St. Xavier's College – Autonomous Mumbai

Syllabus
For 10th Semester Courses in
M.Sc. LIFE SCIENCE
(June 2019 onwards)

Contents:
Syllabus (theory and practical) for Courses:

Percent revision:
2015-16: No revision
2016-17: No revision
2017-18: No revision
2018-19: 8.33% (1001), 50% (1002), 50% (1003), 75% (1004) and 40-50% revision in practicals
2019-20: No revision

LIFE SCIENCE

M.Sc. **Course No.: SLSC1001**

Course title: Medical Genetics

Learning Objectives:

On the completion of the course, the student must understand:

1. The inheritance pattern of Mendelian and Non-Mendelian traits
2. Multifactorial conditions that defer from the classical Mendelian single gene disorders
3. Techniques of conventional and molecular cytogenetics
4. The concepts and practice of genetic counseling
5. The organization of the human genome and the applications of the Human Genome Project.

Number of lectures: 60

UNIT I: **(15 lectures)**

1. History of Human Genetics **(1)**
2. Pedigrees- gathering family history, pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees **(3)**
3. Monogenic traits **(5)**
   a. Autosomal inheritance-dominant, recessive
   b. Sex-linked inheritance
   c. Sex-limited and sex-influenced traits
   d. Mitochondrial inheritance - nonpenetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity, genomic imprinting and uniparental disomy, spontaneous mutations, mosaicism and chimerism, male lethality, X-inactivation
4. Complex traits **(6)**
   a. Polygenic inheritance of continuous (quantitative) traits, normal growth charts, Dysmorphology
   b. Polygenic inheritance of discontinuous (dichotomous) traits- threshold model, liability and recurrence risk
   c. Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity)
   d. Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship
   e. Approaches to analysis of complex traits- 'Nature vs nurture', role of family and shared environment, monozygotic and dizygotic twins and adoption studies

UNIT II: **(15 Lectures)**

1. Human cytogenetics **(2)**
2. Techniques in human chromosome analysis (including molecular techniques) **(3)**
3. Human karyotype: banding techniques – C, G, R, Q, High resolution banding, nomenclature of banding **(3)**
4. Nomenclature of aberrant karyotypes **(1)**
5. Common syndromes due to numerical chromosome changes **(3)**
6. Molecular Cytogenetics – FISH, Principle, probes used, Types of FISH, CGH, spectral, Karyotyping **(3)**

UNIT III: **(15 Lectures)**

1. Historical overview of genetic counseling **(4)**
   a. Models of Eugenic, Medical/Preventive, Decision making Psychotherapeutic counseling; current definition and goals
   b. Philosophy and ethos of genetic services and counseling,
2. Physical examination
   a. General and dysmorphology examination
   b. Documentation
3. Prenatal and pre-implantation diagnosis **(3)**
   a. Indications for prenatal diagnosis
   b. Indications for chromosomal testing
   c. Noninvasive methods
   d. Invasive methods
4. Legal and ethical considerations **(1)**
5. Common syndromes due to structural alterations (translocations, duplications, deletions, microdeletion, fragile sites). Common chromosome abnormalities (Autosomal, sex linked, mitochondrial). **(4)**
6. Genome imprinting Syndromes: Prader-Willi & Angelman syndromes, Beckwith-Wiedeman Syndrome **(3)**

UNIT IV: **(15 Lectures)**

1. The Human Genome project (**4**)
   a. History, organization and goals of human genome project
   b. Mapping strategies, current status of various maps; DNA segment nomenclature
2. Organization of human genome **(6)**
   a. Mitochondrial genome
   b. Gross base composition of nuclear genome
   c. Gene density
   d. CpG islands
   e. RNA-encoding genes
   f. LINES and SINES
3. Gene families **(5)**
   a. Multigene families – Classical gene families, families with large conserved domains, families with small conserved domains
   b. Gene superfamilies
   c. Gene families in clusters and dispersed - globin genes and histone genes
   d. Pseudogenes
   e. Repetitive DNA and transposable elements
   f. Origin of gene families

References:

1. Griffiths AJF, Wessler SR, Carroll SB and Doebley J (2015) "Introduction to Genetic Analysis" *W.H.Freeman Publishers*.
2. Russell PJ (2009) "iGenetics – A Molecular Approach" *Benjamin Cummings Publication*.
3. Lewis R (2005) "Human Genetics- Concepts and Application" *McGraw Hill Pub*.
4. John Reid & Tom Strachan (2011) "Human Molecular Genetics" *Garland Science, Taylor and Francis Group*.
5. Daniel L. Hartl and Maryellen Ruvolo (2012) "Genetics – Analysis of Genes and Genomes" *Jones and Bartlett India Pvt. Ltd*.
6. Peter Turnpenny and Sian Ellard (2013) "Emery's Elements of Medical Genetics" *Churchill Livingston Pub*.

LIFE SCIENCE

M.Sc. **Course No.: SLSC1002**

Title: Pharmacology and Clinical Research

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. Understanding the scope of clinical research and its application

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 transporters **(1)**
5. 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 **(4)**
   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 **<u>any one</u>** 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: Drug safety and efficacy **(15 lectures)**

1. General pathway of drug discovery/development **(3)**
   Pharmacological screening models for therapeutic areas (one case study) **(6)**
2. Toxicological screening **(6)**

UNIT IV: Clinical trials **(15 lectures)**

1. Clinical trials – rationale and phases **(3)**
2. Ethical and regulatory aspects of clinical trials in India **(2)**
3. Clinical Research - regulations, guidelines, ethics **(2)**
4. Searching, understanding and evaluating current clinical research **(2)**
5. Planning, Biostatistics, Protocol, Conduct, Results **(3)**
6. Communication clinical research - written and verbal **(3)**

References:

1. Ed. Hardman JG, Limbird LE (2001) "Goodman Gillman's The Pharmacological Basis of Therapeutics" *McGraw Hill Press*.
2. Ed. Shargel L. (1999) "Applied Biopharmaceutics and Pharmacokinetics" *Prentice-Hall International*.
3. Ghosh MN (1984) "Fundamentals of Experimental Pharmacology". *Scientific Book Agency*.
4. Forman JC, Johansen TJ (1996) "Textbook of Receptor Pharmacology" *CRC Press*.
5. Vogel HG & Vogel WH (1997) "Drug Discovery and Evaluation –Pharmacological Assays" *Springer*.
6. Pharmacology-related journals from PubMedCentral (refer study pack for papers)

LIFE SCIENCE

M.Sc. **Course No.: SLSC1003**

Title: Cancer Biology and Stem Cell Biology

Learning Objectives:

1. Understanding the genetic basis of cancer
2. To identify the various factors that can transform a cell to become cancerous
3. Elucidate the underlying principles of how cancer cells bypass the normal controls
4. Understanding how cancer can be tackled by targeting the characteristics specific to the cancerous cells.
5. Provide the student with information of basic principles, recent developments and scope of some contemporary areas of stem cell research in biology research and medicine.

Number of lectures: 60

UNIT I: Cancer biology - 1 **(15 lectures)**

1. Introduction & The Hallmarks of Cancer and cancer assays and models **(**3**)**
2. Cell cycle control **(**1**)**
3. Pathways that contribute to tumour progression **(**11)
    a. Rb pathway
    b. Signal transduction
    c. BCR-Abl
    d. Myc
    e. Checkpoint signalling

UNIT II: Cancer Biology – 2 **(15 lectures)**

1. Pathways contributing to tumour progression **(**7**)**
    a. p53
    b. Telomerase
    c. BRCA1
    d. Mis-match repair
    e. APC and Wnt signalling
2. Tumour Immunology
3. Angiogenesis **(**2**)**
4. Epigenetics and Cancer **(**2**)**
5. Cancer stem cells (2)
6. Metastasis (2)

* including but not limited to

UNIT III: **Embryonic Development and Embryonic Stem Cells** **(15 Lectures)**

1. The Evolving Concept of a Stem Cell: Definitions, Criteria and Standards **(2)**
2. Embryonic Development: Overview of Human Embryogenesis - Fertilization to Gastrulation **(3)**
3. Totipotency, Pluripotency and Multipotency **(2)**
4. Molecular pathways of Pluripotency (NOTCH, BMP, Sonic Hedgehog pathways) **(4)**
5. Human Embryonic Stem cells and Directed Differentiation, Cord Blood Stem Cells **(4)**

UNIT IV: **Stem Cell Research** **(15 Lectures)**

1. The Stem Cell Niche **(2)**
2. Adult Stem Cells - Hematopoeitic, Neural, Mesenchymal Stem cells **(3)**
3. Induced Pluripotent Stem Cells (iPSCs) **(3)**
4. Transdifferentiation **(3)**
5. Ethical and Religious issues and Regulatory considerations **(1)**
6. Potential applications and Future Challenges:
   a. Cell Replacement Therapies **(3)**
   b. Tissue Engineering
   c. Stem Cell Gene Therapy (Translational Stem Cell Medicine)

References:

1. Hanahan D and Weinberg R (2011) 'Hallmarks of Cancer: The Next Generation' *Cell 144*, 646-674.
2. Weinberg R (2013) 'The Biology of Cancer' *Garland Science.*
3. Alberts B (2016) 'Molecular Biology of the Cell' *Garland Science.*
4. Kleinsmith L (2005) 'Principles of Cancer Biology' *Pearson.*
5. Lanza R. et al (2009) 'Essentials of Stem Cell Biology' *Springer.*
6. 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.

LIFE SCIENCE

M.Sc. **Course No.: SLSC1004**

Title: Applied Biology

Learning Objectives:

1. To understand the concepts of culturing animal cells, setting up a basic cell culture laboratory and applications of Animal tissue culture.
2. To explain the tenets in the emerging field of nutraceuticals
3. Provide the student with information of basic principles, recent developments and scope of some contemporary areas of nanosciences.
4. An understanding of the implications of a toxic exposure in humans and relevant experimental models.
5. An understanding of general toxicology principles and their application in the prevention and management of toxic exposure.

Number of lectures: 60

Unit I: Introduction to Animal Cell and Tissue Culture (15 lectures)

1. Advantages and Disadvantages of animal cell culture and tissue culture. **(1)**
2. Basics of Lab Set up, Sterilization, Liquid handling, Biosafety Levels and cabinets, Incubators, Culture vessels **(3)**
3. Media: Common Components, Types with examples, Serum free media **(1)**
4. Growth of cells in vitro, cell culture growth parameters **(2)**
5. Methods of cell dissociation/separation and preparation of primary cell culture, maintaining a cell line **(3)**
6. Contamination: detection and prevention. **(1)**
7. Organ culture and cryopreservation of tissues and cell lines. **(2)**
8. Advances in tissue culture: Tissue engineering, 3D Printing of organs **(2)**

UNIT II: Nutraceuticals and Cosmeceuticals (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)**
7. Cosmeceuticals (2)

UNIT III: 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)
Tools of Nanoscience (Self study) **(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 IV: Toxicology **(15 lectures)**

1. General Principles of Toxicology:
   a. Dose-Response Relationship **(2)**
   b. Animal models as predictors of human toxicity **(2)**
2. Mechanisms of Toxicity **(9)**
   a. Chemical Carcinogens/Radiation
   b. Alcohols/Analgesics
   c. Pulmonary/Inhalation Toxicants
   d. Tobacco, Marijuana
   e. Psychostimulants/Antidepressants
   f. Pesticides
   g. Bacterial, Insect & Snake Toxins
   h. Heavy Metals

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References:

1. Freshney RI (2015) "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" *John Wiley & Sons*.
2. Davis JM (2011) "Animal Cell Culture: Essential Methods" *John Wiley & Sons*.
3. Chadwick R., Henson S., Mosley B., Hurst G.W. (2003) "Methods of Analysis for Functional Foods and Nutraceuticals" *Springer.*
4. Nanotechnology: 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.
5. Nelson, L.S., Lewin, N.A., Howland, M.A., Hoffman, R.S., Goldfrank, L.R. and Flomenbaum, N.E. (2011) "Goldfrank's Toxicologic Emergencies" *McGraw-Hill Global*.

Template of Theory Question paper

Courses: SLSC1001, 1002, 1003 & 1004

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

Course: SLSC10PR

Research Project/ Literature Survey = 200 marks

For the project:

Internal: Literature survey = 25 marks, Laboratory work = 50 marks and Poster/ Paper = 25 marks

External: Dissertation = 60 marks and Final presentation = 40 marks

Department of Life Science and Biochemistry

	M.Sc. II Life Science Exam Grid Semester 10				
Course	**Exam**	**Knowledge and Information**	**Understanding**	**Application and Analysis**	**Total**
1001	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**
1002	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**
1003	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**
1004	CIA	10	5	5	20
	CIA	10	5	5	20
	End semester	20	20	20	60