SOPHIA COLLEGE

(AUTONOMOUS)

Affiliated to the University of Mumbai

Syllabus for Semesters I to II

Program: B.Sc.

Course: Life Sciences

(Choice Based Credit System with effect from the year 2021-22)

SOPHIA COLLEGE (AUTONOMOUS)

F. Y. B.Sc. Life Science Syllabus

(Choice based Credit and Grading System)

Academic year 2021- 2022

SEMESTER I

Course code	Unit	Topic headings	Credits	L / week
Paper I	**Cell and Microbial Biology**			
SBSLSC101	1	A Preview of the Cell	4	15
	2	Introduction to Microbiology		15
	3	Microbial growth and its control		15
SBSLSCP101		Practical	2	
Paper II	**Biomolecules and separation techniques**			
SBSLSC102	1	Biomolecules	4	15
	2	Molecular Biology		15
	3	Techniques		15
SBSLSCP102		Practical	2	

SEMESTER II

Course code	Unit	Topic headings	Credits	L / week
Paper I	**Eukaryotic cell biology**			
SBSLSC201	1	Nucleus and Cell membrane – Structure and function	4	15
	2	Cell Organelles		15
	3	Cytoskeleton, cell cycle and cell division		15
SBSLSCP201		Practical	2	
Paper II	**Classical Genetics, Evolution and Ecology**			
SBSLSC202	1	Genetics- I	4	15
	2	Genetics-II		15
	3	Evolution and Ecology		15
SBSLSCP202		Practical	2	

SEMESTER I

PAPER –I CELL AND MICROBIAL BIOLOGY

Learning Objectives:

- Learn the basic principles of microbiology
- Learn about types of microscopy to visualize microbial cells
- Understand the differences between prokaryotic and eukaryotic cells
- Study the different types of microorganisms
- Learn about microbial growth and its control

Paper I	Cell and Microbial Biology		Credits: 4
Course code	**Unit**	**Topic headings**	**L / week**
SBSLSC101	**1**	**A Preview of the Cell**	**15**
		1. Visualization of the cell – Microscopy – Principle, Resolving Power and types of microscopy–Brightfield, Fluorescence, Electron microscopy –Transmission and Scanning	3
		2. Types and comparison of cells – Bacteria, Archaea and Eukaryotes	2
		3. Limitation on size and compartmentalization of functions	1
		4. Evolutionary origin of organelles and Endosymbiont Hypothesis	2
		5. Overview of Eukaryotic organelles	2
		6. History of Microbiology – Spontaneous generation and Germ theory	2
		7. Role of microorganisms in agriculture, industry and medicine	3
SBSLSC101	**2**	**Introduction to Microbiology**	**15**
		1. Viruses, Viroids and Prions: Virus–structure and life cycle of a bacterial virus (lytic and lysogenic), animal virus – DNA virus (ex. Herpes virus) RNA virus (plus and minus stranded), Retrovirus and plant virus (TMV) Viroids, Prions – e.g. scrapie	5
		2. Prokaryotic cell –Structure Cell wall – Gram positive and Gram negative Nucleoid; capsule / glycocalyx; flagella and endospore	4
		3. Fungi – Growth and reproduction – asexual and sexual	2
		4. Algae – Structural organization	2
		5. Protozoa – Morphological diversity	2

SBSLSC101	**3**	**Microbial growth and its control** 1. Requirements for growth– • Physical – Temperature, pH, Osmotic pressure • Chemical – Carbon, nitrogen, sulphur, phosphorus, oxygen, trace elements, growth factors • Biofilm formation • Culture Media • Anaerobic growth 2. Kinetics of growth • Binary fission and cell growth • Growth curve and generation time • Batch and continuous cultures • Isolation of microorganisms • Preservation of microorganism 3. Control of microbial growth • Physical • Chemical • Antimicrobial	**15** 5 6 4
SBSLSCP101	**Practical**		**Credits : 2**
	1. Writing a science lab report. 2. Bright field microscopy of stained and unstained samples 3. Measurement of cell size under microscope (concept of mm and μm) 4. Introduction to Stains and Dyes Monochrome staining of bacteria, animal cell (from cheek), plant cell (onion peel) 5. Microbial staining technique: Gram staining; cell wall staining 6. Demonstration of Sterilization of laboratory material(principle of use of autoclave) 7. Slide culture technique for observation of fungi 8. Determination of Minimum Inhibitory Concentration (MIC)of NaCl for a bacterial culture 9. Open ended project/ course based research projects- To encourage development of better reading strategies, comprehension skill, learner centered approach, problem based learning, reflective thinking. **Note: Students will be continuously monitored for their active participation during lab sessions.**	

Reference Books:

1. **Experiments in Microbiology, Plant Pathology and Biotechnology**, Aneja K.R., 5th edition (2017), New Age International Publishers.
2. **Becker's World of the Cell: International Edition,** Hardin J., Bertoni J.P., Kleinsmith L.J., 8th edition (2011), Pearson Publisher.
3. **Brock Biology of Microorganisms,** Madigan M, Martinko J., Bender K., Buckley D., Stahl D., 14th edition (2017), Pearson Publishers
4. **Ananthanarayan and Paniker's Textbook of Microbiology**, Reba Kanungo, 10th edition (2017), Universities Press Publishers
5. **Microbiology: An Introduction,** Tortora G.J., Funke B.R., Case C.L., 12th edition (2016), Pearson Publication
6. **Prescott, Harley and Klein's, Microbiology,** Willey J., Sherwood L., Woolverton C, 7th edition (2008), McGraw Hill Higher Education

PAPER –II BIOMOLECULES AND SEPARATION TECHNIQUES

Learning Objectives:

- To understand the composition of molecules within living cells
- To grasp the principles underlying the techniques of separation of molecules

*Brief History and applications to be included in all the topics

Paper II	Biomolecules and separation techniques		Credits: 4
Course code	**Unit**	**Topic headings**	**L / week**
SBSLSC102	**1**	**Biomolecules** **1.Non-carbon-containing molecules in cells:** a. Water- the most abundant component • Molecular structure and physico-chemical properties • corresponding functions in cells and reasons for it being the basis of life b. Inorganic Ions: • Macro-elements- Na, K, Cl, Ca, P, Mg, S • Micro-elements – Fe, Cu Zn, Mn, I, Ni function in cells **2. Carbon-containing components in cells:** a. Amino acids and Protein macromolecules • biological amino acids - general structure and reactions • classification of amino acids based on – biochemical nature and structure • structure-function relation in proteins b. Protein structure and folding, Molecular Chaperones • Primary – Quaternary structures within proteins with typical examples • protein folding chaperones and disease c. Monosaccharide Sugars and Polysaccharide Carbohydrates • Nomenclature and structure of common sugars d. Fatty Acids and Lipids • Nomenclature and structure of common lipids e. Nucleotides and Nucleic Acid Macromolecules • Nomenclature and structure	**15** 2 1 3 2 2 2 3
SBSLSC102	**2**	**Molecular Biology** **1. Molecular genetics:** • Early experiments that defined the nature of the gene (Griffith's, Avery's and Hershey's Experiments) • Concept of the gene- a structural unit of coding • Chromatin structure and packaging **2. Macromolecular synthesis:** • Concept of macromolecules • DNA synthesis in prokaryotes • DNA synthesis in eukaryotes	**15** 9 6

SBSLSC102	**3**	**Techniques** **1. Extraction techniques** • Cell lysis techniques – Physical, chemical • Solvent extraction of lipids **2. Separation and analytical techniques** • Precipitation • Filtration • Dialysis • Centrifugation • Chromatography • Electrophoresis Using the above techniques to isolate/ analyze particular molecule using a typical example	**15** 3 12
SBSLSCP102	**Practical**		**Credits : 2**
	1. Introduction to lab discipline and good laboratory practices. 2. Solution making: a. Preparation of solutions of a given chemical compound b. Preparation of dilutions from a stock solution 3. Water molecules and its properties (solvent, density, cohesion and adhesion, colligative properties) 4. pH and its usage: a. pH meter b. Making of own pH indicator papers 5. Colorimetry: a. Wavelength of maximum absorbance b. Verification of Beer-Lambert's law 6. Study of separation techniques: a. Dialysis b. Isoelectric Precipitation of proteins c. Density gradient centrifugation 7. Detection and localization of carbohydrates, proteins, lipids and nucleic acids in vitro and in tissues. 8. Detection of amino acids using chromatography technique 9. Origami and modeling of biochemical structures 10. Extraction of DNA from onion 11. Open ended project/ Course- based research project: To encourage small group discussions and problem solving **Note: Students will be continuously monitored for their active participation during lab sessions.**	

Reference Books:

1. **Lehninger-Principles of Biochemistry,** Nelson D.L. and Cox M.M.,7th edition(2017), *W H Freeman & Co Publishers.*
2. **Introduction to Practical Biochemistry,** Plummer M. and Plummer D.T 3rd edition (1988), *McGraw Hill Publication*
3. **Biological Science**, Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., 3rd edition (2005), *Cambridge University Press.*

SEMESTER II

PAPER –I EUKARYOTIC CELL BIOLOGY

Learning Objectives:

- Learn the structure and function of components of eukaryotic cell
- Understand the structure and role of nucleus and plasma membrane
- Learn about protein formation and trafficking through the endomembrane organelles
- Describe the structure and function of mitochondria and chloroplasts
- Understand the process and mechanism of cell division – mitosis and meiosis

Paper I	**Eukaryotic Cell Biology**		**Credits: 4**
Course code	**Unit**	**Topic headings**	**L / week**
SBSLSC201	**1**	**Nucleus and Cell membrane – Structure and function** 1. Nucleus • Structure of Interphase nucleus - nuclear membrane, nucleolus, nucleosome model • Euchromatin and Heterochromatin • Specialized chromosomes – polytene and lampbrush chromosomes 2. Membrane – their structure and function History and models of membrane structure 3. Transport across membranes • Transport processes • Simple and Facilitated Diffusion • Active transport – example Na+/K+pump • Vesicular transport – Endocytosis and exocytosis, Phagocytosis 4. Cell adhesion, cell junctions and extracellular structures • Cell- cell junctions – tight junctions, gap junctions, adhesion junctions • Extracellular matrix of animal cells –collagen, elastin, laminins 5. Plant cell surface – plant cell wall and plasmodesmata	**15** 5 2 4 3 1
SBSLSC201	**2**	**Cell Organelles** 1. Endoplasmic reticulum and ribosomes • Ribosomes – structure of prokaryotic and eukaryotic ribosomes and role in protein synthesis • Rough ER – structure and role in protein synthesis – signal peptide hypothesis • Smooth ER – structure and functions(also function as sarcoplasmic reticulum • ER role in biosynthesis of membranes 2. Golgi Complex • Structural organization • Brief introduction to role of Golgi in protein glycosylation and proteasome in protein	**15** 3 2

		degradation 3.Lysosomes • Formation of lysosomes and role in digestion of materials • Lysosomal storage diseases – silicosis and Tay-Sachs disease 4.Peroxisomes • Function in animal and plant cells • Zellweger syndrome 5.Mitochondria • Structure and role in oxidative phosphorylation in ATP synthesis • Mitochondrial DNA and associated disease – LHON 6.Plastids • Types of plastids • Structure of chloroplast and role in Photosynthesis • Photosynthetic pigments	2 2 3 3
SBSLSC201	**3**	**Cytoskeleton, cell cycle and cell division** 1.Cytoskeleton Types of cytoskeletal elements • Microtubules – Structure and role in spindle formation and cilia/ flagella; microtubule motor proteins • Microfilaments – Structure and role in muscle contraction and motility (migration via lamellipodia/amoeboid movement/cytoplasmic streaming) • Intermediate filament – Structure and functions 2. Cell cycle • Cell cycle stages • Regulation of Cell cycle (in brief–role of cyclins and Cdks) • Cancer as an example of dysregulation of cell cycle 3. Cell Division •Mitosis stages and cytokinesis, Metaphase chromosomes: centromere and • Meiosis – Stages and significance–crossing over	**15** 5 4 5

SBSLSCP201	Practical		Credits : 2
		1. Electron micrographs of organelles and junctions 2. Barr body from buccal smear 3. Cytoplasmic streaming in plant cells 4. Mitosis from onion root tip 5. Permanent slides of meiotic stages 6. Staining of striated muscle 7. Plasmolysis using Tradescantia leaf 8. Methyl green pyronin staining for localization of nucleic acids **Note: Students will be continuously monitored for their active participation during lab sessions.**	

Reference Books:

1. **Molecular Biology of the Cell**, Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P, 5th Edition (2007)/ 6th edition (2014), Garland Science Publication
2. **Becker's World of the Cell: International Edition**, Hardin J., Bertoni J.P., Kleinsmith L.J., 8th edition (2011), Pearson Publisher
3. **Cell Biology**, Karp G, 7thEdition- International Student Edition (2013), Wiley Publication.
4. **Molecular Cell Biology,** Lodish H.,Berk A., Kaiser C.A., 7thEdition (2012), Macmillan Learning Publications.
5. **Principles of Cell Biology**, Plopper G, 2nd edition (2016), Jones and Bartlett Learning Publication.
6. **Biological Science**, Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., 3rdEdition (2005), Cambridge University Press.

PAPER –II Classical Genetics, Ecology and Evolution

Learning Objectives:

- To understand the history and basics of modern genetics
- To grasp the influence of environment on survival of organisms along with theories on origin of life and evolution

Paper II	**Classical Genetics, Evolution and Ecology**		
Course code	**Unit**	**Topic headings**	**L / week**
SBSLSC202	**1**	**Genetics** **1. Science of Genetics** – Overview and history of Modern Genetics, Chromosome Theory of Inheritance-Sutton-Boveri, Thomas Hunt Morgan's Experiment **2. Mendelian inheritance** Herman's experiment on X-ray induced mutations- Concept of homozygous, heterozygous, phenotype, genotype, alleles; Mendel's Laws and Mono and Dihybrid ratios. Sickle cell anaemia as an example to explain the concept of gene. **3. Modification of Mendel's laws -** Gene interactions: incomplete dominance, co-dominance; Multiple genes, Multiple alleles: Blood group, Epistasis, Linkage, Sex-limited, sex influenced. **4. Non-Mendelian inheritance** - Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance. **5. Pedigree analysis** - Symbols of Pedigree, Pedigrees of Sex-linked and Autosomal (dominant and recessive).	**15** 3 4 3 3 2
SBSLSC202	**2**	**Genetics** **1. Allelic Variation and Gene function** - Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete and incomplete), Expressivity, Pleiotropism. **2. Chromosomal anomalies**– Structural: deletion, duplication, inversion, translocation. Numerical: euploidy and aneuploidy (e.g. Downs, Turners, Klienfelter's, Cri-du-chat).	**15** 5 4

		3. Applications - scope of genetics in Healthcare, therapeutics, evolutionary biology, Biotechnology. **4. Branches of genetics.**	4 2
SBSLSC202	**3**	**Ecology and Evolution** 1. Organism and its environment: Distribution and abundance of Organisms, Importance of carbon-based life. Concept of Ecosystem. 2. Biotic Environment: Population, population density, Reproduction, Population growth (Natality, Mortality) Extinction of Population. 3. Interspecific and Intraspecific Population Regulation: Competition, Dispersal, Territoriality, Predation. (Lotka-Volterra model), Parasitism, Mutualism. 4. Theories of Origin of Life a. Spontaneous generation Vs. Biogenesis, other theories (special creation/steady state /Cosmozoan theory) b. Biochemical evolution (Alexander Oparin and Stanley Miller) 5. Lamarkian Evolution	**15** 3 3 4 4 1
SBSLSCP202		**Practical** 1. Pairing game to produce a Punnet square. 2. Meiosis from *Tradescantia* (demonstration/Photograph) 3. Study of bacterial motility by Hanging drop technique 4. Collection of blood group information from family and construction of pedigree charts 5. Evolution card games 6. Adaptive radiation using a. Darwin finches b. Mouth parts in insects- mosquito, housefly and cockroach. 7. Animal Biodiversity: a. Part I: Classification of Animals –Invertebrates b. Part II: Classification of Animals–Vertebrates c. Digital recording and detailed classification of one animal from campus/ local environment 8. Biostatistics: a) Purpose of Biostatistics: Data collection, Discrete and continuous variables, qualitative and quantitative Biostatistics. Study of Class Intervals and calculation of frequency, Representation – tabular and graphical– line graph, frequency curve, Ogive curve, histogram and pie	**Credits : 2**

		diagram. (Also represented using computers – Excel), c) Measures of central tendency – mean, median, mode and standard deviation d) Box-Whisker plot. 8. Perform a search on any one topic using Pub Med, download about ten abstracts and prepare a summary of the literature. 9. Field Visit and Report. **Note: Students will be continuously monitored for their active participation during lab sessions.**	

Reference Books:

1. **Biology**, Brooker, Widmaier, Graham, Stiling, 4th edition (2016), McGraw-Hill Education Publication
2. **Campbell Biology**, Reece, Urry, Cain, Wasserman, Minorsky, Jackson, 11th edition (2016), Pearson Publication
3. **Biological Science**, Freeman S, (2004), Benjamin Cummings Publishing Company.
4. **Genetics and Molecular Biology: With Fundamentals of Biostatistics**, Hyde D. R., 1st edition (2010), McGraw Hill Education Publication
5. **iGenetics: A Molecular Approach,** Russelle P., 3rd edition (2010), Pearson Benjamin Cummings Publications.
6. **Biology: The Core**, Simon E.J., 2nd edition (2016), Pearson Publication.
7. **Lamarck's Revenge: How Epigenetics Is Revolutionizing Our Understanding of Evolution's Past and Present,** Ward P. (2018), Bloomsburg Publishing.

Note: All practicals in each course in both semesters have to be understood in terms of Instrumentation, Technique, Concept and Relevance *or whichever may be applicable*