SOPHIA COLLEGE (AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: MSc
Life Sciences (Specialization in Neurobiology)

Syllabus for the Academic Year 2023-2024

based on the National Education Policy 2020

SOPHIA COLLEGE (AUTONOMOUS)

PROGRAMME SPECIFIC OUTCOMES	
1	The students will develop knowledge to comprehend the core concepts of system biology,cellular biology and biochemistry inclusive of practical skills in the same.
2	The students will understand and reflect on the knowledge of ethical principles regarding the use of science.
3	The students will exhibit the ability to understand, analyze and evaluate original research literature and to communicate this understanding using appropriate technology.

DEPARTMENT OF LIFE SCIENCES

COURSE DETAILS FOR MAJOR:

	SEMESTER I			
	Major Paper I	**Major Paper II**	**ELECTIVE PAPER**	**RESEARCH METHODOLOGY**
TITLE	**Cell Biology and Macromolecules**	**Systems Biology I**	**Bioinformatics, Biostatistics, & Toxicology**	**Research Methodology & Scientific communication**
TYPE OF COURSE DSE/DSC	**Major**	**Major**	**Elective**	**Research Methodology**
CREDITS	**6**	**6**	**4**	**4**

	SEMESTER II			
	Major Paper I	**Major Paper II**	**Elective Paper**	**Field Project/Internship**
TITLE	**Molecular Genetics**	**Cell and System Biology II**	**Evolution & Population Biology**	**Research project/internship in laboratory/industry.**
TYPE OF COURSE DSE/DSC	**Major**	**Major**	**Elective**	**Field Project**
CREDITS	**6**	**6**	**4**	**4**

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Science Life Science Major		**Semester – 1**	
Course Title: Cell Biology and Macromolecules		**Course Code: SLSC511MJ**	
COURSE OBJECTIVES: To enable understanding of: 1. Microbial diversity and structure of prokaryotic cell 2. Microbial growth and its control 3. Organelles of eukaryotic cells – structure and function 4. Concept of intercellular communication 5. The various methods used to study cellular processes			
COURSE OUTCOMES: The learner will be able to : 1. Learn the fundamentals of prokaryotic and eukaryotic cell structure and growth 2. Use the knowledge of different .microscopic techniques to visualize different cell structures 3. Discern the factors regulating gene function in both prokaryotic and Eukaryotic systems			
Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assesment**	**2 Hours**	**50 marks**
	Continous Assessment	**--**	**50 marks**

UNIT 1		**Biology of Prokaryotes**	15 hours
	1.1 1.2	Prokaryotic Cell Structure Microbial Diversity a) Archaea: General characteristic and types (Halophiles, Methanogens; Hyperthermophilicarchaea and Thermoplasma) b) Bacteria: characteristics and any 3 types with examples (Purple and green bacteria, budding bacteria rods, Spirochetes, Sheathed bacteria, Endospore forming rods and cocci) c) Viruses: Structure and life cycle of bacteriophage, DNA virus and RNA virus.	1 2 3 2
	1.3	Microbial Growth: Growth curve	2
	1.4	Antibiotics and Antibiotic stewardship	1

	1.5	**Techniques in cell biology** Visualizing cells using a) Light microscopy, b) Phase contrast and DIC for unstained cells c) Fluorescence microscopy d) Confocal microscopy, and e) Electron microscopy	4
UNIT 2		**Biology of Eukaryotes**	
	2.1	Eukaryotic Cell Structure: Plasma Membrane Structure, lipid bilayer, membrane proteins	1
	2.2	Principles of Membrane Transport: Transporters and Active Membrane Transport; Ion Channels and electrical properties of membranes.	2
	2.3	Intracellular Compartments and Protein Sorting: Compartmentalization of cells, Endoplasmic Reticulum, Golgi apparatus and transport from ER to Golgi and lysosomes, Endocytosis and Exocytosis; Transport of molecules into nucleus, mitochondria chloroplast and peroxisomes. Proteosomal destruction of misfolded/unfolded protein	4
	2.4	Nucleus: Membrane and nuclear pore complex, nucleolus, nucleosome model .	1
	2.5	Cytoskeleton: Dynamic structure of Cytoskeletal filaments, Molecular motors, functions of cytoskeleton.	2
	2.6	Cell junctions, Cell adhesion and Extracellular Matrix: Tight junctions, Gap Junctions, Adhesion junctions, Cadherins, Integrins	2
	2.7	**Techniques to enhance visualization**: a) Fluorescent tags for live imaging, antibody or radioisotope binding for specific molecule detection, light emitting indicators for ion concentrations, b) Optical traps to manipulate objects, single molecule visualization using Total Internal Reflection Fluorescence microscopy. c) *in situ* localization and FISH	3

UNIT 3		**Biomolecules**	15 hours
	3.1	Cellular Biochemistry a) The concept of Energy and Work within cells b) Metabolism of biomolecules: Synthesis and breakdown of carbohydrates, lipids, amino acids, nucleotides and vitamins (lipid soluble and insoluble) using one typical example each	1 4
	3.2	Nucleic acid biochemistry a) Nucleic acid packing: Packing of DNA into chromosomes – structure-function relationships; chromatin organization and remodeling, Proteins associated with chromosome structure (scaffold and associated proteins)	2
	3.3	DNA Replication a) Mechanisms of DNA replication in prokaryotes and eukaryotes: DNA modifying enzymes (kinases, polymerases, ligases). b) DNA replication models, connection of replication to cell cycle, c) Reverse Transcriptase and Restriction endonucleas	3
	3.4	Regulation of gene expression a) in prokaryotes (Lac and trp operon) b) in eukaryotes: initiation, elongation and termination (Gal operon) Eukaryotic translation c) Post-transcriptional processing and transport of RNA, Non-coding RNAs	3
	3.5	Techniques in macromolecular biology PCR, Nested PCR, Multiplex PCR, RT-PCR, qRT- PCR, RAPD, RFLP, DNA sequencing.	2

UNIT 4		**Biomolecules II**	15 hours
	4.1	Protein Biochemistry a) Protein- Conformation of proteins, Structure function relationships of typical proteins – fibrous and globular, Ramachandran plot b) Post translational Modifications c) Protein sequencing/detection of amino acids: Edman's and Sanger's reaction	4
	4.2	Enzymes – Classification, Activity and Specific activity, Enzyme kinetics, Enzyme inhibition, Allosteric enzymes, Application of Enzymes in Industry, Agriculture and Research	4
	4.3	Techniques in Protein purification: a) Centrifugation b) Sedimentation c) Chromatography (Adsorption, Affinity, d) Gel filtration, ion-exchange, HPLC) e) Protein sequencing/detection of amino acids: Edman's and Sanger's reaction f) Spectrophotometry in quantitation of macromolecules. g) X-ray crystallography	7

Practicals for Major Paper (SLSC511MJP) (02 credits)

1. Staining of capsule/endospore/flagella from the given culture
2. Electron Micrographs of cell organelles (demonstration)
3. Preservation of micro-organisms: sub culturing, glycerol stocks, concept of lyophilization (demonstration)
4. Growth curve of *E. coli and* Diauxic growth curve.
5. Isolation of auxotrophic mutants after exposure to UV/ chemical mutagen. 13. Induction of the Lac operon and assessment of enzyme activity using a suitable system (e.g. *E. coli*).
6. Antibiotic sensitivity tests – Agar Cup method and Disc Diffusion method\
7. Microscopy – light, phase contrast, DIC, fluorescence (nuclear staining using Ethidium bromide or DAPI / lysosomal staining using acridine orange / phalloidin staining for actin filaments) – Demonstration
8. Extraction of lipid by Bligh and Dyer method and detection and estimation by TLC
9. Extraction and estimation of ascorbic acid from vegetable source by colorimetric method
10. Extraction and estimation of phosphorus by Fiske-Subbarao method.

REFERENCES

1. Alberts B. et al, Molecular Biology of the Cell, 2016,*Garland Science*
2. Hunt T and Wilson J., The Problem Book - for Molecular Biology of the Cell'
3. Karp G., Iwasa J., Marshall W., Cell Biology, 8th Edition, 2013, *Wiley InternationalPublisher.*
4. Lodish H., Molecular Cell Biology, 5th Edition,2016,*W. H. Freeman & Co.*
5. Brock, Biology of Microorganisms, 13th Edition, 2012, *Benjamin Cummins*
6. Spector, David L. & Goldman, R.D., Basic Methods in Microscopy: Protocols and Concepts From Cells: A Laboratory Manual, 2006, *Cold Spring Harbour Laboratory Press.*
7. Tortora G., Microbiology an Introduction, 10th Edition, 2010, *Benjamin Cummins*
8. Berg J.M., Tymoczko J.L., and Stryer L.,Biochemistry, 2006, 6th edition, *Freeman Publishers, New York.*
9. Brooker, Robert J., Concepts of Genetic,2012, 2nd Edition, *McGraw-Hill Publication.* Hardin J., Bertoni J.P., Kleinsmith L.J., Becker's World of the Cell: International Edition, 2011, 8th Edition, *Pearson Publishers.*
10. Nelson D.L. and Cox M.M.,Lehninger Principles of Biochemistry, 2000, 6th edition. *Worth Publishers, New York.*
11. Lewin, B., Genes XI, 2006, 11thEdition,*Jones and Bartlett Publishers*.
12. Pierce B., Genetics: A Conceptual Approach, 3rd edition, 2008, *W. H. Freeman & Co.* Plummer M. and Plummer D.T., Introduction To Practical Biochemistry, 1988, 3rd Edition, *McGraw Hill Publication*
13. Strachnan T. and Read A.P. Human Molecular Genetics, 2014, 4thEdition, *Garland Science Publisher.*
14. Russell, P.J., *i*Genetics- A Molecular Approach, 3rd edition, 2010, *Pearson Publishers*.
15. Snustad& Simmons, Principles of Genetics, 6th edition, 2012, *John Wiley & Sons Inc.*
16. Voet D. and Voet J.G., Biochemistry, 2010, 4th edition*, Wiley &SonsPublishers, New York.*
17. Wilson, K. & Walker, J., Principles and Techniques of Biochemistry and Molecular Biology, 2010, 7th Edition,*Cambridge University Press.*

SOPHIA COLLEGE (AUTONOMOUS)

ASSESSMENT DETAILS:

I. Internal Assessment (IA): 50 marks

- IA is a separate head of passing.
- A learner should get a minimum of 20 marks out of 50 to be declared PASS in the course.
- 2 activities of 25 marks each.
- If the learner does not get 20 marks out of 40, the learner will have to appear for the IA ATKT.

II. Semester End Examination (SEE): 50 marks

- SEE is a separate head of passing.
- A learner should get a minimum of 20 marks in SEE to be declared PASS in the course.
- All units of the syllabus will be covered in SEE and will be given equal weightage.
- An additional SEE will be held for those who are absent, due to valid reasons, for the main/regular SEE.
- If the learner does not get 20 marks out of 50, the learner will have to appear for the SEE ATKT.

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Science **Life Science Major II**		**Semester – 1**	
Course Title: Systems Biology I		**Course Code: SLSC512MJ**	
COURSE OBJECTIVES: To enable understanding of: 1. Physiological systems that maintain homeostasis-Digestive, Circulatory, Excretory 2. Basics of Immunology 3. Host Parasite interactions and diseases 4. Techniques used in physiology and immunology			
COURSE OUTCOMES: The learner will be able to : 1. Apply the gained knowledge of the various systems and diseases associated with lack of systemic homeostasis 2. Identify the appropriate routine analysis of various biological fluids and tissue samples 3. Understand the epidemiology, pathophysiology of emerging infectious diseases			
Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assesment**	**2 Hours**	**50 marks**
	Continous Assessment	**--**	**50 marks**

UNIT 1			15 hours
	1.1	**Physiology-I** 1. Levels of Organization of Animal body at Tissue and Organ level. 2. Concept and Definition of Homeostasis. Homeostatic control and their relevance. 3. Disruptions in Homeostasis and its impact on Physiology.	4
	1.2	**Digestive system:** 1. Digestive tract and accessory digestive organs. 2. Digestive processes and an overview of three major nutrients. 3. Gastrointestinal Hormones	3

	1.3	**Circulatory System:** 1. Blood, blood vessels and blood pressure. 2. Anatomy of the heart and its electrical activity. 3. Events associated with cardiac cycle.	4
	1.4	**Excretory system:** 1. Nephron as a functional unit, 2. Basic renal processes, Globular filtration, Tubular reabsorption, and Tubular excretion. 3. Urine excretion and body's state of hydration.	4
UNIT 2	2.1	**Immunology** 1. Cells and organs of the Immune System, Mechanisms of Innate immunity – including Complement system 2. Antibody structure and function, Generation of antibody diversity, B cell ontogeny 3. T cell receptors and their diversity, T cell ontogeny – Helper and cytotoxic T cell 4. MHC molecules and antigen presentation 5. Vaccine- active and passive immunization; Types of vaccine	15 hours 3 4 4 2 2
UNIT 3		**Diseases**	15 hours
	3.1	**Host parasite interactions and Diseases** 1. Mechanisms of pathogenesis: bacterial and viral; Parasite evasion strategies 2. Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Laboratory diagnosis, Prophylaxis, and Treatment a. Bacterial- eg. Typhoid, Cholera,Tuberculosis / Leprosy b. Viral- eg. Polio, AIDS c. Parasitic- eg. Malaria, Roundworm/ Filariasis, Ebola/ Zika d. Fungal- eg. Candidiasis	2 5 5
	3.2	**Plant Pathology** 1. Tungro virus	3

		2. Bacterial Leaf Blight 3. Red rot disease 4. Root-knot nematode 5. Fundamental concept of disease resistance is plants and production of disease free plants	
UNIT 4		**Techniques in systems biology I**	15 hours
	4.1	Physiology I a) Kidney function tests – BUN, creatinine (range, basic interpretation/biological significance) b) Cardiac function tests – Troponin, creatinine kinase (range, basic interpretation/biological significance)	3 4
	4.2	Techniques in immunology a) Immunoelectrophoresis b) ELISA, Western blot, Chemiluminescence c) Immunohistochemistry and Immunofluorescence, d) Production of Monoclonal antibodies	2 6

Practicals for Major Paper (SLSC512MJP) (02 credits)

1. Histology – processing of tissue, preparation and cutting of sections and staining and preparation of permanent slide
2. Agglutination Reactions: Study of Blood groups, Isohemagglutinin titre in blood and Quantitative Widal Test
3. Precipitation Reactions: Single (Radial) immunodiffusion and Double immunodiffusion (Ouchterlony)
4. Separation of Mononuclear cells (lymphocytes) using a gradient and the determination of viable count of the same (Demonstration).
5. Innate Immunity: Testing the effects of saliva/tears/lysozyme on *Staphylococcus, Streptococcus.*
6. Biochemical tests for identification of microorganisms: Catalase, IMViC, Urease
7. Recording and Measurement of Blood Pressure, Correlation significance of Systole/Diastole and Heart rate, recording of ECG (Interpretation)

REFERENCES

1. Alberts B., Johnson A., Lewis L., Morgan D., Raff M., Roberts K., Walter P., Molecular Biology of the Cell, 2007 or 2014, 5th Edition or 6th Edition, *Garland Science Publication.*
2. Delves P., Mastin S. et al, Roitt's Essential Immunology, 2006, 11th Edition, *Blackwell Publishing.*

3. Guyton A.C. and Hall J.E., Text Book of Medical, 2006, 11th Edition, *Elsevier Saunders*
4. Kuby Immunology by Punt, Stranford, Jones, Owen, 2018, 8th ed, *W. H. Freeman.* Mukherjee, Kanai L., Medical Laboratory Technology, 1988, Reprint Edition, *Tata MacGraw Hill Publishing Co. Ltd., New Delhi.*
5. Seeley R, Stephens T and Tate P, Anatomy and Physiology, 2004, 6th Edition, *The McGraw−Hill Companies.*
6. Spector, David L. & Goldman, R.D., Basic Methods in Microscopy: Protocols and Concepts From Cells: A Laboratory Manual, 2006, *Cold Spring Harbor Laboratory Press.*
7. Taiz, Zeiger, Moller and Murphy, Plant Physiology, 2014 6th edition, *Sinauer Publications.*
8. Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., Biological Science, 2005, 3rd Edition, *Cambridge University Press.*
9. Tortora G. and Grabowski S., Principles of Anatomy and Physiology, 2010, 10th Edition, *John Wiley & Sons, Inc.*

ASSESSMENT DETAILS:

I. Internal Assessment (IA): 50 marks

- IA is a separate head of passing.
- A learner should get a minimum of 20 marks out of 50 to be declared PASS in the course.
- 2 activities of 25 marks each.
- If the learner does not get 20 marks out of 40, the learner will have to appear for the IA ATKT.

II. Semester End Examination (SEE): 50 marks

- SEE is a separate head of passing.
- A learner should get a minimum of 20 marks in SEE to be declared PASS in the course.
- All units of the syllabus will be covered in SEE and will be given equal weightage.
- An additional SEE will be held for those who are absent, due to valid reasons, for the main/regular SEE.
- If the learner does not get 20 marks out of 50, the learner will have to appear for the SEE ATKT.

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Science **Life Science Elective**	**Semester – 1**
Course Title: Toxicology, Biostatistics I & Bioinformatics	**Course Code: SLSC511E**

COURSE OBJECTIVES:

1. Pursue the students in understanding how algorithms in an online database platform are used to store, process and analyze data regarding biological samples
2. Aims to teach the students the significance of statistical calculation for validating any scientific data set
3. Aims at educating students about the different toxins, and route of exposure, followed by risk assessment, prediction and management.

COURSE OUTCOMES:

The learner will be able to :

1. learn different in silico tools for studying drug interaction, binding affinity, active target identification and modifications for some diseases and so on
2. interpret any scientific results by using descriptive statistical methods effectively.
3. demonstrat and understand the fundamental concepts of modern statistical theory and their probabilistic foundation.
4. apprehend the major classes of toxicology, different toxins, and route of exposure, risk assessment, prediction and management.

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Continuous Assessment**	**Theory**	**50 marks**
		Practical	**50 marks**

UNIT 1		**Bioinformatics**	15 hours
	1.1	1. Introduction to bioinformatics	1
		2. Biological databases and their types –Primary and secondary databases, specialized databases, possible limitations of databases .	1
		3. Sequence alignment: Pairwise and multiple sequence alignment and statistical significance (P and E value).	2
		4. Phylogenetic trees – Molecular evolution, rooted and unrooted trees, phylograms and	3

		cladograms, UPGMA, Neighbour Joining Method, Maximum Parsimony. 5. Omics techniques: Genomics (SNP microarray), transcriptomics (cDNA microarray), Mass spectrometry-based proteomics (chemical versus metabolic labelling, gel based versus gel free methods) and omics data management (e.g. gene ontology)	3
	1.2	**Biostatistics** 1. Probability: Addition theorem, Multiplication theorem, Baye's theorem 2. Normal Distribution, Binomial Distribution, Poisson Distribution (including characteristics of these distributions), concept of skewness and kurtosis 3. Correlation: Scatter plots, Karl Pearson correlation. 4. Regression: Linear regression (Y on X, X on Y), concept of multiple linear regression.	5
UNIT 2		**Toxicology**	15 hours
	2.1	1. History of toxicology, classification of toxicology. 2. Toxicants: Exposure, exposure characterization. 3. Routes of exposure: Organism environment interaction, Animal and plant toxins, Absorption and distribution of toxicants, 4. Hazard identification: Risk assessment (Human health risk assessment) Risk prediction and Management (management of acute intoxication, natural detoxification– Biochemical and genetic mechanism)	2 2 5 6

SOPHIA COLLEGE (AUTONOMOUS)

Practical : Elective Paper 2 credits (SLSC511EP) (02 credits)

1. **Basics of Biostatistics**
    a. Normal Distribution, Binomial Distribution, Poisson Distribution (including characteristics of these distributions), concept of skewness and kurtosis)
    b. Correlation: Scatter plots, Karl Pearson correlation.
    c. Regression: Linear regression (Y on X, X on Y), concept of multiple linear regression.
    d. Estimation: Point and interval, confidence interval and standard error of mean.
    e. Discussion on sampling techniques: simple random sampling, stratified random sampling, systematic sampling

2. **Bioinformatics:**

    a. Multiple sequence alignment
    b. Phylogenetic tree analysis
    c. BLAST- BLASTn, BLASTp,
    d. Primer designing using BLAST and BioEdit
    e. Gene ontology
    f. OMIM
    g. KEGG
    h. Finding ORFs

3. Determination of population density (*Daphnia* or any suitable organism) by sub sampling method
4. Effect of toxicity in water on *Daphnia.*
5. Calculation of Biodiversity index from the given table-top habitat.
6. Extraction of DNA by DPA method using a suitable source, estimation of purity and visualization by Agarose gel electrophoresis.
7. Isolation of RNA from a suitable system and estimation (orcinol reagent), estimation of purity and visualization by Agarose gel electrophoresis.
8. Extraction and estimation of proteins by Folin Lowry
9. Separation of proteins using SDS-PAGE.

Reference Books:

1. Jonathan Pevsner (2015) "Bioinformatics and Functional Genomics" 3 rd Ed. Wiley. 2. Arthur M. Lesk. (2013) Introduction to Bioinformatics. 4th Ed. Oxford University Press. 3. Zhumur Ghosh, Bibekanand Mallick. (2008). Bioinformatics: Principles and Applications Oxford University Press. 4. David W. Mount. (2004) Bioinformatics: Sequence and Genome Analysis. 2nd Ed. Cold Spring Harbor Laboratory Press, New York. 5. S C Rastogi, N Mendiratta, P Rastogi. Bioinformatics: Methods and Applications – Genomics, Proteomics and Drug Discovery. 3rd Ed. PHI Learning Pvt. Ltd., New Delhi. 6. University websites (Online).
2. Arora P.N. &MalhanP.K. Biostatistics, 2002, First Reprint Edition, Himalaya Publishing House.
3. Banerjee P.K., Introduction to Biostatistics,2004, First Edition, S. Chand & Company Pvt. Ltd.

4. GurumaniN., An Introduction to Biostatistics, 2011, Second Revised Edition, M.J.P. Publisher.
5. Mahajan B.K., Methods in Biostatistics, 2002, Sixth Reprint Edition, Jaypee Brothers Medical Publishers (P) Ltd.
6. Nelson, L.S., Lewin, N.A., Howland, M.A., Hoffman, R.S., Goldfrank, L.R. and Flomenbaum, N.E. (2011) "Goldfrank's Toxicologic Emergencies" McGraw-Hill Global.
7. Santra S.C., Fundamentals of Ecology and Environmental Biology,2010, First Edition, New Central Book Agency (P) Ltd.

ASSESSMENT DETAILS:

Only Continuous Assessment (CA) will be conducted

- Only CA is to be conducted of 50 marks.

1. CA 1: Test - 25 marks (Duration for answering the Test: Max. 60 Minutes)
   Format: Questions testing the following skills of students.
   Remembering, Understanding & Applying
2. CA 2: Any Activity - 25 marks
   Format: Aims at testing the following skills of students.
   Analyzing, Evaluating & Creating (weightage of each aspect may be determined by the concerned teacher depending on the requirements of the course)

- If a student fails to pass (scores less than 20) then students will have to appear for 50 marks ATKT – one IA Test of 25 marks covering questions based on 3 aspects of Bloom's Taxonomy (duration of test will be 60 minutes) and one assignment of 25 Marks.
- The minimum score to pass the Course will be 20 marks out of 50 marks.
- Students' CA activity-related scores with assessed papers and feedback (tests, other activities, assignments etc.) will be shared individually with students.
- Rubrics for all CAs with question papers must be shared with the Exam Committee.
- Grievance Redressal Mechanism for addressing grievances related to CAs.
- Students will apply in a prescribed format to the respective Vice Principals. The grievance will be addressed by involving the concerned faculty and the other Exam Committee member/s deputed by the Principal.

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Science **Life Science Major**		**Semester – 1**	
Course Title: Research Methodology & Scientific communication		**Course Code: SLSC511RM**	
COURSE OBJECTIVES: 1. To study the various elements of Research Methodology 2. To apply scientific writing skills while carrying out research 3. To understand the importance of ethics in research and publication.			
COURSE OUTCOMES: The learner will be able to : 1. Identify the difference between the types of research designs and methodologies. 2. Design research projects in line with the ethical considerations. 3. Prepare manuscripts for effective scientific communication.			
Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**30**	
Credits		**4**	
Evaluation System	**Graded Subject**	**Continuous Assessment**	**50 marks**

UNIT 1		**Introduction to Research Methodology**	15 hours
	1.1	Research – A Systematic Process of Enquiry Introduction Rationale Types- Basic, Applied, Need-Based	4
	1.2	Types of Research studies: Prospective or Retrospective Case-control Cross Sectional Longitudinal (to be applied to students' actual research projects)	6
	1.3	Elements of Research methodology: Experimental Design, Data Documentation and Analysis	5
UNIT 2		**Science Communication**	15 hours

	2.1	Structure and components of a research paper and research paper writing	2
	2.2	Principles of effective writing: Literature review, Report writing: Thesis/Dissertation, Grant writing Reference Writing System	8
	2.3	Types of grants: Fellowship/ Travel/ Project/Conference/Workshop & Proposal writing	5
UNIT 3		**Designing Effective Research**	15 hours
	3.1	Planning a research project Definition and Formulation of a Problem, Designing and conducting a research project	5
	3.2	Literature sources- Library, Books, Data Bank, Websites etc	4
	3.3	Statistical Tools & Softwares for data analysis-EXCEL, SPSS Publication of research findings	6
UNIT 4		**Ethics in Research**	15 hours
	4.1	Patents & It's Types	3
	4.2	Ethics in publication - Part 1: Plagiarism & its types Ethics in publication - Part 2: IPR & Conflict of Interest	5
	4.2	Ethical Guidelines in Animal Research Ethical Guidelines in Wildlife Research Ethical Guidelines in Clinical Research	7

Reference Books:

1. Booth V., Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings, 2003, *Cambridge University Press*.
2. Creswell J.W., Cresswell J.D., Research Design: Qualitative, Quantitative, and Mixed Method Approaches, 2017, *Sage Publications*.
3. Day R. A., Gastel B., How to Write & Publish a Scientific Paper, 2011, *Greenwood*.

4. Gurumani N., Research Methodology for Biological Sciences, 2006, *MJP Publishers*.
5. Matthews J.R., Matthews R.W., Successful Scientific Writing: A Step-By-step Guide for the Biological and Medical Sciences, *Cambridge University Press*.
6. Marczyk G., DeMatteo D., Festinger D., Essentials of Research Design and Methodology, 2010,*John Wiley and Sons, Inc*.
7. Laake P., Benestad H.B., Olsen B.R., Research Methodology in the Medical and Biological Sciences, 2007, *Acad Press*.
8. Kothari, C.R.. (2004). Research methodology : Methods and techniques (2nd revised edition).
9. Röcklinsberg, H., Gjerris, M., & Olsson, I. (2017). Animal Ethics in Animal Research. Cambridge: Cambridge University Press. doi:10.1017/9781108354882

ASSESSMENT DETAILS:

Only Continuous Assessment (CA) will be conducted

- Only CA is to be conducted of 50 marks.

1. CA 1: Test - 25 marks (Duration for answering the Test: Max. 60 Minutes)
   Format: Questions testing the following skills of students.
   Remembering, Understanding & Applying
2. CA 2: Any Activity - 25 marks
   Format: Aims at testing the following skills of students.
   Analyzing, Evaluating & Creating (weightage of each aspect may be determined by the concerned teacher depending on the requirements of the course)

- If a student fails to pass (scores less than 20) then students will have to appear for 50 marks ATKT – one IA Test of 25 marks covering questions based on 3 aspects of Bloom's Taxonomy (duration of test will be 60 minutes) and one assignment of 25 Marks.
- The minimum score to pass the Course will be 20 marks out of 50 marks.
- Students' CA activity-related scores with assessed papers and feedback (tests, other activities, assignments etc.) will be shared individually with students.
- Rubrics for all CAs with question papers must be shared with the Exam Committee.
- Grievance Redressal Mechanism for addressing grievances related to CAs.
- Students will apply in a prescribed format to the respective Vice Principals. The grievance will be addressed by involving the concerned faculty and the other Exam Committee member/s deputed by the Principal.

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Science Life Science Major		**Semester – 2**	
Course Title: Molecular Genetics		**Course Code: SLSC523MJ**	
COURSE OBJECTIVES: 1. To understand the theory of classical genetics. 2. To understand the DNA repair mechanism. 3. To acquire detailed understanding of Regulation of gene expression. 4. Introduce techniques in genetics.			
COURSE OUTCOMES: 1. Students will be able to understand the concept of Classical genetics. 2. Students will be able to understand the processes involved in regulation of genes . 3. Students will be able to understand different tools in genetics and to apply these techniques for genetic manipulation.			
Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assesment**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

UNIT 1		**Inheritance biology**	15 hours
	1.1	Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests.	3
	1.2	Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance.	3
	1.3	Extensions of Mendelian principles: Codominance, incomplete dominance, Lethal and Essential Genes, Anticipation, Penetrance, Expressivity, Epistasis	5
	1.4	Non-Mendelian Inheritance: Cytoplasmic/maternal inheritance, organelle genetics	4
UNIT 2		**Regulation of gene expression, Epigenetics and DNA damage & repair**	15 hours
	2.1	Regulation of gene expression: a) Regulation of gene expression in prokaryotes and eukaryotes	3

		b) Transposable elements in bacteria, Insertion segment elements, composite transposons, replicative and non-replicative transposons, Mu transposition, Controlling elements in TnA and Tn10 transposition, short interspersed elements (SINEs) and long interspersed elements (LINEs)	4
	2.2	Epigenetics, DNA damage and repair: a) Epigenetics: Imprinting, mechanism (Methylation and Acetylation) b) DNA damage and Repair: Types of DNA damage (Deletion, duplication, inversion, translocation, ploidy and their genetic implications) , DNA repair mechanisms- nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand break	3 5
UNIT 3		**Molecular Biology/Genetics**	15 hours
	3.1	Microbial genetics: transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating.	3
	3.2	Quantitative genetics: Pleiotropy and epistasis, polygenic inheritance, heritability and its measurements, QTL mapping	3
	3.3	Gene mapping methods: Linkage maps and lod score for linkage testing, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids	4
	3.4	Mutation: conditional, loss of function, gain of function	
	3.5	Human genetics: Pedigree analysis, karyotypes using examples, genetic disorders; Human Genome Project and Genome wide association studies.	1 4
UNIT 4		**Techniques in genetics**	15 hours
	4.1	Vectors 1. Phages (λ, M13, SV 40, Baculo virus) 2. Plasmids (pBR322), Ti plasmids in plants 3. Cosmids, YAC, BAC, PAC	4 2
	4.2	Screening/ selection techniques – Antibiotic / blue-white screening	4
	4.3	Gene cloning, transgenic animal and plant production DNA libraries - genomic and cDNA libraries RNase protection assay, microarray Gene therapy: Ex vivo and in vivo therapy, strategies and delivery.	5

Practicals for Major Paper (SLSC523MJP) (02 credits)

1. Isolation of plasmid from E. coli and transformation of E.coli cells.
2. Extraction of DNA from brain / neural cell culture.
3. Extraction of RNA from brain / neural cell culture.
4. PCR of gene from neural tissue and demonstration of PCR product using AGE (Demonstration)
5. RFLP analysis of PCR product (Demonstration).
6. Study of sex-linked inheritance in *drosophila melanogaster.*
7. G&C banding of mammalian metaphase chromosomes.
8. Determination of ploidy in zebrafish embryo.

REFERENCES

1. Berg J.M., Tymoczko J.L., and StryerL.,Biochemistry, 2006, 6th edition, Freeman Publishers, New York.
2. Hardin J., Bertoni J.P., Kleinsmith L.J., Becker's World of the Cell: International Edition,
3. 2011, 8th Edition, Pearson Publisher.
4. Nelson D.L. and Cox M.M.,Lehninger Principles of Biochemistry, 2000, 6th edition. Worth Publishers, New York.
5. Lewin, B., Genes IX, 2006, Jones and Bartlett Publishers.
6. Pierce B., Genetics: A Conceptual Approach, 3rd edition, 2008, W. H. Freeman & Co.
7. Russell, P.J., iGenetics- A Molecular Approach, 3rd edition, 2010, Pearson Publishers.
8. Snustad& Simmons, Principals of Genetics, 6th edition, 2012, John Wiley & Sons Inc.
9. Read A.P. and Strachnan T.,Human Molecular Genetics, 2010, 4th Edition, Garland Science.
10. Voet D. and Voet J.G., Biochemistry, 2010, 4th edition, Wiley & SonsPublishers, New York.

ASSESSMENT DETAILS:

I. Internal Assessment (IA): 50 marks

- IA is a separate head of passing.
- A learner should get a minimum of 20 marks out of 50 to be declared PASS in the course.
- 2 activities of 25 marks each.
- If the learner does not get 20 marks out of 40, the learner will have to appear for the IA ATKT.

II. Semester End Examination (SEE): 50 marks

- SEE is a separate head of passing.
- A learner should get a minimum of 20 marks in SEE to be declared PASS in the course.

SOPHIA COLLEGE (AUTONOMOUS)

- All units of the syllabus will be covered in SEE and will be given equal weightage.
- An additional SEE will be held for those who are absent, due to valid reasons, for the main/regular SEE.
- If the learner does not get 20 marks out of 50, the learner will have to appear for the SEE ATKT.

Programme: Science **Life Science Major II**	**Semester – 2**
Course Title: Cell and Systems Biology II	**Course Code: SLSC524MJ**

COURSE OBJECTIVES:

1. To enable understanding of the basics of cell division and cell cycle and molecules in cell cycle regulation.
2. To understand cell signaling with examples and cell death processes and pathways involved.
3. Understand in detail about the Endocrine, Reproductive and Nervous systems and study the associated developmental aspects.
4. Outline the fundamentals of different tools used in cell and systems biology.

COURSE OUTCOMES:

1. Students will be able to differentiate between different cell cycle stages and gain knowledge about cyclins and cyclin dependent kinases.
2. Inculcate and apply the knowledge of the model system while proposing objectives for their project work.

3. Compare, contrast and apply the knowledge of different tools for their project work.			
Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

UNIT 1		**Cell Biology**	15 hours
	1.1	1. Cell division: a. An overview of prokaryotic and eukaryotic cell division b. Events in M-phase 2. Cell cycle: a. Stages of the cell cycle – Interphase (G0, G1, S G2), Mitosis b. Major cell cycle checkpoints c. Role of proteins controlling spindle assembly 3. Embryonic cell cycle- Comparison of embryonic and somatic cell cycle 4. Cyclins & CDK's: a. Types and role of Cyclins, CDKs and Cdk inhibitor proteins in regulation b. Importance of Rb/E2F; Role of p53	4
	1.2	Loss of cell cycle control in relation to cancer. a. Overview of cancer and genes involved along with their functions b. Mutations causing loss of cell cycle control	3 4

	1.3	Cell death and cell survival: 1. Necrosis: Morphological and cellular changes due to necrosis 2. Apoptosis: a. Apoptosis: morphological changes b. Genes involved in apoptosis: bcl2 family, Caspases, adaptor proteins c. Molecular mechanisms: i. Extrinsic pathway ii. Intrinsic pathway iii. Caspase independent (CICD) pathway 3. Autophagy a. Process of Autophagy b. Autophagy and diseases (any one example)	4
UNIT 2		**Cell signalling**	15 hours
	2.1	1. Overview of types of signalling- endocrine, autocrine, paracrine & nervous system signalling. 2. Modes of Cell Signalling- Direct & indirect. 3. Types of messengers – hydrophobic and hydrophilic. 4. Types of receptors – a) Extracellular receptors (ligand-gated receptor, Enzyme coupled receptors, G-protein coupled receptors with examples). b) Intracellular receptors with example. c) Regulation of receptors. d) Agonist & antagonist of receptors. 5. Signal Transduction of the above receptors. 6. Regulation of cell signalling and feedback mechanism.	3 3 3 2 4
UNIT 3		**System Biology**	15 hours

	3.1	Physiology: 1. Endocrine system: Functions of Endocrine glands (an overview) Biological roles of hormones (protein, glycoprotein and steroid hormones any one example with their mechanism of action 2. Nervous system General organisation of nervous system, basic functional unit of nervous system Impulse generation and conduction of nerve impulse Synaptic transmission: Electrical and Chemical with examples of two neurotransmitters and their receptors 3. Reproductive system: Gametogenesis and fertilization, Zygote formation, implantation, placentation, sex determination Major events in the trimesters of pregnancy, parturition and lactation	3 4 4
	3.2	Developmental biology: 1. Concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation 2. Early development: cleavage, blastula formation, embryonic fields, gastrulation neurulation 3. Introduction to Model system-Dictyostelium (cell aggregation and differentiation), Drosophila (maternal genes and zygotic genes), C.elegans (cell lineage and cell fate), zebrafish/ hydra (embryogenesis, regeneration) 4.Fate maps, chimeras, embryo lethal mutants, transient transgenesis	4
UNIT 4		**Techniques in Cell biology & Systems biology**	15 hours
	4.1	1. Cell cycle analyses - Detection of specific cyclins, flow cytometry, MTT cell proliferation assay 2. Apoptosis - Detection of pro- and anti- apoptosis proteins, Detection of DNA fragmentation - TUNEL, COMET assay, Membrane permeability assay/ Phospholipid symmetry (Annexin V staining), Autophagy – markers of autophagy (LC3, Atg8) assays	3 4 2
	4.2	1. ART – IVF and ICSI 2. Sonography	

		3. Karyotyping, amniocentesis/ chorionic villi sampling 4. Genetic counselling (eg. thalassemia)	6

Practicals for Major Paper (SLSC524MJP) (02 credits)

1. Neutral red staining for apoptosis in developing chick embryo.
2. MTT cell proliferation assay (Demonstration).
3. Assessment of signaling pathways (PKC, IP3 and Calcium) in the regulation of nitrate assimilation in plants/ bacteria.
4. Principle and working of Pregnancy test kit.
5. Effect of temperature on *C elegans* development.
6. Development of cartilage & bone of Zebrafish: Visualization Techniques (Alizarin, Alcian blue).
7. Density valuation of Daphnia from a given culture.
8. Literature Review, Research proposal and preliminary data submission (MANDATORY)

(Note: The practicals are based on the development and physiological processes.)

REFERENCES

1. Alberts B., Johnson A., Lewis L., Morgan D., Raff M., Roberts K., Walter P., Molecular Biology of the Cell, 2007 or 2014, 5th Edition or 6th Edition, *Garland Science Publication.*
2. Delves P., Mastin S. et al, Roitt's Essential Immunology, 2006, 11th Edition, *Blackwell Publishing.*
3. Guyton A.C. and Hall J.E., Text Book of Medical, 2006, 11th Edition, *Elsevier Saunders*
4. Kuby Immunology by Punt, Stranford, Jones, Owen, 2018, 8th ed, *W. H. Freeman.* Mukherjee, Kanai L., Medical Laboratory Technology, 1988, Reprint Edition, *Tata MacGraw Hill Publishing Co. Ltd., New Delhi.*
5. Seeley R, Stephens T and Tate P, Anatomy and Physiology, 2004, 6th Edition, *The McGraw−Hill Companies.*
6. Spector, David L. & Goldman, R.D., Basic Methods in Microscopy: Protocols and Concepts From Cells: A Laboratory Manual, 2006, *Cold Spring Harbor Laboratory Press.*
7. Taiz, Zeiger, Moller and Murphy, Plant Physiology, 2014 6th edition, *Sinauer Publications.*
8. Taylor D.J., Green N.P.O., Stout G.W., Ed. Soper R., Biological Science, 2005, 3rd Edition, *Cambridge University Press.*
9. Tortora G. and Grabowski S., Principles of Anatomy and Physiology, 2010, 10th Edition, *John Wiley & Sons, Inc.*

ASSESSMENT DETAILS:

SOPHIA COLLEGE (AUTONOMOUS)

I. Internal Assessment (IA): 50 marks

- IA is a separate head of passing.
- A learner should get a minimum of 20 marks out of 50 to be declared PASS in the course.
- 2 activities of 25 marks each.
- If the learner does not get 20 marks out of 40, the learner will have to appear for the IA ATKT.

II. Semester End Examination (SEE): 50 marks

- SEE is a separate head of passing.
- A learner should get a minimum of 20 marks in SEE to be declared PASS in the course.
- All units of the syllabus will be covered in SEE and will be given equal weightage.
- An additional SEE will be held for those who are absent, due to valid reasons, for the main/regular SEE.
- If the learner does not get 20 marks out of 50, the learner will have to appear for the SEE ATKT.

Programme: Science	**Semester – 2**

SOPHIA COLLEGE (AUTONOMOUS)

Life Science Elective			
Course Title: Evolution & Population Biology		**Course Code: SLSC522E**	
COURSE OBJECTIVES: 1. To infer evolutionary concepts and theories. 2. To understand the evolutionary time scale and relate to origin of life. 3. To interpret various concepts of population biology. 4. To gain knowledge of various ecological interactions.			
COURSE OUTCOMES: 1. Students will be able to comprehend the process of evolution. 2. Students will be able to solve problems based on population biology. 3. Students will be able to identify various ecological interactions.			
Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Continuous Assessment**	**Theory**	**50 marks**
		Practical	**50 marks**

UNIT 1		**Evolution**	15 hours
	1.1	1. Evidences of evolution- homologous, anatomical, geographical, biochemical, fossil-formation, types of fossils	2
		2. Origin of cells and unicellular evolution: Concept of Oparin and Haldane; Miller's experiment, evolution of prokaryotes and unicellular eukaryotes.	3
		3. Palaeontology and evolutionary history: The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale, Trends in human evolution, Social evolution, Molecular palaeontology techniques (protein, DNA, RNA based)	4
		4. Theories of Evolution- Lamarckism, Darwinism- concepts of variation, adaptation, struggle, fitness and natural	2

		selection, Mendelism, spontaneity of mutations, the evolutionary synthesis. 5. Species & speciation: concept of species, speciation, isolating mechanisms 6. Molecular Evolution: molecular divergence and molecular clocks, molecular tools in phylogeny. 7. Human genetic disease evolution: BRCAI (Breast cancer), G6PD Deficiency	 3 2 1
UNIT 2		**Population Biology**	15 hours
	2.1	Population Biology: 1. Dynamics, Density, age structure of a population, 2. Population growth, Exponential and Logistic growth, carrying capacity 3. Population Genetics: gene pool, gene frequency, Hardy Weinberg Law and its role in evolution and speciation 4. Ecological interactions: Intra and Interspecific competition, predation, Mutualism, Parasitism, communalism, symbiosis 5. Adaptive dynamics theory, Eco-evolutionary feedback	 2 4 3 3 3

Practical : Elective Paper 2 credits (SLSC511EP) (02 credits)

1. Study life cycle of Dictyostelium (Demonstration)
2. Calculation of gene frequency of ABO blood group in human population
3. Calculation of gene frequency due to selection and genetic drift
4. Problems in Genetics a. Problem solving: Multiple alleles, Lethal genes
5. Problem solving: Hardy Weinberg equation, Pedigree analysis.
6. Study of evolution of dental anatomy.

Reference Books:

1. Arora P.N. & Malhan P.K. Biostatistics, 2002, First Reprint Edition, Himalaya Publishing House.
2. Strickberger's Evolution, B. Hall and B. Hallgrimsson. 4th Edition (2008). Jones andBartlett.
3. Remarkable Creatures: Epic Adventures in Search of the Origin of Species, Sean B. Carrol,(2009), MarinerBooks.
4. Population Genetics, M.B.Hamilton,(2009),Wily-Blackwell.
5. Population Genetics: A Concise Guide J.H.Gillespie,(2004),Johns Hopkins UniversityPress.
6. Lamarck's revenge: How epigenetics is revolutionizing our understanding of evolution's past and present, Peter Ward, 1st edition (2018), BloomsburyPublishers.

ASSESSMENT DETAILS:

Only Continuous Assessment (CA) will be conducted

- Only CA is to be conducted of 50 marks.

1. CA 1: Test - 25 marks (Duration for answering the Test: Max. 60 Minutes)
   Format: Questions testing the following skills of students.
   Remembering, Understanding & Applying
2. CA 2: Any Activity - 25 marks
   Format: Aims at testing the following skills of students.
   Analyzing, Evaluating & Creating (weightage of each aspect may be determined by the concerned teacher depending on the requirements of the course)

- If a student fails to pass (scores less than 20) then students will have to appear for 50 marks ATKT – one IA Test of 25 marks covering questions based on 3 aspects of Bloom's Taxonomy (duration of test will be 60 minutes) and one assignment of 25 Marks.
- The minimum score to pass the Course will be 20 marks out of 50 marks.
- Students' CA activity-related scores with assessed papers and feedback (tests, other activities, assignments etc.) will be shared individually with students.
- Rubrics for all CAs with question papers must be shared with the Exam Committee.
- Grievance Redressal Mechanism for addressing grievances related to CAs.
- Students will apply in a prescribed format to the respective Vice Principals. The grievance will be addressed by involving the concerned faculty and the other Exam Committee member/s deputed by the Principal.

SOPHIA COLLEGE (AUTONOMOUS)