St. Xavier's College (Autonomous) Mumbai

Syllabus
For 7th Semester Courses in
M.Sc. Life Science
(June 2018 onwards)

Contents:

Percent revision:
2015-16: No revision
2016-17: No revision
2017-18: No revision
2018-19: 15% (0703), 50% (0704) and 40-50% revision in practicals
2019-20: No revision
2020-21: No revision

LIFE SCIENCE

M.Sc. **Course No.: SLSC0701**

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. Alberts B (2016) 'Molecular Biology of the Cell' *Garland Science.*
2. Karp G (2013) 'Cell Biology' *Wiley.*
3. Lodish H (2016) 'Molecular Cell Biology' *W. H. Freeman & Co.*
4. Cooper G (2015) 'The Cell: A Molecular Approach' *Sinauer Associates Inc.*
5. Watson J (2017) 'Molecular Biology of the Gene' *Pearson.*
6. Nelson D and Cox M (2017) 'Lehninger Principles of Biochemistry' *W. H. Freeman & Co.*
7. Voet D, Voet J and Pratt C (2016) 'Fundamentals of Biochemistry' *Wiley.*

LIFE SCIENCE

M.Sc. **Course No.: SLSC0702**

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 entrepreneurships
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. Robert A. Day, Barbara Gastel. (2011) "How to Write & Publish a Scientific Paper" *Greenwood*.
2. Vernon Booth, (2003) "Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings" *Cambridge University Press*.
3. Janice R. Matthews, Robert W. Matthews "Successful Scientific Writing: A Step-By-step Guide for the Biological and Medical Sciences" *Cambridge University Press*.
4. Purdue OWL and other online resources.
5. John W. Creswell, J. David Cresswell (2017) "Research Design: Qualitative, Quantitative, and Mixed Method Approaches" *Sage*.
6. Petter Laake, Haakon Breien Benestad, Bjorn Reino Olsen (2015) "Research Methodology in the Medical and Biological Sciences" *Elsevier*.
7. N Gurumani (2006) "Research Methodology for Biological Sciences" *MJP Publishers*.
8. Geoffrey Marczyk, David DeMatteo, David Festinger (2005) "Essentials of Research Design and Methodology" *John Wiley and Sons, Inc*.
9. Desai V (2011) "Small-Scale Industries and Entrepreneurship" *Himalayan Publishing House*.
10. Collins Ipand Lazier W (1992) "Beyond entrepreneurship" *Prentice Hall*.
11. Ganguli,P (2001) "Intellectual Property Rights" *Tata McGraw Hill.*

LIFE SCIENCE

M.Sc. **Course No.: SLSC0703**

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 and free energy changes that drive biochemical reactions.
3. Acquire a clear understanding of protein structure and folding, and its relation to protein function.
4. Comprehend enzyme kinetics and inhibition, and the role of coenzymes in enzyme function.
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 **(3)**
   a. Brownian motion.
   b. Diffusion and osmosis.
   c. Viscosity (Reynolds numbers, motors and propulsion).
3. Thermodynamics **(6)**
   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/ Protein or enzyme assembly **(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. **(2)**
2. Kinetics of single substrate enzyme-catalysed reactions: **(3)**
   a. Michaelis-Menten equation, Kinetic studies using MM plot
   b. Lineweaver Burk plot and Eadie Hofstead plot
3. Kinetics of allosteric enzyme-catalysed reactions: Hill's equation, Hill's coefficient and its significance. **(2)**
4. Enzyme inhibition: reversible, irreversible, allosteric **(2)**
   (Competitive, Uncompetitive, Non-competitive)
5. Role of coenzymes in enzyme function: Mechanism of action of any 2 coenzymes, **(3)**
   Examples of reactions involving all the coenzymes derived from water soluble vitamins.

UNIT IV **(15 lectures)**

1. Basic cellular metabolism (schematics only). **(9)**
   a. Carbohydrates: Glycolysis, HMP shunt, TCA cycle, Gluconeogenesis, Glycogen metabolism
   b. Lipids: Synthesis and breakdown of TAGs & fatty acids; synthesis and utilization of ketone bodies and their significance in pregnancy, diabetes mellitus, starvation, alcoholism and in weight loss programs
   c. Amino acids: Deamination, transamination, Urea cycle, inborn errors in the metabolism of amino acids (Phenylketonuria/Alcaptonuria)
   d. Significance of ATP in metabolism
2. Hormonal regulation and integration of metabolism. **(1)**
3. Metabolic disorders (as guided study/assignments/presentations) **(2)**
   For example: Diabetes mellitus (endocrine), Hepatic dysfunction (alcohol-induced cirrhosis), Anorexia (psychosomatic), Dyslipidemia/ Hypercholesterolemia (dietary)]]
4. Physiological role of Fat-soluble vitamins and disorders associated with their deficiency/excess **(3)**

References

1. Gilbert HF (1992) "Basic Concepts in Biochemistry: A Student's Survival Guide" *McGraw-Hill.*
2. JM Berg, JI Tymoczko, L Stryer, GJ Gatto, Jr. (2010) "Biochemistry" *WH Freeman and Company*.
3. Nelson D and Cox M (2017) 'Lehninger Principles of Biochemistry' *W. H. Freeman & Co.*
4. Voet D, Voet J and Pratt C (2016) 'Fundamentals of Biochemistry' *Wiley.*
5. N Price and L Stevenson (2000) "Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins" *Oxford University Press*.
6. M Dixon and EC Webb (1964) "Enzymes" *Academic Press*.
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.: SLSC0704**

Title: Laboratory Management and Analytical Techniques

Learning Objectives:

To introduce the students to:

1. Basic clinical laboratory setup as well as GLP and accreditations
2. Various approaches used in the study of biological samples.
3. The principles of separation and investigation applied to analysis of biological samples.
4. Current trends in calibrations and certifications association with instrumentation techniques (to be covered in practicals).

UNIT I: Laboratory setup and management **(15 Lectures)**

1. Introduction to Clinical Laboratory **(8)**
    a. Standard Clinical Laboratory set up
    b. General Safety guidelines
    c. Decontamination and Disinfection.
    d. Sterilization techniques
    e. Hazard analysis, Safety Data Sheets, and First Aid Kit.
2. 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: Separation methods **(15 Lectures)**

Principle, instrumentation and application in biomolecular analysis of

1. Chromatography **(6)**
    a. Column, thin layer, paper, adsorption
    b. Partition, ion exchange, affinity chromatography, Size exclusion
    c. HPLC, GC, Reverse Phase
2. Electrophoresis **(5)**
    a. Agarose, SDS PAGE, Capillary Electrophoresis
    b. 2D PAGE, Pulse Field Gel Electrophoresis
    c. Western Blot, Southern Blot
3. Centrifugation **(4)**
    a. Factors affecting centrifugation
    b. Differential centrifugation
    c. Density gradient
    d. Analytical centrifugation

UNIT III: Techniques based on Microscopy and Electromagnetic Spectrum

(15 Lectures)

Principle, instrumentation and application of

1. Microscopy **(7)**
    a. Light microscopy, Dark Field, Phase Contrast, DIC
    b. Fluorescence, Confocal microscopy
    c. Electron Microscopy (Scanning and Transmission), specimen preparation, Cryo TEM
    d. Scanning Probe microscopy (AFM)
2. Spectrometry **(8)**
    a. Colorimeter and UV-Visible spectrophotometer, Beer-Lamberts Law
    b. Qualitative and quantitative methods of analysis-protein estimation methods, Hypo and hyper-chromicity coupled assays
    c. Fluorescence and Luminescence analysis
    d. Turbidimetry

UNIT IV: Techniques for composition, sequence or structure determination

(15 lectures)

Principle, instrumentation, technique and application of

1. Atomic absorption and emission spectroscopy **(2)**
2. ORD/CD spectroscopy **(1)**
3. IR and Raman Spectroscopy **(2)**
4. Mass Spectroscopy (Biomolecules) **(3)**
5. X-Ray Diffraction **(3)**
6. NMR spectroscopy **(2)**
7. Next Generation Sequencing for Nucleotides **(2)**

References:

1. Godkar, P.B. Godkar, P.D. (2014) "Textbook of Medical Laboratory Technology (Set of 2 Volumes): Clinical Laboratory Science and Molecular Diagnosis" *Bhalani Publishing House*.
2. Skoog, D.A., Holler, F.J., Crouch S.R. (2018) "Principles of Instrumental Analysis" *Cengage Learning*.
3. Sheehan, D. (2010) "Physical Biochemistry: Principles and Applications" Wiley-Blackwel.
4. Garcia L.S. (2014) "Clinical Laboratory Management" *American Society for Microbiology Press*.
5. McPherson R.A., Pincus, M. R. (2017) "Henry's Clinical Diagnosis and Management by Laboratory Methods" *Elsevier*.
6. Manz, A., Dittrich, P.S., Pamme, N., Iossifidis, D. (2015) "Bioanalytical Chemistry" *Imperial College Press*.
7. Schalkhammer, Thomas G.M. (2002) "Analytical Biochemistry" *Springer (India) Private Limited*
8. Cooper, T.G. (2009) "The Tools of Biochemistry" *Wiley*.
9. Spector, David L. & Goldman, R.D. (2006) "Basic Methods in Microscopy: Protocols And Concepts From Cells: A Laboratory Manual" Cold Spring Harbor Laboratory Press.
10. Pawley, James B. (2006) "Handbook of Biological Confocal Microscopy" *Springer Science Plus Business Media*.
11. Chandler, Douglas E. & Roberson, Robert W. (2009) "Bioimaging: Current Concepts in Light and Electron Microscopy" *Jones and Bartlett Publishers*.
12. Wilson, K. & Walker, J. (2013) "Principles and Techniques of Biochemistry and Molecular Biology" *Cambridge University Press.*

Practicals:

Course: SLSC07PR

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. Estimation of Protein by various methods. Comparison of the sensitivity of estimation methods

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

8. 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

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

Template of Theory Question paper

M.Sc. Life Science

0701, 0702, 0703, 0704

CIA I – 20 marks, 45 mins.

Objectives/Short questions

CIA II – 20 marks

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

End Semester exam – 60 marks, 2 hours

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

M.Sc. Life Science

Practical Evaluation

Course: SLSC07PR

CIA & End Semester Practical Exam	**Total marks: 200**
CIA	80 marks
ESE	120 marks

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

Department of Life Science and Biochemistry

	M.Sc. I Life Science Exam Grid Semester 7				
Course	**Exam**	**Knowledge and Information**	**Understanding**	**Application and Analysis**	**Total**
0701	CIA	10	6	4	**20**
	CIA	10	6	4	**20**
	End semester	30	20	10	**60**
Course	**Exam**	**Knowledge and Information**	**Understanding**	**Application and Analysis**	**Total**
0702	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**
0703	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**
0704	CIA	7	7	6	**20**
	CIA	7	7	6	**20**
	End semester	20	20	20	**60**