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 2022-23)

SOPHIA COLLEGE (AUTONOMOUS)

F. Y. B.Sc. Life Science Syllabus

(Choice based Credit and Grading System)

Academic year 2022- 2023

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	

SOPHIA COLLEGE (AUTONOMOUS)

F. Y. B.Sc. Life Science Syllabus

(Choice based Credit and Grading System)

Academic year 2022- 2023

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

COURSE CODE: SBSLSC101

PAPER –I CELL AND MICROBIAL BIOLOGY

Course Objectives

CO1: Introduce students to basics of microscopy, types of microscopes to visualize microbial cells, microorganisms.

CO2: Make the students learn about diverse microbes, microbial diversity, the cell wall structure and its propagation

CO3: Introduce students to parameters of microbial growth and conditions for their control

Course Outcomes

Student will be able to

LO1: differentiate between different microscopic methods to observe samples

LO2: classify microbes on their appearance

LO3: understand the importance of the components for the growth of bacteria in culture media and also about mechanisms that inhibit their growth

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** 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 2. Prokaryotic cell –Structure Cell wall – Gram positive and Gram negative Nucleoid; capsule / glycocalyx; flagella and endospore 3. Fungi – Growth and reproduction – asexual and sexual 4. Algae – Structural organization 5. Protozoa – Morphological diversity	**15** 5 4 2 2 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). Example: measurement of pollen grain from different flowers, starch grains (iodine) from different food sources. 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), media preparation and pouring plates. 7. Slide culture technique for observation of fungi 8. Demonstration of AST (by disc diffusion method) and Minimum Inhibitory Concentration (MIC) for a bacterial culture 9. Isolation of Pure Culture of Bacteria by Streak Plate Method 10. 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:

- Aneja K.R., Experiments in Microbiology, Plant Pathology and Biotechnology, 2017,5th Edition, *New Age InternationalPublishers.*
- Hardin J., Bertoni J.P., Kleinsmith L.J., Becker's World of the Cell: International Edition, 2011, 8th Edition, *PearsonPublisher*.
- Madigan M, Martinko J., Bender K., Buckley D., Stahl D., Brock Biology of Microorganisms, 2017, 14th Edition, *Pearson Publishers*
- Reba Kanungo, Ananthanarayan and Paniker's Textbook of Microbiology,2017,10thEdition, *Universities Press Publishers*
- TortoraG.J.,FunkeB.R.,CaseC.L.,Microbiology:AnIntroduction,2016,12thEdition, *Pearson Publication*
- Willey J., Sherwood L., Woolverton C., Prescott, Harley and Klein's, Microbiology, 2008, 7th Edition*, McGraw Hill HigherEducatio*

SEMESTER I

COURSE CODE: SBSLSC102

PAPER –II BIOMOLECULES AND SEPARATION TECHNIQUES

Course objectives

CO 1 :To introduce the students with biological molecules of living cells .

CO 2 :To familiarize students with process of DNA synthesis

CO 3 :To introduce students with extraction, separation and analytical techniques

Course outcomes

Students will be able to

LO 1 : identify the biomolecules involved in living cells.

LO 2 : understand DNA synthesis process

LO 3 : analyze the techniques involved in extraction and separation techniques.

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, structure of common sugars and reactions 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** 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	**Credits : 2**

	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:

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

SEMESTER II
COURSE CODE: SBSLSC201
PAPER –I EUKARYOTIC CELL BIOLOGY

Course Objectives

CO1: Make the students learn the structure and function of components of eukaryotic cell like nucleus, plasma membrane, chloroplast and mitochondria

CO2: Make the students learn about protein formation and trafficking through the endomembrane organelles

CO3: Make the students understand processes and mechanism of cell division

Course Outcomes

Students will be able to

LO1:differentiate between Euchromatin and Heterochromatin, active and passive transport across the membrane in animals and plants

LO2:differentiate between different cell-cell junctions and extracellular matrix which contribute stability and elasticity to the cell

LO3: gain an insight into the different cell organelles and diseases associated due to their malfunctions

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 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	**15** 3 2 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 musclecontraction and motility (migration via lamellipodia/amoeboid movement streaming) • Intermediate filament – Structure and functions 2. Cell cycle • Cell cycle stages • Regulation of Cell cycle (in brief–role of cyclins and Cdks)	**15** 5 4

		• Cancer as an example of dysregulation of cell cycle 3. Cell Division Mitosis stages and cytokinesis, metaphase chromosome: centromere and Meiosis – Stages and significance- cross over.	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:

Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P., Molecular Biology of the Cell, 2007 or Edition or6 Edition,*Garland* 2014, 5 *Science Publications*

Hardin J., Bertoni J.P., Kleinsmith L.J., Becker's World of the Cell: International Edition, 2011, 8thEdition, *Pearson Publisher*

Karp G, Cell Biology, 2013, 7thEdition- International Student Edition, *Wiley Publication.*

LodishH.,BerkA.,KaiserC.A.,MolecularCellBiology,2012,7thEdition , *Macmillan Learning Publications.*

Plopper G, Principles of Cell Biology, 2016, 2ndEdition*, Jones and Bartlett Learning Publication.*

Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., Biological Science, 2005, 3rdEdition, *Cambridge University Press.*

SEMESTER II
COURSE CODE: SBSLSC202
PAPER –II CLASSICAL GENETICS, ECOLOGY AND EVOLUTION

Course Objectives
CO 1 :To make the students understand the history and basics of modern genetics.
CO 2 :To familiarize the students about the influence of the environment on survival of organism
CO 3 :To introduce students with theories on the origin of life and evolution.

Course Outcomes:
Students will be able to
LO 1 : achieve an understanding of classical genetics.
LO 2 : identify genetic disorders.
LO 3 : understand the process of 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 with problems, chi square - for 3:1 and 1:1 ratio. Use sickle cell anaemia as an example to explain the concept ofgene **3. Modification of Mendel's laws -** Gene interactions: incomplete dominance, co-dominance; Multiple genes, Multiple alleles: Blood group, Epistasis, Linkage, Sex limited, sexinfluenced. **4. Non-Mendelian inheritance** - Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparentalinheritance. **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). **3. Applications** - scope of genetics in Healthcare therapeutics, evolutionary biology, Biotechnology. **4. Branches of genetics.**	**15** 5 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 ofLife 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 b) Study of Class Intervals and calculation of frequency, Representation – tabular and graphical– line graph, frequency curve, Ogive curve, histogram and pie diagram (also represented using Excel) (c) Measures of central tendency – mean, median, mode and standard deviation, d) Box-Whisker plot. 9. Perform a search on any one topic using PubMed, download about ten abstracts and prepare a summary of the literature. 10. Field Visit and Report. **Note: Students will be continuously monitored for their active participation during lab sessions.**	**Credits : 2**

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

<u>Reference Books:</u>

Brooker, Widmaier, Graham, Stiling, Biology, 2016, 4th edition, *McGraw-Hill Education Publication*

Campbell, Reece, Urry, Cain, Wasserman, Minorsky, Jackson, Biology, 2016, 11thEdition, *Pearson Publication*

Freeman S., Biological Science, 2004, Benjamin Cummings Publishing Company.

Hyde D. R., Genetics and Molecular Biology: With Fundamentals of Biostatistics, 2010, 1st Edition, *McGraw Hill Education Publication*

Russelle P., *iGenetics*: A Molecular Approach, 2010, 3rdEdition, *Pearson*

Benjamin Cummings Publications.

Simon E.J., Biology: The Core, 2016, 2nd Edition, *Pearson Publication.*

Ward P., Lamarck's Revenge: How Revolutionizing Epigenetics Is Our Understanding of Evolution's Past and Present, 2018, *Bloomsburgpublishing.*