   Penetrance and expressivity, Pleiotropy, Phenocopies, Uniparental Disomy, Incomplete dominance and Epistasis

3. Genetics of multifactorial characters: (6)
   Polygenic inheritance and the normal distribution
   Multifactorial inheritance – the liability/ threshold model
   Studying multifactorial traits – adoptees and twins

UNIT III – Association studies and linkage disequilibrium (15 lectures)

1. Linkage and recombination of genes in a chromosome
2. Resolution of genetic heterogeneity by linkage analysis
3. Studying linkage disequilibrium – HapMap project, use of tag-SNPs
4. Mapping and identifying disease genes and mutation

UNIT IV – Evolutionary change in populations (15 lectures)

1. Genotype, phenotype and allele frequencies
2. Hardy-Weinberg principle
3. Random mating and Hardy-Weinberg (HW) equilibrium
4. Relationship between gene frequency and heterozygosity
5. Microevolution
6. Genetic variation in populations

References:

1. Human Genetics By Ricky Lewis
2. Methodology in Human Genetics By AEH Emery
3. Human Genetics By F. Vogel
4. Human Molecular Genetics By John Reid & Tom Strachan.
5. Genetics – analysis of Genes & Genomes - Daniel L. Hartl & Elizabeth W. Jones
6. The Science of Genetics - Alan G. Atherly, Jack R. Girton & John F. McDonald
7. Genetics – a conceptual approach - Benjamin A. Pierce
8. Principles of Genetics - D. Peter Snustad & Michael J. Simmons
9. Introduction to Genetic analysis - Griffiths, Wessler, Lewontin, Gelbart, Suzuki & Miller

LIFE SCIENCE

M.Sc. **Course No. MS.LSC.1.02**

Title: Scientific communication, Research methodology, Intellectual Property Rights, Entrepreneurship

Learning Objectives:

The objectives of this course are to enable a student to:

1. Comprehend and write a scientific research paper.
2. Use scientific software to analyze and present data for research.
3. Design, execute and statistically analyze experiments using the principles of scientific research methodology.
4. Understand Intellectual property rights and patent law applicable to bio-entrepreneurship.
5. To convert an idea into a viable business model for entrepreneurship.

Number of lectures: 60

UNIT I: Communication Skills **(15 lectures)**

1. Introduction to the structure of a scientific research paper
2. Reading a scientific research paper and construction of an abstract
3. Usage of software in writing research paper (to construct graphs, bibliography, etc.)
4. Writing a scientific research paper
5. Designing a poster/ MS-Powerpoint presentation from a paper.

UNIT II: Research Methodology **(15 lectures)**

1. Introduction - Basic research, Applied research, Need-based research
2. Identifying and defining the problem
3. Planning a research project
4. Literature search - information sources, library resources - books, journal, abstracts hand books, procedure manuals, encyclopaedia, annual reports, data banks, CDROMS, online literature search - internet access, websites, directories of information resources
5. Experimental design - approaches to research design - descriptive, correlational, experimental, semi-experimental, meta-analysis, pilot study
6. Progress of research - Research communication - use of statistical tools in presentation of research findings, need for peer-review, publication of research findings (impact factor, citation index)

UNIT III: Intellectual Property Rights **(15 lectures)**

1. Intellectual property rights: meaning, evolution - classification and forms
2. Rationale for protection of IPRs - importance of IPRs in the fields of science and technology
3. Patents - concepts and principles of patenting - patentable subject matter (Biotechnology and IPR - microorganisms as inventions, plant varieties, food security, genetic engineering, biodiversity, bioinformatics software protection, sharing of biological R&D material)
4. Procedure for obtaining patents - rights of patents - infringement of patent rights

5. Remedies for infringement of patent right - Patentability and emerging trends (National and International scenario - IPO, TRIPs)

UNIT IV: Entrepreneurship **(15 lectures)**

1. Concept, definition, structure and types of entrepreneurship
2. Process of entrepreneurial development
   a. Planning a New Enterprise
   b. Policies and Schemes
   c. Entrepreneur competency (leadership)
3. Product planning and development
   a. Concept of projects, project management
   b. Search for business idea - opportunity identification, project selection and formulation
   c. Design and network analysis - Institutional interphase for enterprise eg. Entrepreneurship Development Institute of India (EDII), Small industries, Service institute, Banks and financial institutions
   d. Project report and project appraisal (case study)
4. Ethical decision making, ethical dilemmas

References:

1 Dr. Vasant Desai, "Small scale industries and entrepreneurship", Himalayan Publishing House
2 Dr. Vasant Desai, "Dynamics of entrepreneurial development and Management" Himalayan Publishing House
3 Corporate Entrepreneurship – Paul Burns
4 The Oxford Handbook of Entrepreneurship
5 Entrepreneurship in the New Millenium – Kutatko Hodgetts.
6 Collins ipand Lazier W, "Beyond entrepreneurship", Prentice Hall , New Jersey, 1992 Hisrich Peters Shephard, "Entrepreneurship", Tata McGraw Hill
7. John W. Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches"
8. Geoffrey R Marczyk, "Essentials of Research Design and Methodology"
9. Vernon Booth, "Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings" (2nd Edition)
10. Robert A. Day "How to Write & Publish a Scientific Paper" 5th Edition
11. Janice R. Matthews, John M. Bowen, Robert W.,"MatthewsSuccessful Scientific Writing: A Step-By-step Guide for the Biological and Medical Sciences"
12. Petter Laake, Haakon Breien Benestad, Bjorn Reino Olsen, "Research Methodology in the Medical and Biological Sciences"
13. Gurumani , "Research Methodology For Biological Science"
14. Ganguli,P., "Intellectual Property Rights"
15. Acharya, N.K.,"Text Book on Intellectual Property Rights"

LIFE SCIECE

M.Sc. **Course No. MS.LSC.1.03**

Title: Biochemistry

Learning Objectives:

On completion of the course, the student must:

1. Know the various physical forces that exist between molecules, the relative movements and interactions that arise due to these forces and the theories that explain them
2. Understand fundamental thermodynamics
3. Be clear about protein structure and the relation of protein folding to its function
4. Comprehend basic enzymology.
5. Understand metabolism, hormonal regulation and the association of metabolic disorders with biomolecules.

Number of lectures: 60

UNIT I **(15 lectures)**

1. Introduction to forces in biology 6)
   a. Van der Waals forces.
   b. Electrostatic and double layer forces (DLVO theory).
   c. Hydration and hydrophobic forces.
   d. Polymer-mediated tethering forces (steric, bridging and depletion forces).
   e. Formation of micelles and liposomes.
2. Concepts of solute movement in Cells and Tissues (4)
   a. Brownian motion.
   b. Diffusion and osmosis.
   c. Viscosity (Reynolds numbers, motors and propulsion).
3. Thermodynamics (5)
   a. Free energy- standard free energy and its relation to temperature & pressure.
   b. Near equilibrium conditions for biochemical reactions.
   c. Redox reactions & high energy phosphate bonds.

UNIT II **(15 lectures)**

1. Protein structure – primary, secondary, super-secondary, tertiary & quaternary structure. (3)
2. Protein folding : (6)
   a. Levinthal paradox,
   b. Models of protein folding,
   c. Role of GroEL-ES system in *in vivo* protein folding.
3. Supramolecular assembly – T-even phage / Lipid Bilayer / Quadruplex DNA. (2)
4. Co-operativity in protein function – Hb – O_2 binding, muscle contraction. (2)
5. Function of multi-subunit protein – ATCase enzyme / PFK enzyme. (2)

UNIT III **(15 lectures)**

1. General principles of enzyme catalysis – acid-base, covalent, metal-ion assisted. (3)
2. Kinetics of single substrate enzyme-catalysed reactions:
   a. Michaelis-Menten equation, Kinetic studies using MM plot,

b. Lineweaver Burk plot,
c. Eddie- Hofstee plot,
d. Woolf's plot. (4)

3. Kinetics of allosteric enzyme-catalysed reactions: Hill's equation, Hill's coefficient and its significance. (3)
4. Enzyme inhibition: reversible, irreversible, allosteric. (5)

UNIT IV **(15 lectures)**

1. Basic cellular metabolism (schematics only). (7)
   a. Carbohydrates: Glycolysis, TCA cycle, Gluconeogenesis, Glycogenesis.
   b. Lipids: Synthesis and breakdown of TAGs.
   c. Amino acids: Deamination, transamination, Urea cycle.
2. Hormonal regulation and integration of metabolism. (3)
3. Metabolic changes associated with disease / disorder (5)
   a. Diabetes mellitus (endocrine).
   b. Hepatic dysfunction (alcohol-induced cirrhosis).
   c. Anorexia (psychosomatic).
   d. Dyslipidemia / Hypercholesterolemia (dietary).

References

1. Basic Concepts in Biochemistry, A Student's Survival Guide Second Edition, Hiram F. Gilbert.
2. Biochemistry, L. Stryer.
3. Principles of Biochemistry, Lehninger, Nelson and Cox.
4. Biochemistry, Voet and Voet.
5. Fundamentals of Enzymology, Price and Stevenson.
6. Enzymes, Dixon and Webb.
7. Quarterly Reviews of Biophysics 34, 2 (2001), pp. 105–267. 2001 Cambridge University Press DOI: 10.1017/S0033583501003687 Printed in the United Kingdom

LIFE SCIENCE

M.Sc. **Course No. MS.LSC.1.04**

Title: Basic Mathematics and Biostatistics

Learning Objectives:

1. To equip students with mathematical and statistical concepts and methods.
2. To introduce students to the display and communication of statistical data. This will include graphical and exploratory data analysis.
3. To help students understand estimation, testing and interpretation for single group summaries such as mean, median, variance, correlation and regression.
4. To promote an understanding of the basics of hypothesis testing, confidence intervals and the interpretation and application of commonly used statistical tests – Z, t, Chi square.
5. To aid in the understanding of the basic concepts of ANOVA.

UNIT I **(15 lectures)**

1. Matrices and determinants (5)
2. Limits and derivatives (5)
3. Differential equations (5)

UNIT II **(15 lectures)**

1. Collection, tabulation and graphical representation of data, frequency distribution. (2)
2. Measures of central tendency (for grouped & ungrouped data) (3)
3. Skewness and Kurtosis (1)
4. Measures of dispersion (3)
5. Concept of sampling, sampling techniques, standard error (3)
6. Simple correlation and regression (3)

UNIT III **(15 lectures)**

1. Concepts of Probability (1)
2. Theories of Probability – Additive and multiplicative theory (2)
3. Binomial, Poisson and Gaussian (Normal)distribution (2)
4. Measure of location (Z score, percentile rank and percentile) (2)
5. Hypothesis Testing - Null hypothesis, Alternative hypothesis, Levels of significance, Type I , Type II error, Critical region (2)
6. Test of significance of Mean :(Z test and t test), Test for proportion (6)

UNIT IV **(15 lectures)**

1. One-way ANOVA, Tukey's post hoc test (3)
2. Two-way ANOVA (4)
3. Design of experiment : randomized design, randomized block and factorial experimental designs (3)
4. Non- parametric tests- Chi-square test of goodness of fit. Sign test, Wilcox test for unpaired test (5)

References:

1. Introduction to Biostatistics, N. Gurumani (2005), PJ publishers
2. Biostatistics: A foundation for analysis in health sciences, W. W. Daniel (1999), John Wiley and sons
3. Biostatistical Analysis by C. Zar, Pearson pub
4. Biostatistics By Khan and Khanum
5. Fundamentals of Biostatistics By P.H. Rao and Janardhan
6. Population Genetics By V. Venugopal and Pratibha Nallari
7. Biostatistical Methods in Agriculture Biology and Medicine By Khan and Khanum

Practicals Semester 1:
Course: MS.LSC.1.PR

Protein Biochemistry and Biostatistics

1. General Laboratory Instructions, Safety and Rules

2. Making of Solutions.

3. Calibration, Accuracy and Precision
   a. Quality assurance; IQ, OQ, PQ and DQ
   b. GLP and GMP compliance
   c. Classification of Instrumental methods
   d. Methods of expressing accuracy and precision
   e. Calibration of Micropipettes, Glass pipettes and other Measuring containers.

4. Use of general lab instruments and their calibration and care: pH meter, Balance etc.

5. Study of Henderson-Hasselbach Equation and calculations for Buffer preparation

6. Amino acid titration

7. Estimation of Protein by various methods: Biuret, Folin Lowry, Bradford and UV. (Use of microlitre volumes and microtitre plate reader for measurements)

8. Comparison of different methods for cell-lysis (yeast cells/bacterial cells and estimation of protein content in cell free supernatant)

9. Protein Purification: extraction and semi-purification of an enzyme (Beta-Amylase/Acid Phosphatase/ beta-galactosidase)
   a. Crude enzyme assays and determination of optimum conditions
   b. Cell lysis
   c. Ammonium sulfate fractionation and dialysis
   d. Column chromatography (Ion exchange/ Gel filtration)
   e. Determination of Specific activity.
   f. Enzyme kinetics
   g. Effect of inhibitors on enzyme reaction
   h. Immobilization of enzyme/ yeast (invertase) and determination of enzyme activity

10. Electrophoresis of Proteins
    a. Native PAGE (Activity staining: LDH/Amylase)
    b. SDS PAGE (CBB/ Silver Staining)
    c. Demonstration of Western Blot

11. Biostatistics Problem

12. Use of MS Excel for Plotting Graphs and calculations

M.Sc. Life Science
PRACTICAL EVALUATION

Semester 1 - CIA - 20 marks x 4 = 80
ESE - 30 marks x 4 = 120
200 marks

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

M.Sc. LIFE SCIENCE

Courses 1.01, 1.02, 1.03, 1.04
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%

St. Xavier's College – Autonomous Mumbai

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

Contents:

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, Thalassemia. (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 Tizzard , 4th ed., SaundersCollege 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. Syphillis
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. : Immumnology 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 B_{12})

M.Sc. Life Science
PRACTICAL EVALUATION

Semester 2 - CIA – 20 marks x 3 = 60
- 20 marks for lab visits = 20
ESE - 30 marks x 4 = 120
200 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%

St. Xavier's College – Autonomous Mumbai

Syllabus
For 3rd Semester Courses in
M.Sc. Life Science
(June 2016 onwards)

Contents:

Syllabus (Theory and Practical) for Courses:

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. Developmemts 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
   c. 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
   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 (5)
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 **(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. 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",
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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 Ed. 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;

LIFE SCIENCE

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: Parkinsons'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. 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.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 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. Molecular Biology of the Gene- Watson, Baker, Bell, Losick, et al.
2. Molecular Cell Biology- Lodish, Baltimore
3. Molecular Biology of the Cell- Alberts, et al.
5. Genetics – analysis of Genes & Genomes - Daniel L. Hartl& Elizabeth W. Jones
6. The Science of Genetics - Alan G. Atherly, Jack R. Girton& John F. McDonald
7. Genetics – a conceptual approach - Benjamin A. Pierce
8. Principles of Genetics - D. Peter Snustad & Michael J. Simmons
9. Introduction to Genetic analysis -Griffiths, Wessler, Lewontin, Gelbart, Suzuki & Miller
10. Genetics- Weaver et al.

LIFE SCIENCE

M.Sc. **Course No. MS.LSC.3.04**

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. (1) (guided study)

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
3. Instrumental methods of analysis, Willard and Merrit.
4. Methods in Spectroscopic analysis, Simon Duckett.
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
6. Visit to a research institute –Electron microscopy (SEM, TEM), Confocal Microscopy, Flow Cytometry.
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
19. Cognitive function tests (COG LAB): Tests for Attention, working and Memory span.
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
		200 marks

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

St. Xavier's College – Autonomous Mumbai

Syllabus
For 4th Semester Courses in
M.Sc. LIFE SCIENCE
(June 2016 onwards)

Contents:

LIFE SCIENCE

M.Sc. **Course No. MS.LSC.4.01**

Title: Human Genetics

Learning Objectives:

On completion of the course, the student must:

1. Understand the concepts of human genetics, in particular, the general features and organization of the human genome, conventional and molecular cytogenetics, chromosomal abnormalities and the human genome project.
2. Comprehend mitochondrial genome organization and its relevance to human evolution.

Number of lectures: 60

UNIT I **(15 lectures)**

1. History of Human Chromosome Research - Denver Conference (1940) -
2. Chicago Conference (1966) - Paris Conference (1971) -Nomenclature of Human Chromosome (2)
3. Nuclear genome: General features and organization of Human Genome (3)
4. Unique sequences and families of reiterated sequences (2)
5. Extragenic repeated sequences and transposable elements, LINES and SINES (3)
6. Gene families: Clustered and Dispersive : eg histone gene clusters, haemoglobin gene clusters (2)
7. Pseudogenes (1)
8. Human genome and the last five million years. (2)

UNIT II **(15 lectures)**

1. Identification of Human diploid chromosome –
a. peripheral blood cultures
b. banding techniques - G-band; Q-band C-band R-band
c. Identification of 23 pairs of Human chromosomes by band position, Chromosomal shape, karyotype, ideogram.
d. An International System for Human Cytogenetic Nomenclature (ISCN) (4)
2. Molecular cytogenetics
a. Fluorescent in situ hybridization (FISH)- principle and technique chromosome painting and molecular karyotyping
b. Comparative genome hybridization(CGH). (3)
3. Perinatal diagnosis & counselling (3)
a. Prenatal diagnosis**:** Chorionic villi samplingFoetoscopy, Ultrascopy, Amniocentesis
b. Postnatal diagnosis
c. Pre-Implantation genetic diagnosis
d. Genetic Counseling and carrier detection
4. Chromosomal syndromes**:** Autosomal syndromes, Sex chromosomal syndromes, Structural chromosomal syndromes (one example each). (2)
5. Genomic imprinting – Mechanism of genomic imprinting, Angelman syndrome/ Prader-Willi syndrome (3)

UNIT III **(15 lectures)**

1. Mitochondrial genome organization. (1)
2. Human Mitochondrial Mapping – Human Mitochondrial genome (3)
3. Mitochondrial DNA & Aging in Human – Mechanism of age-related increase in mtDNA damage, decline of oxydative phosphorylation capacity with age, late onset degenerative diseases. (4)
4. Transcription and translation of mt genes. (3)
5. mtDNA & human disease (2)
6. Tracing Human History through Mitochondrial DNA –To study Human evolution using mtDNA. (2)

UNIT IV **(15 lectures)**

1. Goals of the project, major scientific strategies & approaches used in HGP. (1)
2. How Human genome was mapped and sequenced: physical mapping, genetic mapping. (6)
3. Technologies used–RFLP, microsatellite markers, STS, EST, DNA microarray (6)
4. HGP & its impact. (2)

References:

1. Human Genetics - By Ricky Lewis
2. Methodology in Human Genetics By AEH Emery
3. Human Genetics By F. Vogel
4. Human Molecular Genetics By John Reid & Tom Strachan.
5. Genetics – analysis of Genes & Genomes - Daniel L. Hartl& Elizabeth W. Jones
6. The Science of Genetics - Alan G. Atherly, Jack R. Girton& John F. McDonald
7. Genetics – a conceptual approach - Benjamin A. Pierce
8. Principles of Genetics - D. Peter Snustad & Michael J. Simmons
9. Introduction to Genetic analysis -Griffiths, Wessler, Lewontin, Gelbart, Suzuki & Miller
10. Genetics – Analysis of Genes and Genomes – 8th Ed. , Daniel L. Hartl and Maryellen Ruvolo, 2012, Jones and Bartlett India Pvt. Ltd.

LIFE SCIENCE

M.Sc. **Course No.: MS.LSC.4.02**

Title: Pharmacology and Nutraceuticals

Learning Objectives:

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

1. Understand the basis of drug action (pharmacodynamics)
2. Describe the various strategies used in pharmacotherapy
3. Explain the concept drug metabolism (pharmacokinetics)
4. Discuss the influence of genetic constitution of an individual on drug response
5. Summarize the principles of clinical pharmacology
6. Explain the tenets in the emerging field of nutraceuticals

Number of lectures: 60

UNIT I: General Principles of Pharmacology (15 lectures)

1. Introduction to Pharmacology (3)
   a. Basic terminology
   b. Sources of drugs and nomenclature of drugs
   c. Routes of drug administration
2. Drug-receptor interactions (pharmacodynamics) (4)
   a. Classification of drug receptors
   b. Principles of drug action – quantal and graded dose-response curves
   c. Theories of drug-receptor interaction – occupancy theory (agonist / antagonist), modified occupancy theory (agonist), allosteric theory (partial agonist)
3. Factors modifying drug-receptor interactions
4. Drug Enzyme interactions (pharmcodynamics) (3)
   a. Classification of enzymes inhibitors
   b. Examples of drugs that are enzymes inhibitors (competitive, non-competitive, uncompetititive and irreversible)
5. Drug Metabolism (5)
   a. Definition, Need, Consequences
   b. Organs involved in DM, Enzymes involved
   c. Phase-I and phase-II transformations
   d. Concept of hard and soft drugs

UNIT II: Pharmacotherapy (15 lectures)

1. Strategies in drug therapy (based on **any one** prototype drug for each) (5)
   a. Central nervous system: antidepressants
   b. Respiratory system: pharmacotherapy of bronchial asthma
   c. GI system: antacids
   d. Cardiovascular system: beta adrenergic blockers
   e. Endocrine system: thyroid modulators
2. Drug delivery systems in pharmacotherapy (4)
   a. Modified or Controlled drug release systems
   b. Targeted delivery system: liposomes
   c. Nanoparticular systems: coated-nanoparticles, nanogels
3. Pharmacogenomics (6)

a. Genomics of PD profile (receptor-allelic variation)
b. Genomic of PK profile (*CYP*-allelic variation)
c. Database resources in pharmacogenomics
d. Methods in pharmacogenomics: association- & expression-based cheminformatics

UNIT III: Clinical pharmacology **(15 lectures)**

1. General pathway of drug discovery/development (3)
2. Pharmacological screening models for therapeutic areas (one case study) (4)
3. Clinical trials – rationale and phases (4)
4. Ethical and regulatory aspects of clinical trials in India (4)

UNIT IV: Nutraceuticals **(15 lectures)**

1. Concept of nutraceuticals and functional foods (1)
2. Classification of nutraceuticals – chemical and biochemical basis (1)
3. Sources and uses of nutraceuticals (4)
4. Disease-management using nutraceuticals (case studies) (4)
5. Monitoring of multi-component phytopharmaceuticals (3)
6. Safety issues regarding nutraceutical consumption (case studies) (2)

References

1. Goodman Gillman's The Pharmacological basis of therapeutics. (2001) Ed. Hardman JG, Limbird LE (Tenth Edition) McGraw Hill press New York.
2. Applied biopharmaceutics and pharmacokinetics (1999) Ed. Shargel L. (4th Edition) Prentice-Hall International, London.
3. Fundamentals of experimental pharmacology. (1984) Ed.Ghosh MN. Scientific book agency, Calcutta.
4. Text book of receptor pharmacology (1996) Eds. Forman JC, Johansen TJ. CRC Press, New York
5. Drug Discovery and Evaluation –Pharmacological assays. (1997) Ed.Vogel HG & Vogel WH. Springer- New York.
6. Methods of Analysis for Functional Foods and Nutraceuticals. Chadwick R., Henson S., Mosley B., Hurst G.W.
7. A guide to understanding dietary supplements. Tracy T.S. et al.
8. Pharmacology-related journals from PubMedCentral (refer study pack for papers)

LIFE SCIENCE

M.Sc. **Course No. MS.LSC.4.03**

Title: Laboratory Management and Routine Diagnostics

Learning Objectives:

The course aims to:

1. Introduce students to basic clinical laboratory setup as well as GLP and accreditations
2. Help students understand routine analysis of biological fluids and specific organ function tests, and their clinical significance
3. Introduce students to non invasive methods for diagnosis

Number of Lectures: 60

UNIT I **(15 lectures)**

1. Introduction to Clinical Laboratory (6)
   a. Standard Clinical Laboratory set up
   b. Decontamination and Disinfection.
   c. Sterilization techniques
   d. Hazard analysis, Safety Data Sheets, and First Aid Kit.
2. Collection, transport and examination of specimen. (2)
3. Total Quality Management: (7)
   a. Quality Control mechanisms, (Internal and External)
   b. Preparation of lab report and cataloguing.
   c. Basic principles of accreditation of labs, (ISO and NABL).
   d. GLP

UNIT II **(15 lectures)**

1. Routine Blood tests (2)
   a. Complete Blood Count and Hematological Indices.
   b. PCV, ESR
   c. Reticulocyte count
2. Variants of hemoglobin and Abnormal hemoglobin identification. (2)
3. Erythrocyte disorders (at least two) (3)
4. Hemostasis, coagulation and routine coagulation tests (7)
   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
5. Basic principles of blood banking. (1)

UNIT III **(15 lectures)**

1. Cardiac profile tests
2. Liver function tests
3. Kidney function tests
4. Thyroid function tests

5. Pulmonary function tests

UNIT IV **(15 lectures)**

1. Routine analysis of body fluids; urine, sputum, CSF, semen, cavity fluids: pericardial, peritoneal and synovial. (7)
2. Parasitology and routine examination of feces.
3. Histopathological approaches to diagnosis (4)

a. Fixation and fixative tissue processing
b. Immunostaining
c. PAP smear.

4. Non-invasive imaging techniques-MRI, CT scan, PET scan, fdg-PET (4)

References:

1. Text book of medical laboratory technology 2nd ed. Dr. P.B. Godkar
2. Lynch's medical laboratory technology by S.S.Raphael 3rd ed.
3. Clinical diagnosis and management by Todd, Sanford and Davidsohn, 7th ed.
4. A manual of medical laboratory technology by A.H. Patel
5. Biology of diseases by Nessar Ahmed, Maureen Dawson, Chris Smith and Ed Wood
6. Technology in the hospital by Joel D. Havell
7. Theory and practice of histological techniques-edited by John D Bancroft and Alan Stevens, 2nd ed.

LIFE SCIENCE

M.Sc. **Course No. MS.LSC.4.04**

Title: Applied Biology

Learning Objectives:

The course intends to:

1. Provide the student with information of basic principles, recent developments and scope of some contemporary areas of nanosciences, stem cell research and forensic science in biology research and medicine.

Number of lectures: 60

UNIT I: Nanotechnology **(15 lectures)**

1. Introduction to Nanoscience and Nanotechnology
   A. History, Definitions, Dimensions – The 'Nano' Scale (1)
   B. Overview of different nanomaterials available (4)
   Carbon based materials – CNT, Fullerenes; Quantum dots; Self-assembled nanomaterials; Core-shell particles [Metals and alloys, Semiconductors, Ceramic and glassy materials, Composites, Zeolites, Porous silicon, Aerogels, Hydrogels]
   C. Unique properties of nanoscale material (2)
   Importance of surface, particle size and particle orientation
   Mechanical, Structural, Optical and Magnetic properties, Melting, Electrical conductivity
   D. Synthesis and fabrication of nanomaterials (Guided self-study) (1)
   Physical, Chemical, Biological (Microbes, Plant extracts, Protein and DNA)
   E. Tools of Nanoscience (Self study – covered in M.LSC.2.04 Analytical Techniques) (1)
   Electron microscopy, SEM, TEM

2. Applications of Nanotechnology:
   A. Biomedical - Imaging and diagnostics, Cancer detection, Drug delivery, Tissue regeneration (3)
   B. Environmental - Water, Air and Soil – Monitoring and mitigation (1)
   C. Energy (Solar cells, fuel cells, batteries) (1)

UNIT II: Stem Cell Biology **(15 lectures)**

1. The Evolving Concept of a Stem Cell : Definitions, Criteria and Standards (1)
2. Embryonic Stem Cells : An overview of Embryogenesis (Fertilization to Gastrulation – Guided Self Study), Molecular pathways of Pluripotency (NOTCH, BMP, Sonic Hedgehog pathways), Human ES cells and Directed Differentiation, Cord Blood Stem Cells. (5)
3. Adult Stem Cells (W.R.T. Hematopoeitic and Neural Stem Cells): Stem Cell Niche, Tissue-specific Stem Cells, Induced Pluripotent Stem Cells (iPS), Transdifferentiation (5)
4. Stem Cell Research:

   a) Ethical and Religious issues and Regulatory considerations (1)

b) Potential applications and Future Challenges : i) Cell Replacement Therapies, Tissue Engineering, Stem Cell Gene Therapy (Translational Stem Cell Medicine) (3)

UNIT III: Forensic Science **(15 lectures)**

1. Introduction to Forensic Science & Forensic Medicine (2)
2. Body Offences[a] (1)
3. Medical Investigations in Body Offences (incl Decomposition) (1)
4. Autopsy / Post-mortem (& Virtuopsy)[a] (2)
5. Ante-mortem Toxicology (1)
6. Post-mortem Toxicology (2)
7. Skeletonized Bodies (Forensic Anthropology)* (2)
8. Forensic Odontology (1)
9. Facial Reconstruction for Identification[a] (2)
10. Biometrics in Human Identification[a] (1)

UNIT IV: Genetics and Immunology in Forensic Science **(15 lectures)**

1. Introduction to Instrumentation (related to gen-immuno) (1)
2. Processing of Biological forensic samples* (1)
3. Body fluids as evidence* (2)
4. Introduction to DNA as evidence (Civil v/s Criminal cases) (2)
5. DNA - sexual assault & body offences (2)
6. Interpretation of Forensic DNA Analysis (incl Statistics)[a] (1)
7. Mitochondrial DNA in Forensics (1)
8. DNA in Wildlife crime, Forensic Botany & Microbiology (2)
9. Primers in Forensic DNA Analysis[a] (1)
10. Forensic Immunology[a] (2)

*Practical [a] assignment

References:

Lanza R. et al (Eds) Essentials of Stem Cell Biology, 2nd Ed. 2009.

Considering the wide scope and dynamic nature of the topics being dealt with, review articles and research papers shall also be a major information resource.

Practical Semester 4:
Course: MS.LSC.4.PR
Pharmacology and Forensics

1. Chemical estimation of any one active drug principle using methodology obtained from Pharmacopoeia (spectrophotometric).
2. Study of any one database used in pharmacogenomics.
3. Chemical assay on any one nutraceutical to determine active principle(s).
4. Skeletonised Bodies (Forensic Anthropology)
5. Processing of Biological forensic samples.
6. Body fluids as evidence.

Research Project

M.Sc. Life Science
Practical Evaluation

Semester 4 - CIA - 20 marks x 4 = 80
ESE – project = 120
200 marks

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

(For the project: 70marks internal + 50 marks external - 30marks dissertation + 20 marks presentation)

M.Sc. LIFE SCIENCE

Courses 4.01, 4.02, 4.03, 4.04
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%