SOPHIA COLLEGE, (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Life Sciences

Programme Code: SBSLSC

F.Y.B.Sc.LSc

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

Programme Outline: FYBScLSc (SEMESTER I)

Course Code	Unit No	Name of the Unit	Credits
SBSLSC101		CELL & MICROBIAL BIOLOGY	4
	1	A Preview of the Cell	
	2	Introduction to Microbiology	
	3	Microbial growth & its control	
SBSLSC102		BIOMOLECULES & SEPARATION TECHNIQIUES	4
	1	Biomolecules	
	2	Molecular Biology	
	3	Techniques	
SBSLSCP101		Practicals	2
SBSLSCP102		Practicals	2

Programme Outline: FYBScLSc(SEMESTER II)

Course Code	Unit No	Name of the Unit	Credits
SBSLSC201		EUKARYOTIC CELL BIOLOGY	4
	1	Nucleus and Cell membrane – Structure and function	
	2	Cell Organelles	
	3	Cytoskeleton, cell cycle and cell division	
SBSLSC202		CLASSICAL GENETICS, EVOLUTION AND ECOLOGY	4
	1	Genetics- I	
	2	Genetics- I	
	3	Evolution and Ecology	
SBSLSCP201		Practicals	2
SBSLSCP202		Practicals	2

Preamble:

The Broad-Based Integrated Biology Undergraduate Program in Life Sciences, which offers the BSc Life Sciences, is a cutting-edge integrated approach to biological sciences. The course is dedicated to the expansion of knowledge, innovation, and ethical practice in the field of life sciences, in recognition of the profound importance of these fields in understanding the complexity of living beings and ecosystems.

Beyond theory, this program provides students with real laboratory activities that will help them hone their skills and obtain invaluable experience in a scientific setting. The student will be prepared to apply state-of-the-art tools and methods, which will reinforce their comprehension of the subjects taught in class. Through encouraging scientific inquiry, interdisciplinary collaboration, and the pursuit of excellence, our program aims to create a community of scholars and researchers who are ready to take on the most important problems facing both humanity and the natural world, regardless of their career goals—research, industry, environmental science, or a combination of these.

PROGRAMME OBJECTIVES

PO 1	Understand and analyze fundamental biological concepts while merging perspectives from several domains related to modern biology
PO 2	Expand professional studies and research in disciplines such as neurology, genetics, cell biology, physiology, biochemistry, immunology, developmental biology, ecology, and biotechnology.
PO 3	Understand and apply information from a variety of scientific resources; assess and interpret graphical data; develop reliable hypotheses, plan experiments, and observational techniques in a laboratory setting; demonstrate problem-solving abilities; and present results from science in verbal and written form.
PO 4	Demonstrate expertise in scientific subjects such as biostatistics, bioinformatics, and analytical procedures required for productive biological research; understand biotechnological processes utilized in business; and anticipate need-based entrepreneurial opportunities in all areas of biology.
PO 5	Engage as a team, establish interpersonal communication skills, and get the confidence to pursue a career in any field of choice.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	The learner will able to understand various fundamental concepts of life science and reflect them in their day-to-day life.
PSO 2	The learner will be proficient with analytical tools and techniques of life sciences
PSO 3	The learner will be able to critical think and analyse any given problem scientifically.

SEMESTER 1

NAME OF THE COURSE	Cell & Microbial Biology	
CLASS	FYBSCLSC	
COURSE CODE	SBSLSC101	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Identify and describe the structure and function of major cellular organelles.
CO 2.	Classify microorganisms into different groups (bacteria, archaea, fungi, protozoa, viruses) based on their structural and functional characteristics.
CO 3.	Evaluate different physical and chemical methods used to control microbial growth, including sterilization techniques, disinfectants, and antimicrobial agents.

COURSE LEARNING OUTCOMES:

CLO 1.	The Learner will be able to understand the basics of microscopy, types of microscopes to visualize microbial cells, microorganisms.
CLO 2.	The Learner will be able to Compare and contrast the diverse microbes, Microbial diversity, the cell wall structure and its propagation.
CLO 3.	The Learner will be able to Gain knowledge about parameters of microbial growth and conditions for their control.

UNIT 1	PREVIEW OF THE CELL (15 LECTURES)
1.1	Visualization of the cell – Microscopy – Principle, Resolving Power and types of microscopy–Brightfield, Fluorescence, Electron microscopy –Transmission and Scanning
1.2	Types and comparison of cells – Bacteria, Archaea and Eukaryotes Limitation on size and compartmentalization of functions
1.3	Evolutionary origin of organelles and Endosymbiont Hypothesis Overview of Eukaryotic organelles
1.4	History of Microbiology – Spontaneous generation and Germ theory Role of microorganisms in agriculture, industry and medicine
UNIT 2	INTRODUCTION TO MICROBIOLOGY
2.1	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
2.2	Prokaryotic cell –Structure Cell wall – Gram positive and Gram negative Nucleoid; capsule / glycocalyx; flagella and endospore 3. Fungi – Growth and reproduction – asexual and sexual Algae – Structural organization, Protozoa – Morphological diversity
UNIT 3	MICROBIAL GROWTH & ITS CONTROL
3.1	Requirements for growth– • Physical – Temperature, pH, Osmotic pressure • Chemical – Carbon, nitrogen, sulphur, phosphorus, oxygen, trace elements, growth factors • Biofilm formation • Culture Media • Anaerobic growth
3.2	Kinetics of growth • Binary fission and cell growth • Growth curve and generation time • Batch and continuous cultures • Isolation of microorganisms • Preservation of microorganism
3.3	Control of microbial growth • Physical • Chemical • Antimicrobial
SBSLSCP101	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.**

REFERENCES:

- 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 HigherEducation*

SEMESTER 1

NAME OF THE COURSE	Biomolecules & Separation Techniques	
CLASS	FYBSCLSC	
COURSE CODE	SBSLSC102	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Define biomolecules and classify them into major categories (carbohydrates, lipids, proteins, nucleic acids).
CO 2.	Identify and explain the principles behind common molecular biology techniques (PCR, gel electrophoresis, cloning, sequencing).
CO 3.	Describe the central dogma of molecular biology (DNA → RNA → protein) and its components.

COURSE LEARNING OUTCOMES:

CLO 1.	The Learner will be able to understand the biological molecules of living cells.
CLO 2.	The Learner will be able to familiarize process of DNA synthesis.
CLO 3.	The Learner will be able to different extraction, separation and analytical techniques.

UNIT 1	BIOMOLECULES (15 LECTURES)
1.1	**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
1.2	**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
UNIT 2	MOLECULAR BIOLOGY
2.1	**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
2.2	**Macromolecular synthesis:** • Concept of macromolecules • DNA synthesis in prokaryotes • DNA synthesis in eukaryotes
UNIT 3	TECHNIQUES
3.1	**1. Extraction techniques** • Cell lysis techniques – Physical, chemical • Solvent extraction of lipids
3.2	**Separation and analytical techniques** • Precipitation • Filtration • Dialysis • Centrifugation • Chromatography • Electrophoresis
SBSLSCP102	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.**

REFERENCES:

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

Programme Outline: FYBScLSc (SEMESTER II)

Course Code	Unit No	Name of the Unit	Credits
SBSLSC201		EUKARYOTIC CELL BIOLOGY	4
	1	Nucleus and Cell membrane – Structure and function	
	2	Cell Organelles	
	3	Cytoskeleton, cell cycle and cell division	
SBSLSC202		CLASSICAL GENETICS, EVOLUTION AND ECOLOGY	4
	1	Genetics- I	
	2	Genetics- II	
	3	Evolution and Ecology	
SBSLSCP201		Practicals	2
SBSLSCP202		Practicals	2

SEMESTER 2

NAME OF THE COURSE	Eukaryotic Cell Biology	
CLASS	FYBSCLSC	
COURSE CODE	SBSLSC201	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Describe the structural components of the nucleus and cell membrane, including lipid bilayer composition, integral proteins, and peripheral proteins.
CO 2.	Identify major organelles such as mitochondria, endoplasmic reticulum (ER), Golgi apparatus, lysosomes, and peroxisomes.
CO 3.	Define the components of the cytoskeleton (microtubules, microfilaments, intermediate filaments) and their structural organization.

COURSE LEARNING OUTCOMES:

CLO 1.	The Learner will gain knowledge about the the structure and function of components of eukaryotic cell like nucleus, plasma membrane, chloroplast and mitochondria.
CLO 2.	The learner will be able to Learn about protein formation and trafficking through the endomembrane organelles.
CLO 3.	The learner will be to understand the processes and mechanism of cell division.

UNIT 1	NUCLEUS AND CELL MEMBRANE – STRUCTURE AND FUNCTION (15 LECTURES)
1.1	. Nucleus • Structure of Interphase nucleus - nuclear membrane, nucleolus, nucleosome model • Euchromatin and Heterochromatin • Specialized chromosomes – polytene and lampbrush chromosomes
1.2	Membrane – their structure and function History and models of membrane structure Transport across membranes • Transport processes • Simple and Facilitated Diffusion • Active transport – example Na+/K+pump • Vesicular transport – Endocytosis and exocytosis, Phagocytosis
1.3	Cell adhesion, cell junctions and extracellular structures • Cell- cell junctions – tight junctions, gap junctions, adhesion junctions • Extracellular matrix of animal cells –collagen, elastin, laminins Plant cell surface – plant cell wall and plasmodesmata
UNIT 2	CELL ORGANELLES (15 LECTURES)
2.1	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
2.2	Golgi Complex • Structural organization • Brief introduction to role of Golgi in protein glycosylation and proteasome in protein degradation
2.3	Lysosomes • Formation of lysosomes and role in digestion of materials • Lysosomal storage diseases – silicosis and Tay Sachs disease Peroxisomes • Function in animal and plant cells • Zellweger syndrome

2.4	Mitochondria • Structure and role in oxidative phosphorylation in ATP synthesis • Mitochondrial DNA and associated disease – LHON Plastids • Types of plastids • Structure of chloroplast and role in Photosynthesis • Photosynthetic pigments
UNIT 3	CYTOSKELETON, CELL CYCLE & CELL DIVISION
3.1	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
3.2	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
3.3	Cell Division •Mitosis stages and cytokinesis, Metaphase chromosomes: centromere and • Meiosis – Stages and significance–crossing over
SBSLSCP201	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.**

REFERENCES:

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

- 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.*
- LodishH.,BerkA.,KaiserC.A.,MolecularCellBiology,2012, 7thEdition, *Macmillan Learning Publications.*
- Plopper G, Principles of Cell Biology, 2016, 2nd Edition*, Jones and Bartlett Learning Publication.*
- Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., Biological Science, 2005, 3rd Edition, *Cambridge University Press.*

SEMESTER 2

NAME OF THE COURSE	Classical Genetics, Evolution and Ecology	
CLASS	FYBSCLSC	
COURSE CODE	SBSLSC202	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Explain the basic principles of inheritance, including Mendelian genetics, genetic variation, and the laws of segregation and independent assortment.
CO 2.	Discuss mechanisms of genetic variation, including mutations, recombination, and genetic drift.
CO 3.	Define ecological levels of organization (individual, population, community, ecosystem, biome) and their interactions.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will able to understand the history and basics of modern genetics.
CLO 2.	The learner will able to understand the influence of the environment on survival of organism.
CLO 3.	The learner will able to learn the theories on the origin of life and evolution.

UNIT 1	GENETICS-I (15 LECTURES)
1.1	**Science of Genetics** – Overview and history of Modern Genetics, Chromosome Theory of Inheritance-Sutton-Boveri, Thomas Hunt Morgan's Experiment
1.2	**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
1.3	**Modification of Mendel's laws -** Gene interactions: incomplete dominance, co-dominance; Multiple genes, Multiple alleles: Blood group, Epistasis, Linkage, Sex limited, sexinfluenced.

1.4	**Non-Mendelian inheritance** - Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparentalinheritance
1.5	**Pedigree analysis** - Symbols of Pedigree,Pedigrees of Sex-linked and Autosomal (dominant and recessive).
UNIT 2	GENETICS-II
2.1	**Allelic Variation and Gene function** - Non Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete and incomplete), Expressivity, Pleiotropism.
2.2	**Chromosomal anomalies**– Structural: deletion, duplication, inversion, translocation. Numerical: euploidy and aneuploidy (e.g. Downs, Turners, Klienfelter's, Cri-du-chat).
2.3	**Applications-** Scope of genetics in healthcare
UNIT 3	ECOLOGY & EVOLUTION
3.1	Organism and its environment: Distribution and abundance of Organisms, Importance of carbon-based life. Concept of Ecosystem. Biotic Environment: Population, population density, Reproduction, Population growth (Natality, Mortality) Extinction of Population.
3.2	Interspecific and Intraspecific Population Regulation: Competition, Dispersal, Territoriality, Predation. (Lotka-Volterra model), Parasitism, Mutualism. 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) Lamarkian Evolution
SBSLSCP202	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.**

REFERENCES:

- Brooker, Widmaier, Graham, Stiling, Biology, 2016, 4th edition, *McGraw-Hill Education Publication*
- Campbell, Reece, Urry, Cain, Wasserman, Minorsky, Jackson, Biology, 2016, 11th Edition, *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*
- *R*usselle P., *iGenetics*: A Molecular Approach, 2010, 3rd Edition, *Pearson Benjamin Cummings Publications.*
- Simon E.J., Biology: The Core, 2016, 2nd Edition, *Pearson Publication.*

ASSESSMENT DETAILS:(this will be same for all the theory papers)

Internal Assessment (25 marks)

Part 1: Project Work (**20 Marks**)

- At the beginning of the semester, students should be assigned project topics drawn from Unit 1 to Unit 4.
- Students can work in groups of not more than 8 per topic.
- Project Marks will be divided as written submission: 10 Marks & Presentation & Viva: 10 marks)
- The Project/Assignment can take the form of Street-Plays/Power-Point Presentations/Poster Exhibitions and similar other modes of presentation appropriate to the topic.
- Students must submit a hard copy of the Project before the last teaching day of the semester.

Part 2: Attendance **– 05 marks**

Semester End Examination – External Assessment (75 marks)

- The duration of the paper will be two hours.
- There shall be four compulsory questions
- Q1-3 shall correspond to the three units. Q1-3 shall contain an internal choice (attempt any 2 of 3). Q1-3 shall carry a maximum of 20 marks
- Q4 shall be a short note from Unit 1 to 3. Q4 shall carry a maximum of 15 marks (3x5 marks) (attempt any 3 of 6)

Practical Assessment (for papers with practicals)

- The duration of the practical exam will be 8 hours.
- The students are allowed to write the paper if the attendance for practicals is more than 75%.
- To appear in the practical exam, students must bring a properly certified journal.
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- To appear in the practical exam, students must bring a properly certified journal.