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 2020-21)

SOPHIA COLLEGE (AUTONOMOUS)

F. Y. B.Sc. Life Science Syllabus

(Choice based Credit and Grading System)

Academic year 2020-2021

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**			
SBSLSC202	1	Nucleus and Cell membrane – Structure and function	4	15
	2	Cell Organelles		15
	3	Cytoskeleton, cell cycle and cell division		15
SBSLSCP202		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 ofmicrobiology
- Learn about types of microscopy to visualize microbialcells
- Understand the differences between prokaryotic and eukaryoticcells
- Study the different types ofmicroorganisms
- Learn about microbial growth and itscontrol

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, Phase contrast, Fluorescence, Confocal, 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–structureandlifecycleofabacterialvirus (lytic and lysogenic), animal virus – DNAvirus (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, Osmoticpressure • Chemical – Carbon, nitrogen, sulphur,phosphorus, oxygen, trace elements, growth factors • Biofilmformation • CultureMedia • Anaerobicgrowth 2. Kinetics of growth • Binary fission and cellgrowth • Growth curve and generationtime • Batch and continuouscultures • Isolation ofmicroorganisms • Preservation ofmicroorganism 3. Control of microbial growth • Physical • Chemical • Antimicrobial	**15** 5 6 4
SBSLSCP101	**Practical**		**Credits : 2**
	1. Bright field microscopy of stained and unstainedsamples 2. Measurement of cell size under microscope (concept of mm and μm) 3. Monochrome staining of bacteria, yeast, animal cell (from cheek), plant cell (onionpeel) 4. Microbial staining technique: Gram staining; cell wall staining 5. Demonstration of Sterilization of laboratory material (principle of use ofautoclave) 6. Streak plating of bacterial suspensions (pure culture and soil sample) 7. Slide culture technique for observation offungi 8. Determination of Minimum Inhibitory Concentration (MIC) of NaCl for a bacterialculture 9. Study of bacterial motility by Hanging droptechnique 10. Open endedproject		

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, *PearsonPublishers*
- 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 HigherEducation*

PAPER –II BIOMOLECULES AND SEPARATION TECHNIQUES

Learning Objectives:

- To understand the composition of molecules within livingcells
- To grasp the principles underlying the techniques of separation ofmolecules

*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 incells:** a. Water- the most abundantcomponent • Molecular structure and physico-chemicalproperties • corresponding functions in cells and reasons for it being the basis oflife b. InorganicIons: • Macro-elements- Na, K, Cl, Ca, P, Mg,S • Micro-elements – Fe, Cu Zn, Mn, I, Ni function incells **2. Carbon-containing components in cells:** a. Amino acids and Proteinmacromolecules • biological amino acids - general structure andreactions • classification of amino acids based on – biochemical nature andstructure • structure-function relation inproteins b. Protein structure and folding, MolecularChaperones • Primary – Quaternary structures within proteins with typicalexamples • protein folding chaperones anddisease c. Monosaccharide Sugars and PolysaccharideCarbohydrates • Nomenclature and structure of commonsugars d. Fatty Acids andLipids • Nomenclature and structure of commonlipids e. Nucleotides and Nucleic AcidMacromolecules • Nomenclature andstructure	**15** 2 1 3 2 2 2 3
SBSLSC102	**2**	**Molecular Biology** **1. Molecular genetics:** • Concept of the gene- a structural unit ofcoding • Early experiments that defined the nature of the gene (Griffith's, Avery's and Hershey'sExperiments) • 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. Extractiontechniques** • Cell lysis techniques – Physical,chemical • Solvent extraction oflipids **2. Separation and analyticaltechniques** • 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 laboratorypractices. 2. Solutionmaking: a. Preparation of solutions of a given chemicalcompound b. Preparation of dilutions from a stocksolution 3. Water molecules and its properties (solvent, density, cohesion and adhesion, colligative properties) 4. pH and itsusage: a. pHmeter b. Making of own pH indicatorpapers 5. Colorimetry: a. Wavelength of maximumabsorbance b. Verification of Beer-Lambert'slaw 6. Study of separationtechniques: a. Dialysis b. Isoelectric Precipitation ofproteins c. Density gradientcentrifugation 7. Detection of carbohydrates, proteins, lipids and nucleic acids in vitro and intissues. 8. Detection of amino acids using chromatographytechnique 9. Origami and modelling of biochemicalstructures 10. Extraction of DNA fromonion		

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

PAPER –I EUKARYOTIC CELL BIOLOGY

Learning Objectives:

- Learn the structure and function of components of eukaryoticcell
- Understand the structure and role of nucleus and plasmamembrane
- Learn about protein formation and trafficking through the endomembraneorganelles
- Describe the structure and function of mitochondria andchloroplasts
- Understand the process and mechanism of cell division – mitosis andmeiosis

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, nucleosomemodel • Euchromatin andHeterochromatin • Specialized chromosomes – polytene and lampbrush chromosomes 2. Membrane – their structure and function History and models of membranestructure 3. Transport acrossmembranes • Transportprocesses • Simple and FacilitatedDiffusion • Active transport – example Na+/K+pump • Vesicular transport – Endocytosis andexocytosis 4. Cell adhesion, cell junctions and extracellularstructures • Cell- cell junctions – tight junctions, gap junctions, adhesionjunctions • Extracellular matrix of animal cells – collagen, elastin,laminins 5. Plant cell surface – plant cell wall andplasmodesmata	**15** 5 2 4 3 1
SBSLSC201	**2**	**Cell Organelles** 1. Endoplasmic reticulum andribosomes • Ribosomes – structure of prokaryotic and eukaryotic ribosomes and role in protein synthesis • Rough ER – structure and role in protein synthesis – signal peptidehypothesis • Smooth ER – structure and functions(also function as sarcoplasmicreticulum • ER role in biosynthesis ofmembranes 2. GolgiComplex • Structuralorganization • Brief introduction to role of Golgi in protein glycosylation and proteasome inprotein	**15** 3 2

		degradation 3.Lysosomes • Formation of lysosomes and role in digestionof materials • Lysosomal storage diseases – silicosis andTay-Sachs disease 4.Peroxisomes • Function in animal and plantcells • Zellwegersyndrome 5.Mitochondria • Structure and role in oxidativephosphorylation in ATP synthesis • Mitochondrial DNA and associated disease – LHON 6.Plastids • Types of plastids • Structure of chloroplast and rolein photosynthesis	2 2 3 3
SBSLSC201	**3**	**Cytoskeleton, cell cycle and cell division** 1.Cytoskeleton Types of cytoskeletalelements • Microtubules – Structure and rolein spindle formation and cilia/ flagella; microtubule motor proteins • Microfilaments – Structure and role inmuscle contraction and motility (migration via lamellipodia/amoeboid movement/cytoplasmic streaming) • Intermediate filament – Structure andfunctions 2. Cell cycle • Cell cyclestages • RegulationofCellcycle(inbrief–roleof cyclins and Cdks) • Cancer as an example of dysregulation ofcell cycle 3. Cell Division •Mitosis stagesandcytokinesis, Metaphasechromosomes: centromere and • Meiosis – Stages and significance –crossing over	**15** 5 4 5

SBSLSCP201	Practical		Credits : 2
		1. Electron micrographs of organelles andjunctions 2. Barr body from buccalsmear 3. Cytoplasmic streaming in plantcells 4. Mitosis from onion roottip 5. Permanent slides of meioticstages 6. Staining of striatedmuscle 7. Plasmolysis using Tradescantia leaf 8. Methyl green pyronin staining for localization of nucleic acids	

Reference Books:

- Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P., Molecular Biology of the Cell, 2007 or 2014, 5thEdition or 6thEdition, *Garland SciencePublications*
- Hardin J., Bertoni J.P., Kleinsmith L.J., Becker's World of the Cell: International Edition, 2011, 8thEdition, *PearsonPublisher*
- 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 UniversityPress.*

PAPER –II Classical Genetics, Ecology and Evolution

Learning Objectives:

- To understand the history and basics of moderngenetics
- To grasp the influence of environment on survival of organisms along with theories on origin of life andevolution

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, Thomas Hunt Morgan'sExperiment 2. **Mendelian inheritance** Herman's experiment on X-ray induced mutations- Concept ofhomozygous, 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. **Chromosome Theory** - Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal), Mechanisms and significance of crossingover. 2. **Chromosomal anomalies**– Structural: deletion, duplication, inversion, translocation. Numerical: euploidy and aneuploidy (e.g. Downs, Turners, Klienfelter's, Cri-du-chat). 3. **Allelic Variation and Gene function** - Non-Epistatic inter-allelic genetic interactions,Atavism/Reversion,	**15** 3 3 5

		Penetrance (complete and incomplete), Expressivity, Pleiotropism. **4. Applications** - scope of genetics using genetic traits in plant and animal breeding, gene mapping, disease and congenital defect prediction, evolutionarytrends. **5. Branches of genetics.**	3 1
SBSLSC202	**3**	**Ecology and Evolution** 1. Organism and its environment: Distribution and abundance of Organisms, Importance of carbon-based life. Concept ofEcosystem. 2. Biotic Environment: Population, population density, Reproduction, Population growth (Natality, Mortality) Extinction ofPopulation. 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 StanleyMiller) 5. Lamarkian Evolution	**15** 3 3 4 4 1
SBSLSCP202	**Practical**		**Credits : 2**
	1. Pairing game to produce a Punnet square. 2. Meiosis from *Tradescantia* (demonstration/Photograph) 3. Collection of blood group information from family and construction of pedigreecharts 4. Evolutioncard 5. Adaptive radiationusing a. Darwin finches b. Mouth parts in insects- mosquito, housefly and cockroach. 6. AnimalBiodiversity: 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/ localenvironment 7. Biostatistics: a) Purpose of Biostatistics: Data collection, Discrete and continuous variables, qualitative and quantitative Biostatistics. 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 computers – Excel), c) Measures of central tendency – mean, median, modeand standarddeviation, d) Chi square problems for monohybrid and dihybridcrosses 8. Localization of lipid globules, starch grains using potato/groundnut 9. Perform a search on any one topic using PubMed, download about ten abstracts and prepare a summary of theliterature.	

Reference Books:

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

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