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 2018-19)

SOPHIA COLLEGE (AUTONOMOUS)

F. Y. B.Sc. Life Science Syllabus

(Choice based Credit and Grading System)

Academic year 2018-2019

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 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**	**Lectures**
SBSLSC101	**1**	**A Preview of the Cell**	**15**
		1. Visualization of the cell – Microscopy – Principle, Resolving Power and types of microscopy– Brightfield, Phase contrast, DIC, 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, viroid's 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) • Viroid's • 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. Microscopy – Bright field (stained and unstained) 2. Measurements (concept of mm and μm) 3. Monochrome staining of bacteria, yeast, animal cell (from cheek), plant cell (onion peel) 4. Gram staining; Capsule staining; Endospore staining; cell wall staining 5. Sterile technique (principle of use of autoclave) 6. Streak plating (pure culture and soil sample) 7. Slide culture technique for fungi 8. MIC of NaCl 9. Hanging drop technique for bacterial motility 10. Open ended project		

Reference Books:

- Aneja K.R., Experiments in Microbiology, Plant Pathology and Biotechnology, 2017,5th Edition, *New Age International Publishers.*
- Hardin J.,Bertoni J.P., Kleinsmith L.J., Becker's World of the Cell: International Edition, 2011, 8th Edition, *Pearson Publisher.*
- 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, 10th Edition, *Universities PressPublishers*
- Tortora G.J., Funke B.R., Case C.L., Microbiology: An Introduction, 2016, 12th Edition, *Pearson Publication*
- Willey J., Sherwood L., Woolverton C.,Prescott, Harley and Klein's, Microbiology, 2008, 7th Edition, *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**	**Lectures**
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&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
US.LSC. 1. 02	**2**	**Molecular Biology** **1. Macromolecular synthesis:** • DNA synthesis • mRNA, tRNAand rRNAsynthesis • Protein synthesis **2. Molecular genetics:** • Concept of the gene- a structural unit of coding • Early experiments that defined the nature of the gene (Griffith's, Avery's and Hershey's Experiments) • Chromatin structure and packing – significance in gene regulation, manipulating gene expression (e.g.- insulin), epigenetics	**15** 9 6

SBSLSC102	**3**	**Techniques** **1. Extraction techniques** • Cell lysis techniques – Physical, chemical • solvent extraction suited to type of molecule **2. Separation and analytical techniques** • Precipitation • Filtration • Dialysis • Centrifugation • Chromatography • Electrophoresis Using the above techniques to isolate/ analyse particular molecule using a typical example	**15** 3 12
SBSLSCP102	**Practical**		**Credits : 2**
	1. Preparation of solutions 2. Water and its properties – acid-base natural indicators andpH – making your own indicator papers 3. Detection of carbohydrates, proteins, lipids and nucleicacids in vitro and in tissues. 4. Origami and modelling of biochemical structures 5. Colorimetry a. Wavelength of maximum absorbance b. Beer-Lambert's law 6. pH meter and its usage 7. Dialysis, Isoelectric Precipitation of proteins, Density gradient centrifugation 8. Chromatography of amino acids 9. Extraction of DNA from onion		

Reference Books:

- Nelson D.L. and Cox M.M.,Lehninger- Principles of Biochemistry, 2017, 7th Edition, W H Freeman & Co Publishers.
- Plummer M. and Plummer D.T., Introduction to Practical Biochemistry, 1988, 3rd Edition, McGraw Hill Publication
- Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., Biological Science, 2005, 3rd Edition, 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**	**Lectures**
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 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 • Role in protein glycosylation and trafficking • Role of proteasome in protein degradation	**15** 3 2

		3. Lysosomes • Formation of lysosomes and role in digestion of material • 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	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 kinetochore, telomere and its maintenance • 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. Diffusion of water using Tradescantia leaf 8. Methyl green pyronin staining for localisation 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, 5th Edition or 6th Edition, Garland Science Publications
- Hardin J., Bertoni J.P., Kleinsmith L.J., Becker's World of the Cell: International Edition, 2011, 8th Edition, Pearson Publisher
- Karp G, Cell Biology, 2013, 7th Edition- International Student Edition, Wiley Publication.
- Lodish H., Berk A., Kaiser C.A., Molecular Cell Biology, 2012, 7th Edition, Macmillan Learning Publications.
- Plopper G, Principles of Cell Biology, 2016, 2nd Edition, Jones and Bartlett Learning Plublication.
- Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., Biological Science, 2005, 3rd Edition, 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**		**Credits: 4**
Course code	**Unit**	**Topic headings**	**Lectures**
SBSLSC202	**1**	**Genetics** 1. **Science of Genetics** – Overview and history of Modern Genetics, Thomas Hunt Morgan's Experiment 2. **Mendelian inheritance** Well'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 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. **Chromosome Theory** - Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal), significance of crossing over. 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** - Multiple allele, Genetic interaction, Epistatic interactions, Non-	**15** 3 3 5

		Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete and incomplete), Expressivity, Pleiotropism. **4. Applications** - scope of genetics, importance of genetics, branches ofgenetics.	4
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**		**Credits : 2**
	1. Pairing game to produce a Punnets square. 2. Meiosis from *Tradescantia*(demonstration/ Photograph) 3. Collection of blood group information from family and construction of pedigree charts 4. Evolution card 5. Adaptive radiation using mouth parts in insects- mosquito, housefly and cockroach. 6. Animal Biodiversity: Part I: Classification of Animals – Invertebrates (asin the chart, provided) Part II: Classification of Animals – Vertebrates (as in the chart, provided) Digital recording and detailed classification of one animal from campus/ local environment 7. Purpose of Biostatistics: Data collection, Discrete and continuous variables, qualitative and quantitative Biostatistics.	

	8. 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), Measures of central tendency – mean, median, mode and standard deviation, Chi square problems for monohybrid and dihybrid crosses 9. Localization of lipid globules, starch grains using potato/groundnut 10. Perform a search on any one topic using PubMed, download about ten abstracts and prepare a summary of the literature.	

Reference Books:

- Brooker, Widmaier, Graham, Stiling, Biology, 2016, 4th edition, McGraw-Hill Education Publication
- Campbell, Reece, Urry, Cain, Wasserman, Minorsky, Jackson, Biology, 2016, 11th Edition
- 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, 3rd Edition, Pearson Benjamin Cummings Publications.
- Simon E.J., Biology: The Core, 2016, 2nd Edition, Pearson Publication.