CENTRAL UNIVERSITY OF KARNATAKA
(Established by an Act of the Parliament in 2009)

Dept. of Life Science
School of Life Sciences
Kadganchi, Aland Road
Kalaburagi-585367

M.Sc. Life Science Program
Based on UGC-CBCS, Learning Outcome Based Curriculum Framework

Vision

To emerge as a globally recognized centre of academic excellence imparting high quality education and pursuing innovative research in basic and applied areas of biological sciences with focus on plant and animal biological systems.

Mission

MS-1: To foster an exciting environment where teaching and research stimulate students at postgraduate and doctoral levels in learning and contribute to new knowledge in the frontier areas of life sciences.
MS-2: To advance research in emerging areas of life sciences and train the next generation of researchers using modern protocols, state of the art techniques, instruments, simulation models and appropriate software.
MS-3: To collaborate with premier research institutions at national and international levels as well as industries for experiential learning and to have access to advanced research facilities.
MS-4: To produce independent, reflective, ethical and critically thinking graduates who will be able to actively engage and contribute to the human development and welfare.

Qualification Descriptors

After the completion of M.Sc. in Life Sciences, students will be able to:
QD-1: Demonstrate comprehensive knowledge and technical skills in the fields of Animal and Plant Biology.
QD-2: Implement the acquired knowledge and skills in identifying appropriate research questions pertaining to animal welfare and plant development and undertaking research studies using appropriate methodology.
QD-3: Apply disciplinary knowledge and skills gained in graduate - training partnership with industry in the fields of life sciences to become professionals in academia, health-sector, agricultural sector, research institutions and related industries at both national and international levels.
QD-4: Communicate the findings of studies undertaken in the fields of animal and plant biology for publication in nationally and internationally recognized and peer reviewed scientific journals.
QD-5: Demonstrate the self-learning skills in diverse learning environments that encourage self-reliance, intellectual growth and professional development.

Mapping of Qualification Descriptors (QD) with Mission Statement (MS)

	MS-1	MS-2	MS-3	MS-4
QD-1	**3**	**3**	**2**	**3**
QD-2	**3**	**3**	**3**	**3**
QD-3	**3**	**3**	**3**	**3**
QD-4	**2**	**3**	**3**	**2**
QD-5	**3**	**3**	**2**	**3**

3- High-level mapping, 2- Medium level mapping, 1- low level mapping

Program Learning Outcome (PLOs)

After the completion of Master's program in Life Sciences, students will be able to:

1. Disciplinary Knowledge- Demonstrate comprehensive knowledge and skills in the areas of biochemistry, molecular biology, genetics, immunology, physiology, developmental biology, tissue culture involving animal/ plant living systems.
2. Communication skills: Demonstrate communication skills for writing research papers, technical reports, project reports and for presentation of their research findings at national/international conferences and seminars.
3. Critical thinking and problem solving: Critically think about and analyse any problem in interdisciplinary and multidisciplinary fields of Life Sciences and apply advanced knowledge to find sustainable solutions.
4. Analytical Skills: Demonstrate the skills to generate data, perform qualitative and quantitative assessment and data interpretation using appropriate software/ tools and draw valid conclusions from the data.
5. Research related skills: Demonstrate the capability to ask appropriate questions, formulate and test hypothesis, design experiments, analyse and interpret the findings indifferent fields of Animal/ Plant Biology.
6. Collaboration/Team work: Demonstrate the ability to work effectively as a member or a leader in a team in Group assignments and Group projects in order to achieve the objective of the group task.

7. Digital Literacy: Demonstrate the competency to use the digital platform, relevant software, simulations and other tools for data analysis and interpretation in the fields ofComputational Biology, Bioinformatics, molecular modelling and allied fields.
8. Moral and Ethical Awareness: Demonstrate the awareness of ethical issues concerning any project prior to planning and execution of work and consequences of unethical behaviour such as falsification, misinterpretation and plagiarism and not adhering to intellectual property rights.
9. Leadership qualities: Demonstrate the ability to initiate new projects, design strategy, identify the resources needed for the project, lead the team members till the completion of the project successfully.
10. Self-learning and life-long learning: Demonstrate learning skills through self-paced and self-directed learning using ICT tools available, primarily aimed at personal development and meeting the demands of work place.

Mapping of Qualification Descriptor (QD) with Program Learning Outcome (PLO)

	QD-1	QD-2	QD-3	QD-4	QD-5
PLO-1	**3**	**2**	**2**	**2**	**2**
PLO-2	**2**	**3**	**2**	**2**	**3**
PLO-3	**2**	**3**	**3**	**3**	**3**
PLO-4	**1**	**3**	**3**	**3**	**3**
PLO-5	**2**	**3**	**3**	**2**	**3**
PLO-6	**1**	**2**	**3**	**3**	**3**
PLO-7	**2**	**2**	**3**	**2**	**3**
PLO-8	**2**	**3**	**3**	**2**	**3**
PLO-9	**1**	**2**	**3**	**2**	**3**
PLO-10	**2**	**2**	**3**	**3**	**3**

3- High-level mapping, 2- Medium level mapping, 1- low level mapping

M. Sc. Life Sciences Course Structure

Semester I			**No. of Credits = 18**				
Code	**Type**	**Title**	**Credits**	**Hours**	**L**	**T**	**P**
PLSTC11001	Core	Biochemistry-I	3	3	3	0	0
PLSTC10009	Core	Ecology and Evolutionary Biology	3	2	2	0	0
PLSTC10003	Core	Genetics	3	3	3	0	0
PLSTC11004	Core	Cell Biology	3	3	3	0	0
PLSTG10003	GE	Cancer Biology (Open Elective)	2	3	3	0	0
PLSPA10109	AECC	Life Science Practical-1 (Based on theory)	4	8	0	2	6
II Semester			**No. of Credits = 18**				
Code	**Type**	**Title**	**Credits**	**Hours**	**L**	**T**	**P**
PLSTC20022	Core	Biochemistry-II	3	2	2	0	0
PLSTC20007	Core	Immunology	3	3	3	0	0
PLSTC20023	Core	Microbiology	3	2	2	0	0
PLSTC20014	Core	Plant Physiology	3	3	3	0	0
PLSTD20203	DSE	Biofuels/ Intellectual Property Rights (MOOCS)	2	2	2	0	0
PLSPA20110	AECC	Life Science Practical -2 (Based on theory)	4	8	0	2	6
III Semester			**No. of Credits = 21**				
Code	**Type**	**Title**	**Credits**	**Hours**	**L**	**T**	**P**
PLSTC30024	Core	Molecular Biology & Biotechnology	3	3	3	0	0
PLSTC31010	Core	Human Physiology	3	3	3	0	0
PLSTC30025	Core	Developmental Biology	3	3	3	0	0
PLSTC30026	Core	Cell & Tissue Culture Technology	3	2	2	0	0
PLSTC30020	Core	Molecular Plant Pathology	3	3	3	0	0
PLSTD30204	DSE	MOOCS: Nanobiotechnology/ Biostatistics & Bioinformatics / Research and Scientific Communications	2	2	2	0	0
PLSPA30111	AECC	Life Science Practical -3 (Based on theory)	4	8	0	2	6
IV Semester			**No. of Credits = 19**				
Code	**Type**	**Title**	**Credits**	**Hours**	**L**	**T**	**P**
PLSRA40111	AECC	Project work	19 (Lab work/internship + thesis writing + seminar = 12 + 5 + 2)		-		

L-Lecture, T-Tutorial, P-Practical

AECC- Ability Enhancement Compulsory Course, GE- Generic Elective, DSE- Discipline Specific Elective

Total Credits=76

Semester –I

Course Code : PLSTC11001	Type: Core
Title: **BIOCHEMISTRY-I**	Credits: 3
Prerequisite knowledge: B.Sc. Biology and Chemistry	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Explain the chemical composition of living matter, basic principles and laws governing biological reactions.

CLO2: Discuss the physical and chemical properties of amino acids, proteins, lipids and carbohydrates using specific examples in living system.

CLO3: Explain the structure and physiochemical properties of nucleic acids and discuss how the genetic information is transferred from DNA to RNA.

CLO4: Explain basic principles of protein folding and diseases related to abnormal folding with specific examples.

CLO5: Distinguish between the different enzyme classes including their structure and functions.

CLO6: Explain enzyme kinetics and the quantitative measurement of enzyme activity, regulation and inhibitory mechanisms.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	1	1	1	1	1	1	1	-	1
CLO2	2	2	-	2	2	-	2	1	-	-
CLO3	-	1	3	3	1	1	2	-	-	-
CLO4	3	2	3	-	3	1	-	1	-	1
CLO5	-	2	2	2	2	1	1	1	-	1
CLO6	3	2	2	3	3	-	2	-	-	1

Detailed Syllabus

Unit I

Chemical basis of life: Composition of living matter, properties of water, Ionization, Acids, Bases, pH, Buffers, Properties of Biomolecules, Covalent and Non-covalent interactions -Vander-Waals forces, Electrostatic interactions, Hydrogen bonding and Hydrophobic interactions.

Unit II

Macromolecules: Structure and classification of carbohydrates and lipids. Structure of amino acids and peptide bonds, Primary structure: Elucidation of primary structure of proteins – Determination of amino acid composition, end group analysis, cleavage by enzymes and chemicals, separation of fragments. Manual and modern methods of sequencing and reconstructing the protein sequence. Assignment of disulfide bonds. Secondary structure: Ramachandran plot. Regular secondary structure*:* α– helix and other types of helices, β – pleated sheet, irregular, turns, loops and triple helical structures. Helix stabilizing and destabilizing amino acids. Tertiary structure: Tertiary structure of myoglobin and chymotrypsin. Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation. Quaternary structure and symmetry: Structure and function of myoglobin and hemoglobin.

Unit III

Spectroscopy techniques: UV, Visible and Raman Spectroscopy, theory and application of circular dichroism, fluorescence, Mass spectrometry, MALDI- TOF, NMR, PMR, ESR and Plasma Emission spectroscopy. Chromatography and Electrophoresis: Partitioning and counter current distribution, Principle, instrumentation, and applications of paper chromatography, Thin layer chromatography (TLC), Gel permeation (size exclusion) chromatography, Ion exchange chromatography, Affinity chromatography, Immobilized metal ion affinity chromatography (IMAC), Hydrophobic interaction

chromatography, Gas chromatography, HPLC. Principle, instrumentation and applications of Native PAGE, SDS-PAGE, Agarose, Starch, and Cellulose acetate electrophoresis. Blotting techniques and Zymography. Centrifugation: Basic principles & types, applications, Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

References

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.
2. Mu, P., & Plummer, D. T. (2001). *Introduction to practical biochemistry*. Tata McGraw-Hill Education.
3. Price, N. C., & Frey, P. A. (2001). Fundamentals of enzymology. *Biochemistry and Molecular Biology Education*, 1(29), 34-35.
4. Tymoczko, J. L., Berg, J. M., & Stryer, L. (2019). *Biochemistry.* Macmillan.
5. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of biochemistry: life at the molecular level*. John Wiley & Sons.

Course Code : PLSTC10009	Type: Core 9
Title: **ECOLOGY AND EVOLUTIONARY BIOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Understand the component of ecosystem and function.

CLO2: Describe the various type of ecosystem and its necessity for sustainable world.

CLO3: Discuss about the availability of natural resources and biogeochemicals.

CLO4: Understand the modern theory of evolution and speciation.

CLO5: Discuss the population genetics and its applications

CLO6: Describe the role of geographical isolation on speciation and adaptive radiation.

CLO7: Understand how the phylogenetic trees are constructed along its various modes of interpretation

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	1	2	1	2	1	1	-	3
CLO2	3	3	3	1	-	3	-	2	2	-
CLO3	2	1	2	3	2	1	1	1	-	3
CLO4	3	2	-	3	3	-	-	3	2	2
CLO5	3	-	2	2	-	3	-	1	-	3
CLO6	3	2	1	3	3	2	2	-	-	1
CLO7	2	1	2	-	3	3	1	-	1	-

Unit- I

Definition, scope, importance & fundamental concepts of ecology; Ecosystems types (natural & artificial); Indian vegetation types, biogeographical zones of India & theory of island biogeography; Ecosystem structure (abiotic and biotic components); Ecosystem functions (Trophic levels, ecological pyramids, productivity and decomposition, & biogeochemical cycles); Ecological Succession; Laws of limiting factors; Cybernetcis; Population Ecology (characteristics of a population; growth curves; r & k selection, kin selection, altruism); Interactions (mutualism, symbiosis, commensalism, competition, parasitism, predation, etc); Biodiversity levels and Types; Species richness; Evenness; Diversity indices & Species-area relationships; Threats to biodiversity; Biodiversity endemism; Hot-spots & Conservation (In-situ & Ex-situ); IUCN Red List of threatened species; Global environmental current issues (pollution, global warming, acid rains, ozone hole); biodiversity conventions & legislations (legal aspects with special reference to India), Environment movement in India (Chipko, Appiko, Bishnoi & Silent valley movements, and Narmada & Jungle Bachao Andolans etc).

Unit- II

Origins of evolutionary thought (Lamarckism, Darwinism, Modern Synthesis); The history of earth (Origin of earth, geological time scale; five major extinctions); The history of life (Theory of special creation, abiogenisis, biogenesis Oparin and Haldane theory, formation of protobionts, first genetic material- RNA world, evolution of DNA molecule, origin of prokaryotes and eukaryotes); Direct and indirect evidences of Evolution; Hardy-Weinberg Law; Types of natural selection and natural selection in action (Industrial melanism, antibiotic and DDT resistance); Adaptive radiation (Galapagos finches); Co-evolution of competitors; Tempo of evolution; Concept of species & speciation modes; Origin and evolution of horse and man (Dryopithecus to *Homo sapiens*).

Unit- III

Neutral theory of molecular evolution; Molecular divergence & Molecular clocks; Evolution of gene families (exemplary of globin gene family, rRNA/cyt c); Phylogenetic trees construction methods (Principles of parsimony & Maximum Likelihood, Distance method; Interpretation of trees, etc.).

References

1. Futuyma, D. J. (2017). Evolutionary biology today and the call for an extended synthesis. *Interface focus*, *7*(5), 20160145.
2. Gadgil, M. (1993). Biodiversity and India's degraded lands. *Ambio*, 167-172.
3. Kimura, M. (1983). *The neutral theory of molecular evolution*. Cambridge University Press.
4. Loreau, M., Naeem, S., & Inchausti, P. (Eds.). (2002). *Biodiversity and ecosystem functioning: synthesis and perspectives*. Oxford University Press on Demand.
5. Magurran, A. E., & McGill, B. J. (Eds.). (2010). *Biological diversity: frontiers in measurement and assessment*. OUP Oxford.
6. Meatyard, B. (2001). Ecology: Principles and Applications-JL Chapman and MJ Reiss; Cambridge University Press, Cambridge, *Biological Conservation*, *3*(98), 381-385.
7. Odum, E. P., & Barrett, G. W. (1971). *Fundamentals of ecology*. Philadelphia: Saunders, Vol. 3, Pp 5.
8. Sharma, P. D., & Sharma, P. D. (2012). *Ecology and environment*. Rastogi Publications

Course Code : PLSTC10003	Type: Core
Title: **GENETICS**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:
CLO1: Understand the basic concepts of genetics.
CLO2: Understand the mendelian and non mendelian pattern of inheritance, concept of linkage and crossing over, sex determination and sex linkage, cytoplasmic and mitochondrial inheritance pattern.
CLO3: Understand the mechanism of mutagenesis, gene transfer in bacteria, concepts of gene mapping and genetic analysis, human genetics, plant genetics which can be utilized as a concept for research.
CLO4: Understand the various methods to evaluate genetic variations and understand the concepts of population genetics and evolution.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	2	1	1	1	-	1	-	-
CLO2	2	2	3	3	2	1	2	2	2	1
CLO3	3	3	3	2	2	1	1	2	2	1
CLO4	3	2	3	3	3	1	2	1	2	2

Detailed Syllabus

Unit I

History of genetics. Chromosome structure and function, special types of chromosomes. Changes in chromosome number and structure. Cell Division, cell cycle and regulation. Mendelian Genetics: Introduction to Mendelism, life history of Mendel, monohybrid cross, dihybrid cross and trihybrid cross, back cross, law of segregation and independent assortment, chromosome theory of inheritance. Allelic and non-allelic interactions: Gene symbols, Concept of alleles, types of dominance, lethal alleles, multiple alleles, test of allelism, Pleiotropy, complementation, gene interaction and epistasis.

Unit II

Linkage and crossing over: Linkage, detection of linkage, crossing over, factors affecting recombination frequency, cytological basis of crossing over, crossing over in four stranded stage, molecular mechanism of crossing over, linkage maps and linkage groups, gene mapping in drosophila, sex determination, sex-linked inheritance and extra-chromosomal inheritance. Cytoplasm inheritance and maternal effects. Genetic Material: Structure of DNA and RNA. Mutation: Classification, spontaneous and induced mutation, mutagens, detection of mutations, molecular basis of mutation, genetic polymorphism, uses of polymorphism, mechanism and role in creating genetic variation/evolution.

Unit III

Bacterial genetics: Transformation, conjugation, transduction. Transposable genetic elements. Human Genetics, blood groups and genetics disorders. Quantitative genetics: Genes and environment, heritability, penetrance and expressivity, probability and chi square test, environmental effects on the development of characters, inheritance of quantitative traits, introduction to population genetics and evolution, phenotype, genotype, gene frequency, hardy weinberg law, factors distinguishing hardy weinberg equilibrium,- mutation selection, migration, gene flow, genetic drift.

References

1. Gardner, E. J., Simmons, M. J. and Snustad, D. P. (1991). *Principles of genetics*. John Willey & Sons Inc.
2. Hartl, D. L. and Jones, E. W. (2009). *Genetics: analysis of genes and genomes*. Jones &

Bartlett Learning.
3. Pierce, B. A. (2012). *Genetics: a conceptual approach*. Macmillan.
4. Snustad, D. P. and Simmons, M. J. (2015). *Principles of genetics*. John Wiley & Sons.

Course Code : PLSTC11004	Type: Core
Title: **CELL BIOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:
CLO1: Understand the origin and evolution of prokaryotes and eukaryotes and explain modern concept of cell theory
CLO2: Discuss the structure and function of different cell organelles, understand the principles of research techniques employed in cell analysis
CLO3: Explain the composition of membrane and understand different ways of transport for the movement of macromolecules
CLO4: Describe various regulatory mechanisms employed to control cellular function and understand the concepts of regeneration, autophagy and cell death
CLO5: Explain the historical discoveries made during the evolution of cell biology
CLO6: Understand and discuss how the various proteins are sorting and sent to their target regions
CLO7: Discuss the how the cells are communicated with each other to perform various biological activities.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	2	1	2	1	-	1	-	-
CLO2	3	1	2	1	3	1	-	1	-	-
CLO3	3	2	2	2	1	1	-	1	-	-
CLO4	3	1	1	3	3	1	-	1	-	-
CLO5	3	2	2	1	1	1	-	1	-	-
CLO6	3	1	2	3	1	1	-	1	-	-
CLO7	3	1	2	3	3	1	-	1	-	-

Detailed Syllabus

Unit I

An overview of the cell and molecular functions of its organelles: Introduction to the Cell Biology (Discovery, cell theory, cellular totipotency, & diversity in size, shape and type, the evolution of the cell (from molecules to first cell), origin of eukaryotic cell (endosymbiont theory) and biochemistry of cell); Methods in cell study (light, phase contrast, fluorescence, confocal, electron microscopy, fractionation of cell contents, tracing cellular molecular with radioactive isotopes, flow cytometry); Molecular organization and function of intracellular organelles (Cell wall, nucleus (Nuclear pore complex & trafficking across nucleus), golgi bodies, endoplasmic reticulum, mitochondria, chloroplast, ribosome, peroxisomes, lysosomes, cytoskeleton (Intermediate filaments, microtubules, & action filaments), vacuoles, cilia and centrioles, and packaging of eukaryotic DNA etc).

Unit II

Membrane Biology (Structure and membrane models; Chemical composition of membrane, diffusion, osmosis, ion channels, passive and active transport, membrane pumps, and electrical properties of membranes (Patch clamp and voltage clamp techniques); Factors affecting the fluidity and permeability of membrane; Clathrin mediated endocytosis, phagocytosis); Protein Sorting (Secretion and transport of proteins to membranes (integral membrane proteins) and various organelles; Signal hypothesis; Protein targeting to mitochondria, chloroplast, and peroxisomes; Extracellular Matrix proteins.

Unit III

Cell Junction and Adhesion (Anchoring junctions, cell matrix junctions; cadherins, integrins, selectins, catenins, desmosomes, hemidesmosomes, occluding junctions, gap junctions); Cell

signaling (Cell signaling molecules, modes of cell signaling, surface receptors, signal transduction pathways (cAMP, Cyclic GMP secondary messenger pathway, phospholipids and calcium ions, P13 Kinasse, MAP kinase, etc.), significance of cell signaling; Cell cycle and regulation (Mitosis and meiosis, cell cycle regulation & check points, apoptosis mechanism and significance).

References

1. Cooper, G. M., Hausman, R. E., & Hausman, R. E. (2007). *The cell: a molecular approach* (Vol. 4, pp. 649-656). Washington, DC, USA: ASM press.
2. Karp, G. (2009). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.
3. Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P. & Matsudaira, P. (2008). *Molecular cell biology*. Macmillan.
4. Robertis, D. (1987). Cell and molecular biology.
5. Vesely, P. (2004). Molecular biology of the cell. By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. ISBN 0-8153-3218-1; hardback; 1,616 pages; Garland Science Inc., New York, 2002.

Course Code : PLSTG10003	Type: GE
Title: **CANCER BIOLOGY** (Open Elective)	Credits: 2
Prerequisite knowledge: None	L-T-P: 0-1-4

After the completion of this course, students will be able to:

CLO1: Understand the cancer types, causes, cell cycle and control.

CLO2: Understand the interaction of cancer cells with normal cells.

CLO3: Describe the process of tumorigenesis, signalling, role of growth factors and receptors in carcinogens.

CLO4: Understand the cancer stem cell, metabolism and emerging therapies.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	1	1	1	1	-	-	2	1	-
CLO2	3	1	2	1	2	-	-	2	1	-
CLO3	3	2	2	1	2	-	-	2	1	-
CLO4	3	2	2	1	2	-	-	2	1	-

Detailed syllabus

Unit I

History of cancer; Types of cancer (Carcinoma, Sarcoma & Melanoma); Types of Tumour (Benign & metastasis); Genetic rearrangements in progenitor cells; G-protein coupled receptors in development of cancer and metastasis. Causes of Cancer (Physical factors, chemical factors & biological factors); Cell cycle control and pRb tumor suppressor; Apoptosis and p53 tumor suppressor; Interaction of cancer cells with normal cells; Angiogenesis.

Unit II

Multi-step tumorigenesis; Aberrant signaling in cancer; Role of growth factors and receptors in carcinogenesis; Familial cancer syndromes; Molecular diagnostic tools for early diagnosis of cancer; Therapeutic interventions in cancer (Surgery, Radiation, and Chemotherapy & Immunotherapy) Preventing Cancer. Cancer stem cells; Tumor Immunology & Cancer Metabolism; Emerging therapies.

References

1. Kleinsmith, L. J. (2006). *Principles of cancer biology*. San Francisco: Pearson Benjamin Cummings, Pp. 225-230.
2. Parkin, D. M., Whelan, S. L., Ferlay, J., Teppo, L., & Thomas, D. B. E. (2002). Cancer incidence in five continents volume VIII. *IARC Sci. Publications*, *155*.
3. Pines, J. (1995, April). Cyclins, CDKs and cancer. In *Seminars in cancer biology*. Academic Press, 6(2): 63-72.
4. Rigby, M., & Taubert, M. (2016). Colouring books for adults on the cancer ward. *BMJ*, *352*.

Course Code : PLSPA10109	Type: AECC
Title: **LIFE SCIENCE PRACTICAL-1 (BASED ON THEORY)**	Credits: 2
Prerequisite knowledge: B.Sc. Biology	L-T-P: 0-0-4

After the completion of this course, students will be able to:

CLO1: Understand different stages of cell division, karyotyping and WBC/RBC count from blood samples

CLO2: Understand the numerical calculation on genetics based on monohybrid, dihybrid, probability and chi square test.

CLO3: Demonstrate the separation of macromolecules using various chromatographic techniques and separation of proteins using filtration techniques

CLO4: Extract enzymes by implementing different purification methodologies and assess the quality of the purified enzymes.

CLO5: Evaluate the concentrations of carbohydrates, proteins and lipids from biological samples using standard procedure.

CLO6: Understand the principle, methodology and applications of western blotting technique.

CLO7: Evaluate the concentrations of nucleic acid, both DNA and RNA.

CLO8: Understand the principle, methodology and applications of polymerase chain reaction (PCR) technique used for amplification of DNA samples.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	2	-	3	1	-	-	-	-
CLO2	3	-	2	-	3	1	1	-	-	-
CLO3	3	2	2	2	2	2	1	1	-	-
CLO4	3	2	3	3	2	1	1	-	-	-
CLO5	3	2	3	2	1	1	2	-	-	-
CLO6	3	2	3	3	2	1	2	-	-	-
CLO7	3	2	2	2	2	1	2	-	-	-
CLO8	3	2	2	2	2	1	2	-	-	-

List of practical's

1. Verification of Beer's Law.
2. Separation of amino acids by paper chromatography
3. To determine the concentration of glycine solution by formylation method
4. To determine the saponification and iodine value of an oil/fat
5. Differentiate between a reducing/ nonreducing sugar
6. Separation of amino acids by paper chromatography
7. Ultra violet absorption spectra of nucleic acids and proteins
8. Purification of enzyme extract by dialysis and ammonium sulphate precipitation
9. Estimation of glycine by formal titration
10. Estimation of reducing sugars by Benedict's titrimetric method and carbohydrates by anthrone method
11. Estimation of proteins by Lowry and Bradford methods
12. Determination of population density in a natural/hypothetical community by quadrate & transect method
13. Study of an aquatic ecosystem and determine diversity indices (richness, Simpson, Shannon-Wiener) in University premises
14. Study of homology and analogy from suitable specimens/ pictures

15. Identification of phytoplankton and zooplankton and differentiation between pond and terrestrial ecosystem
16. Demonstration of NCBI and blast portal
17. Sequence analysis and multiple alignment and phylogeny construction
18. Mitosis in onion root tip cells and meiosis in onion flower buds
19. Human Karyotyping
20. Determination of blood smear preparation (WBC count)
21. Numerical experiments on monohybrid, dihybrid, trihybrid, test cross, back cross, probability and Chi-square test
22. Determination of linkage and cross-over analysis (through two point test cross and three point test cross data)

References

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10. Robertis, D. (1987). Cell and molecular biology.
11. Sadasivam, S, and Manickam, A., (2001), Biochemical Methods, 3rd edition, New Age International Publishers, New Delhi.
12. Snustad, D. P. and Simmons, M. J. (2015). *Principles of genetics*. John Wiley & Sons.
13. Strategies for protein purification and characterization. *Trends in Cell Biology*, *6*(12), 489.
14. Molecular biology of the cell. By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter WalterGarland Science Inc., New York, ISBN 0-8153-3218-1, pp. 1,616.
15. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology*. Cambridge university press.

Semester II

Course Code : PLSTC20022	Type: Core
Title: **BIOCHEMISTRY-II**	Credits: 3
Prerequisite knowledge: B.Sc. Biology and Chemistry	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Distinguish between the different enzyme classes including their structure and functions.

CLO2: Explain enzyme kinetics and the quantitative measurement of enzyme activity.

CLO3: Discuss various types of inhibitory mechanisms involved in enzyme activity.

CLO4: Understand the basics of clinical biochemistry.

CLO5: Explain the basic concept of preparation, preservation, and handling of clinical samples.

CLO6: Explain the various requirements of setting up of clinical laboratory

CLO7: Explain the clinical importance of bimolecules in diagnosing the various diseases

CLO8: Understand and learn the safety measures in clinical laboratory.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	3	1	2	1	-	2	1	-
CLO2	3	1	2	1	2	1	-	2	1	-
CLO3	2	2	3	1	2	1	-	2	1	-
CLO4	3	1	2	1	2	1	-	1	1	-
CLO5	3	1	2	1	3	1	-	2	1	-
CLO6	3	1	3	1	2	1	-	2	1	-
CLO7	3	1	2	1	-	2	1	2	1	-
CLO8	3	1	3	1	-	2	1	2	1	-

Detailed Syllabus

Unit I

Introduction to enzymes: characteristics, nomenclature and classifications, enzyme units, thermodynamics of enzymatic reaction. Enzyme inhibition: reversible, irreversible and allosteric. Enzyme kinetics, and their catalytic mechanisms: catalysis, specificity and mechanism of enzyme action. Regulation of enzyme activity in the living system: Allosteric regulation and inhibition, activation of latent enzymes, compartmentation of metabolic pathways, control of enzyme synthesis, enzyme degradation and isoenzymes. Chemical kinetics and order of reactions, Michaelis and Menten equation, Vmax and Michaelis constant. Mechanisms of actions of serine proteases, lysozyme and glutathione reductases. Enzyme patterns in diseases. Applications of enzymes in food, pharmaceuticals, medicine and diagnostics. Synthesis of antibiotics, production of therapeutics and fine chemicals. Artificial enzymes / synenzymes.

Unit II

Metabolism: Introduction to metabolism, metabolism of carbohydrates, metabolism of lipids, metabolism of amino acids, integration of metabolism, metabolism of nucleotides, mineral metabolism.

Unit III

Introduction to Clinical Biochemistry Definition and scope of clinical biochemistry in diagnosis, collection and preservation of biological fluids (blood, urine & CSF); Requirements of setting up of clinical laboratory, collection preparation, preservation, and handling of clinical samples, quality control, Safety measures in clinical laboratory; Clinical Importance of Biomolecules: Carbohydrates (Estimation of glucose, glycosurias, GTT's, hyper & hypoglycemia, blood glucose regulation); Lipids (lipid profile estimation, hypercholesterolemia, hyperlipoproteinemia, atherosclerosis and it risk

factors). Proteins (albumin, hypoalbuminemia, hypoproteinemia, Bence Jones proteins, proteins in CSF and their estimation).

References

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.
2. Mu, P., & Plummer, D. T. (2001). *Introduction to practical biochemistry*. Tata McGraw-Hill Education.
3. Price, N. C., & Frey, P. A. (2001). Fundamentals of enzymology. *Biochemistry and Molecular Biology Education*, 1(29), 34-35.
4. Tymoczko, J. L., Berg, J. M., & Stryer, L. (2019). *Biochemistry*. Macmillan.
5. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of biochemistry: life at the molecular level*. John Wiley & Sons.

Course Code : PLSTC20007	Type: Core
Title: **IMMUNOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Understand the anatomy of major components of immune system and explain their functional role.

CLO2: Comprehend the mechanisms of primary and secondary immune responses against pathogens.

CLO3: Describe the types of pathogens and various barriers of infection involved in defense.

CLO4: Understand the role of immune system in various diseases and its affect in immunodeficiency.

CLO5: Discuss the mechanisms of Transplantation and its application in therapy.

CLO6: Distinguish between the various types of antigen-antibody interaction and understand the techniques used in clinical diagnostics.

CLO7: Gain knowledge on the implications of vaccine technology in therapeutic development.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	1	2	2	3	-	1	-	2	3
CLO2	2	3	-	1	3	1	1	2	1	2
CLO3	3	2	3	2	-	1	-	1	2	-
CLO4	3	3	-	2	2	-	1	-	-	-
CLO5	3	-	3	1	-	2	3	1	-	2
CLO6	3	3	1	3	2	1	2	-	-	3
CLO7	2	-	3	3	3	1	2	2	2	1

Detailed Syllabus

Unit I

Fundamental concepts and anatomy of the immune system: Components of innate and acquired immunity, Phagocytosis, Inflammatory responses. Hematopoiesis; organs and cells of the immune system, primary and secondary lymphoid organs, lymphatic system. Mucosal and cutaneous associated lymphoid tissue. Barriers to infection - skin, mucous membrane, inflammation, complement system. Recognition and response: Properties of Antigens and Antibodies, Haptens and determinants epitopes and paratopes. Antigenicity, carbohydrates, proteins, nucleic acids, and cells as antigens, Super antigens, Valency of antigen.

Unit II

Immunoglobulins and immune response: Structure, classes and subclasses. Hyper variable region, isotypic, allotypic and idiotypic variation. Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing. Primary and secondary immune response. Reticuloendothelial system T, B and accessory cells. Subsets of T and B cells. T-helper cells, T-killer cells, T-suppressor cells. Development of T and B cells. T and B cell receptors, antigen processing and presentation. T and B cell interaction. Cytokines and co-stimulatory molecules - Lymphokines, interleukens structure and function. Suppression of immune response α, IL-2, TNFβ of IL-1 immunoglobulin gene - generation of immunoglobulin diversity gene rearrangement and other mechanisms.

Unit III

Clinical Immunology: Autoimmunity, types of autoimmune disorders, and role of $CD4^+$ T-cells. Transplantation - Immunological basis of graft rejection, and immunosuppressive therapy. Cancer

immunotherapy. Immunodeficiency diseases, Hypersensitive reactions (Type I, II, III and IV). Antigen-antibody interactions: Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, Immunofluorescence, flow cytometry and immune-electron microscopy. Vaccines - Adjuvants, vaccines and their preparations. Polyclonal and monoclonal antibodies - Hybridoma technique.

References

1. Blume, S. (2017). *Immunization: how vaccines became controversial*. Reaktion Books.
2. Janeway, C. A., Travers, P., Walport, M., & Capra, D. J. (2001). *Immunobiology*. UK: Garland Science: Taylor & Francis Group, Pp. 600.
3. Mahy, B. W., & Compans, R. W. (Eds.). (1996). *Immunobiology and pathogenesis of persistent virus infections*. Harwood Academic.
4. Murphy, K., & Weaver, C. (2016). *Janeway's immunobiology*. Garland science.
5. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology*. New York, NY, USA: WH Freeman, Pp. 574.
6. Pichler, W. J. (Ed.). (2007). *Drug hypersensitivity*. Karger Medical and Scientific Publishers.

Course Code : PLSTC20023	Type: Core
Title: **MICROBIOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:
CLO1: Understand the origin and evolution of microbial world and explain different concept of involved in various specialisations of microbiology
CLO2: Discuss the principles of research techniques employed in Microbiology
CLO3: Explain the detailed classification of microbial taxonomy and diversity
CLO4: Understand and discuss molecular approaches to microbial taxonomy
CLO5: Explain the historical discoveries made during the evolution of microbiology
CLO6: Understand and discuss the application of various microorganisms in various fields like agriculture, medicine, industry etc.
CLO7: Understand and discuss the microbial interactions in various nutrients cycles

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	-	2	1	-	-	1	-	-	2
CLO2	-	2	-	3	3	1	1	-	-	-
CLO3	-	-	1	2	3	1	-	-	-	2
CLO4	3	3	-	1	-	1	1	-	-	2
CLO5	2	2	1	1	1	-	1	-	-	-
CLO6	-	2	3	-	3	1	2	-	-	2
CLO7	2	-	3	-	3	-	2	-	-	-

Detailed Syllabus

Unit I

Historical Perspective (Discovery of microbial world, landmark discoveries the field of microbiology, role of microorganisms (in human health & diseases)); Methods in Microbiology (Disinfection and sterilization techniques, methods and principles in culture techniques, bright field, dark field, phase contrast, DIC, fluorescence, confocal, electron microscopy and other major instruments in microbiology); Microbial Taxonomy and Nutrition (Bacteria, archea, and viruses classification; Biology of algae, fungi, and yeast; nutritional classification of bacteria).

Unit II

Prokaryotic cell Structure and Function (Cell walls, and solute transport across membranes, flagella, pili, slime, capsules, cell inclusions, mesosomes, endospores, gas vesicles, bacterial locomotion including positive and negative chemotaxis); Microbial Growth (Growth curve, mathematical expression of exponential growth phase, measurement of growth and growth yields, synchronous growth, effect of environmental factors on growth; bacterial biofilm and quorum signaling).

Unit III

Microbial Metabolism (An overview of metabolism, glycolysis, citric acid cycle, electron transport and oxidative phosphorylation, pentose-phosphate pathway, Entner-Doudoroff pathway, glyoxalate pathway, fermentation, aerobic and anaerobic respiration); Microbial Genetics (Transformation, conjugation, transduction, bacterial genome with special reference to E.coli & Phage λ, basic concept of microbial genomics); Microbial Diversity (Extremophiles classification & Mechanism of various extremophiles); Microbial Ecology (Microbial interactions in carbon, sulphur and nitrogen cycles, soil microorganisms associated with vascular plants, bioremediation, basic concept of metagenomics and metatranscriptomics); Microbial Diseases (Normal microbiota, diseases of viruses, bacteria, and pathogenic fungi, nosocomial, opportunistic, emerging infectious diseases, mechanism of microbial pathogenicity, antimicrobial, antifungal and antiviral drugs).

References

1. Cappuccino, J. G., & Sherman, N. (2011). Microbiology: A Laboratory Manual (9th edition).
2. Glazer, A. N., & Nikaido, H. (2007). *Microbial biotechnology: fundamentals of applied microbiology*. Cambridge University Press.
3. Mims, C., Dockrell, H., Goering, R., Roitt, I., Wakelin, D., & Zuckerman, M. (2004). Medical microbiology. *Structure*, *7*, 7.
4. Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology*. CRC Press.
5. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2006). Microbiology 5th edition.
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8. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1986). The methods of microbiology. In *General microbiology* (pp. 16-42). Macmillan Education UK.
9. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2009). *Industrial microbiology: an introduction*. John Wiley & Sons.
10. Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi (4th edition). Prentice Hall International, Inc, London.

Course Code : PLSTC20014	Type: Core
Title: **PLANT PHYSIOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Botany	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Describe the concepts of water use efficiency, water relation and role of aquaporin.

CLO2: Learn the process of solute transportation in plant.

CLO3: Describe the concept of transport protein involved in mineral up-taking.

CLO4: Learn the thermodynamic and chemistry principal involve in transportation.

CLO5: Learn molecular regulation of respiration and photo-respiration in plant

CLO6: Understand the stress physiology and molecular regulations, and its implication on agro-economy.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	3	3	3	2	1	1	2	1
CLO2	3	2	3	3	2	3	-	-	2	-
CLO3	3	1	2	2	-	2	1	1	1	2
CLO4	2	2	-	-	3	3	-	1	2	3
CLO5	3	-	3	3	1	1	1	-	2	1
CLO6	2	2	-	2	3	-	1	1	-	-

Detailed Syllabus

Unit I

Plant and water: Introduction to concepts of physiology, water relation of a plant cell- Laws of diffusion and permeability, concept of chemical potential, surface tension and capillary rise, water potential and its component, soil plant Atmosphere continuum- Water movement in soil and root, root pressure, cohesion theory of water uptake, hydraulic lift "Aquaporins". Solute Transport: Nernst potential and Goldman equation, membrane transport- active and passive transport, channels, carriers and pumps, potassium transport, calcium transport, phosphate transport, nitrogen transport, iron transport, zinc transport, aluminum transport, sulfate transport, micro- and macronutrients and key to mineral deficiency, phloem transport, long distance transport in phloem.

Unit II

Photosynthesis: Basic principles of light absorption, light harvesting complexes, excitation energy transfer, photo-oxidation of water, mechanism of electron and proton transport, carbon assimilation C3, C4 and CAM pathways of CO_2 fixation, photorespiration. Transpiration and stomatal movement. Phytochromes, photoreceptors and photo-morphogenesis. Mineral nutrition and assimilations of inorganic nutrients: nitrogen and sulfur metabolism, and assimilation of other anions and cations.

Unit III

Respiration: Glycolysis, TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, alternative oxidase system. Stress physiology: Water stress, heat stress, cold stress, flooding and ROS formation, oxidative stress.

References

1. Bhatla, S. C., & Lal, M. A. (2018). *Plant physiology, development and metabolism*. Springer.
2. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). (2015). *Biochemistry and molecular biology of plants*. John wiley & sons.
3. Hopkins, W. G., & Huner, N. P. (1995). Introduction to plant physiology.

4. Taiz, L., Zeiger, E., Moller, I. M., & Murphy, A. (2015). *Plant physiology and development* (No. Ed. 6). Sinauer Associates Incorporated.
5. Teaching Tools in Plant Biology (www.aspb.org).

Course Code : PLSTD20203	Type: DSE
Title: **BIOFUELS**	Credits: 2
Prerequisite knowledge: B.Sc. Biology and Chemistry	L-T-P: 2-0-0

After the completion of this course, students will be able to:

CLO1: Understand the type of biofuels and the future resources available

CLO2: Discuss the application biofuel in various energy sectors.

CLO3: Describes the methods which are being used for generating Biofuels

CLO4: Understand the usability about the various feedstocks's which can be a potential source of biofuel.

CLO5: Discuss about hydrogen fuel cell and their impact in future energy demand

CLO6: Discuss the mechanism of microbial fuel cell and its advantages

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	-	3	3	-	2	-	1	-	3
CLO2	3	2	-	2	1	3	1	1	-	2
CLO3	2	-	2	3	-	-	-	-	-	3
CLO4	3	2	3	1	3	3	1	1	1	-
CLO5	3	1	2	3	-	1	-	-	2	3
CLO6	1	2	3	-	3	3	1	1	-	1

Detailed syllabus

Unit I

Introduction and perspective of Biofuels: Fossil versus renewable energy resources, economic impact of biofuels, Comparison of Bio-energy Sources, Biorefinery, generation of biofuel, alternative energies, Bio-Diesel and other alternative liquid fuels, Policy of biofuels, Biofuels around the world. Biofuels scenario -in India and worldwide: History of Biofuel; Advantages and disadvantages of biofuels. Generation of biofuels: first, second, third and fourth generation of biofuels and present status.

Unit II

Biofuel Feed stocks: Various types of feedstocks, starch feedstocks, sugar feedstocks, lignocellulosic feedstcoks, plant oils and animal fats, miscellaneous feedstocks. Production of Biofuels: Chemistry of biodiesel production, methods of biodiesel production; Ethanol production from sugar, fermentation process and types of fermenters. Biological Production of Hydrogen by various microorganisms: Photobiological hydrogen production by using algae, Hydrogen Production by Fermentation various metabolic process for hydrogen production. Microbial Fuel Cells and its role in energy production: Microbiology of methane production, biomass sources for methane production, biogas composition and use, biochemical basis of fuel cell design.

References

1. Drapcho, C. M., Nghim, N. P., & Walker, T. (2008). *Biofuels engineering process technology*. McGraw-Hill Education.
2. Soetaert, W., & Vandamme, E. J. (Eds.). (2011). *Biofuels* (Vol. 15). John Wiley & Sons.

Course Code : PLSPA20110	Type: AECC
Title: **LIFE SCIENCE PRACTICAL-2 (BASED ON THEORY)**	Credits: 2
Prerequisite knowledge: B.Sc. Biology	L-T-P: 0-0-4

After the completion of this course, students will be able to:
CLO1: Distinguish various cell culture methodologies and evaluate the growth curve of microbes
CLO2: Examine the morphological properties of microbes using microscopy
CLO3: Evaluate the count of WBC/RBC in blood samples
CLO4: Demonstrate the formation of immune complex by antigen- antibody interactions
CLO5: Perform separation of antigens from complex mixtures under influence of electric field
CLO6: Evaluate the concentrations of Ab of interest using different ELISA techniques
CLO7: Isolate different cells from venous blood sample and examine their morphological characteristics

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	-	3	-	1	2	1	1	-	-
CLO2	2	1	2	-	3	2	-	1	-	-
CLO3	2	2	1	-	2	2	1	-	-	-
CLO4	2	1	2	-	3	2	-	1	-	-
CLO5	3	2	3	-	1	2	1	1	-	-
CLO6	2	1	2	-	3	2	1	1	-	-
CLO7	2	1	2	-	1	2	-	-	-	-

List of practical's

1. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
2. Isolation and purification of the microbial cultures using serial dilution, streak plate and spread plate method
3. Gram's staining
4. Preparation of nutrient agar and nutrient broth for the cultivation of bacterial species
5. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
6. Study of various stages of malaria parasite in RBCs using permanent mounts.
7. Ouchterlony's Double diffusion and single radial immune-diffusion (SRID)
8. Immunoelectrophoresis
9. ELISA
10. Isolation of IgG from human serum or IgY from chicken egg
11. Purification of IgG by affinity chromatography
12. Immuno-histochemistry and complement assay
13. Demonstration of bolting
14. Demonstration of the effect of auxins on rooting
15. To determine the stomatal index and stomatal frequency in a mesophyte and xerophytes
16. To determine the osmotic potential of plant cell sap by plasmolytic method
17. To demonstrate hill reaction
18. To demonstrate the process of osmosis with varying solution concentration
19. To demonstrate unequal transpiration from the two surfaces of a leaf.
20. Separation of plant pigments (chlorophyll) by chromatography
21. To study the effect of different concentration of CO2 on the rate of photosynthesis.

22. To study the effect of light intensity (by changing the distance) on the rate of photosynthesis using aquatic plant
23. Determination of effect of PH and temperature on the activity of human salivary alpha amylase

References

1. Seeley Jr, H. W., & VanDemark, P. J. (1962). Microbes in action. A laboratory manual of microbiology. Microbes in action. A laboratory manual of microbiology.
2. Lennette, E. H., Balows, A., Hausler Jr, W. J., & Truant, J. P. (1980). Manual of Clinical. Microbiology. Washington, DC: American Society for Microbiology, 195-219.
3. Sadasivam, S, and Manickam, A., (2001), Biochemical Methods, 3rd edition, New Age International Publishers, New Delhi.
4. Blume, S. (2017). *Immunization: how vaccines became controversial*. Reaktion Books.
5. Janeway, C. A., Travers, P., Walport, M., & Capra, D. J. (2001). *Immunobiology*. UK: Garland Science: Taylor & Francis Group, Pp. 600.
6. Mahy, B. W., & Compans, R. W. (Eds.). (1996). *Immunobiology and pathogenesis of persistent virus infections*. Harwood Academic.
7. Murphy, K., & Weaver, C. (2016). *Janeway's immunobiology*. Garland science.
8. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology*. New York, NY, USA: WH Freeman, Pp. 574.
9. Pichler, W. J. (Ed.). (2007). *Drug hypersensitivity*. Karger Medical and Scientific Publishers

Semester III

Course Code: PLSTC30024	Type: Core
Title: **MOLECULAR BIOLOGY & BIOTECHNOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Learn various experiments carried out by famous scientist and will understand the replication mechanism in prokaryotes and eukaryotes.

CLO2: Understand the transcription, translation and post modification mechanism in cells and will be able to learn gene concept and its role in regulating the cascade of genes.

CLO3: Develop innovative ideas to explore in laboratory conditions and will gain knowledge on gene manipulation and its importance in animal and plant biotechnology.

CLO4: Understand the principle behind different enzymes and vectors used in recombinant DNA technology and will be able explain gene cloning, cDNA library construction, transformation and transfection techniques.

CLO5: Explain the scopes and applications of genetic engineering, PCR and sequencing technology.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	2	1	-	1	1	-	-	-
CLO2	3	2	2	1	1	2	1	-	-	-
CLO3	3	2	3	1	2	2	2	-	-	-
CLO4	3	2	3	1	2	2	2	1	-	-
CLO5	3	2	3	1	1	1	1	1	-	-

Detailed Syllabus

Unit I

Historical perspective. Different experiments on DNA (semi-conservative, Messelson and Stahl). DNA replication: prokaryotic and eukaryotic. The major enzymes involved in DNA replication. Replication in viruses - rolling circle model. Application of mitochondrial DNA. Nucleases: Diversity of Structure, Function and Mechanism. Mechanisms of DNA damage, repair and mutagenesis. Structure, function and types of RNA. Transcription: steps of genetic transcription, mRNA processing, overview, prokaryotic and eukaryotic transcription, specific features of RNA Polymerases I, II and III their structure and assembly, RNA biosynthesis in prokaryotes and eukaryotes initiation, elongation and termination. RNA dependent RNA synthesis. Post Transcriptional Modifications: Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA. Translation: Overview of translation, genetic code and its features and triplet codon, studies of Khorana, Nirenberg, triplet binding techniques, degeneracy, wobble hypothesis. Ribosomes, protein synthesis - initiation elongation and termination, differences in translation between prokaryotes and eukaryotes. Post translation modification of proteins - signal cleavage, disulphide bond formation, O and N-glycosylation, folding of nascent protein, role of chaperons, attachment of glycosyl anchor, and other modifications.

Unit II

Structure of gene - promoters, introns, exons, other regulatory sequences, enhancers, silencers, function of introns. Regulation of Gene Expression in Prokaryotic - Operon concept - Lac operon, structure and regulation. Galactose Operon - Role of two promoters, Arabinose operon - Positive control, tryptophan operon - attenuation control. DNA Binding Protein Motifs - Zinc finger, Leucine Zipper,

Helix-Turn - Helix and other motifs. Regulation at the level of post translational modification proteins stability, N-end rule, PEST and othersequences, ubiquitin mediated degradation. Gene manipulation in the post-genomics era. Recombinant DNA technology and its applications: DNA modifying enzymes, DNA cloning and manipulating cloned DNA. Labeling of DNA. Cloning vectors: structure, biology, types, and uses.

Unit III

Transformation, RNA isolation, cDNA Synthesis, cDNA library construction and its applications. Genomic DNA library construction and its applications. Identification and analysis of recombinant DNA Clones. Methods to study gene expression and its applications, protein-protein interactions and its applications. Different hybridization techniques. Site-directed mutagenesis. Introduction of DNA into mammalian cells; Transfection techniques; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array. Genome editing (Crispr-cas, Zfn, Talen etc.) and their applications. Antisense RNA technology. Gene silencing methods and their applications. Transgenic systems and their applications.

References

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., & Watson, J. D. (1994). Molecular biology of the cell, 3rd addition. *New York: Garland Science*.
2. Brown, T. A. (2020). *Gene cloning and DNA analysis: an introduction*. John Wiley & Sons.
3. Lewin, B., & Genes, I. X. (2008). Jones and Bartlett Publishers. *Inc.*, *Sudbury*.
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5. Primrose, S. B., Twyman, R. M., & Old, R. W. (2001). *Principles of gene manipulation*, Oxford: Blackwell Science. Vol. 6.
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Course Code: PLSTC31010	Type: Core
Title: **HUMAN PHYSIOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Understand the mechanism of function of human system

CLO2: Specify and characterize the various systems present in human body

CLO3: Understand the interlink mechanisms of different organs

CLO4: Learn the entire process of various important systems at molecular level

CLO5: Learn the various mechanism involved in normal functioning of organs

CLO6: Understand the connection between brain and various organs

CLO7: Gain in-depth knowledge about the biochemical concepts of organs and their functions

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	-	-	2	-	1	2	1	2
CLO2	3	-	-	-	3	2	-	-	1	2
CLO3	3	2	3	2	3	2	2	-	2	3
CLO4	3	2	2	2	3	3	1	2	2	3
CLO5	2	2	2	2	3	2	-	-	3	3
CLO6	2	-	2	-	2	-	-	-	1	2
CLO7	3	-	2	-	2	-	1	-	3	2

Detailed Syllabus

Unit I

Circulation and Nervous System: Blood - Composition, cells. Erythrocytes: structure and function. WBC: types and functions. Buffer systems, homeostasis, blood volume, blood pressure and its regulation. Platelets and their function. Mechanism of blood clot, digestion of clot, anticoagulants. CSF: composition and function. Nervous system: Structure of a neuron, nerve transmission. Respiratory System: Respiratory System; Mechanism of gas exchange, oxygen binding by haemoglobin and factors affecting oxygenation and acid-base balance.

Unit II

Hepatobiliary, Digestive and Excretory System: Hepatobiliary system: Anatomy of the liver, secretory and excretory function; detoxification and formation of bile. Digestive system: GI tract, digestion and absorption of carbohydrates, proteins and lipids. Mechanism of HCl production in the stomach. Role of pancreas in digestion and other gastrointestinal hormones. Excretory System: Ultra structure of the nephron, glomerular filtration, acid-base balance, formation of urine.

Unit III

Muscle physiology: Skeletal muscle and smooth muscle, muscle proteins; actin, myosin, tropomyosin, troponin, Mechanism of muscle contraction. Endocrine system: Endocrine organs in man. Pancreas: structure and hormones of endocrine, Menstrual cycle. Classification of hormones based on solubility and structure.

References

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2. Guyton, A. C., & Hall, J. E. (2015). Blood Cells, Immunity, and Blood Coagulation. *Guyton and Hall Textbook of Medical Physiology, 13th edition/JE Hall.–Elsevier Health Sciences*, 443-494.

3. Jayaraman, J., & Jayaraman, J. (1981). *Laboratory manual in biochemistry* (pp. 75-76). Delhi, India: Wiley Eastern.
4. Khurana, I. (2018). *Medical physiology for undergraduate students-E-book*. Elsevier Health Sciences.
5. Randell, D., Burrgren, W., Eckert, R., & French, K. (2002). *Eckert Animal Physiology: Mechanisms and Adaptations*. WH Freeman.
6. Schmidt-Nielsen, K. (1997). *Animal physiology: adaptation and environment*. Cambridge university press.

Course Code : PLSTC30025	Type: Core
Title: **DEVELOPMENTAL BIOLOGY**	Credits: 2
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Understand the basic concepts of development in animals and plants and its complexity.

CLO2: Understand the mechanism of gamete formation and the process of their fertilization, developmental stage of an embryo & specific organs such as vulva, eye lens and limbs.

CLO3: Explain the post embryonic development of organisms focusing on the mechanism of regeneration in mammals.

CLO4: Learn molecular regulation involved during cell division, importance of endo-reduplication in plant development, the genetic control, key genes function in leaf development and phyllotaxy.

CLO5: Understand plant hormones biosynthesis, signalling pathway and their role in flowering.

CLO6: Learn circadian, photoperiodism, molecular regulation of seed development and germination in plant system.

CLO7: Gain knowledge about molecular switching of vegetative SAM into Inflorescence meristem.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	2	1	2	1	-	1	-	-
CLO2	3	2	2	1	1	2	1	1	-	-
CLO3	3	2	3	1	2	1	-	1	-	-
CLO4	2	2	1	-	1	1	-	-	-	-
CLO5	2	1	3	-	1	1	-	1	-	-
CLO6	3	2	1	-	1	1	-	1	-	-
CLO7	3	-	3	-	1	-	-	1	-	-

Detailed syllabus

Unit I

Basic concepts of development biology: Potency, commitment, specification, induction, competency, determination and differentiation, morphogenetic gradients, cell fate and cell lineages, Stem Cells, genomic equivalence and the cytoplasmic determinants, imprinting; mutants and transgenics in analysis of development.

Unit II

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals (C. elegans, Drosophila, zebrafish, birds and mammals); embryogenesis. Morphogenesis and organogenesis in animals: Animal models of Cell aggregation and differentiation, axes and pattern formation, organogenesis, eye lens induction, limb development and regeneration, differentiation of neurons, post embryonic development- larval formation, metamorphosis, environmental regulation of normal development.

Unit III

Introduction to plant development: comparison of plant and animal development, evolution of developmental complexity from algae to angiosperm. Role of plant cell division and expansion in development. Plant cell cycle- endoreduplication and control of plant cell size. Regulation of plant architecture, shoot apical meristem, root apical meristem and positional control of root development, phyllotaxy, lateral organ development- leaf primordia imitation, leaf development, generation of patterns-regulation of stomatal patterning in plants. Plant growth regulators, types, mode of action and their biosynthesis. Environmental regulation of plant development: photoperiodism and circadian

rhythms and biological clock, phytochrome, cryptochrome, uvr8 and phototropins, vernalization of plants. Seed germination and dormancy and leaf or plant Senescence. Reproductive development of Plants, Inflorescence initiation, Flower development in plants, Embryogenesis in higher plants.

References

1. Bhatla, S. C., & Lal, M. A. (2018). *Plant physiology, development and metabolism*. Springer.
2. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). (2015). *Biochemistry and molecular biology of plants*. John wiley & sons.
3. Gilbert, L. (Ed.). (2013). *Metamorphosis: a problem in developmental biology*. Springer Science & Business Media.
4. Gilbert, S. F. (2017). Developmental biology, the stem cell of biological disciplines. *PLoS biology*, *15*(12), e2003691.
5. Grubb, B. J. (2006). Developmental Biology, Scott F. Gilbert, editor. *Integrative and Comparative Biology*, *46*(5), 652-653.
6. Hall, B. K. (2012). *Evolutionary developmental biology*. Springer Science & Business Media.
7. Hopkins, W. G., & Hüner, N. P. (1995). Introduction to plant physiology.
8. Jones, R., Ougham, H., Thomas, H., & Waaland, S. (2012). *Molecular life of plants*. Wiley-Blackwell.
9. Pua, E. C. (2010). *Plant developmental biology-biotechnological perspectives*. Heidelberg; Springer.
10. Slack, J. M., & Dale, L. (2021). *Essential developmental biology*. John Wiley & Sons.
11. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant physiology and development* (No. Ed. 6). Sinauer Associates Incorporated.
12. Teaching Tools in Plant Biology (www.aspb.org).
13. The *Arabidopsis* Book, ASPB publication (available freely at www.aspb.org).
14. Tuan, R. S., & Lo, C. W. (2000). Developmental biology protocols. *Developmental Biology Protocols*, 3-5.

Course Code : PLSTC30026	Type: Core
Title: **CELL & TISSUE CULTURE TECHNOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:

CLO1: Determine the optimal conditions required for mammalian tissue culture.

CLO2: Explain the basic concept of animal cloning and how to select the appropriate clone.

CLO3: Distinguish between different immunological methods implemented to isolate and culture animal cells.

CLO4: Learn and demonstrate the various methods of the processes involved in tissue culture.

CLO5: Understand the phytohormone regulations and its application in tissue culture

CLO6: Learn plant tissue culture engineering and development of newer protocols.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	1	3	1	2	1	-	2	1	-
CLO2	3	1	2	1	2	1	-	2	1	-
CLO3	2	2	3	1	2	1	-	2	1	-
CLO4	3	1	2	1	2	1	-	1	1	-
CLO5	3	1	2	1	3	1	-	2	1	-
CLO6	2	1	2	1	1	1	-	2	1	-
CLO7	3	1	2	1	3	1	-	2	1	-

Detailed Syllabus

Unit I

Culture of Animal cells: History of animal cell culture, Advantages and limitations of tissue culture, biology of cultured cells, aseptic handling, equipment and materials required, defined media and cell lines. Bioethics and safety. Primary culture: Isolation of mouse and chick embryo, human biopsies, methods for primary culture, subculture, selection of cell line and routine maintenance. Cloning and Selection: Cell cloning, stimulation of plating efficiency, suspension cloning, isolation of clones, isolation of genetic variants, interaction with substrate, selective inhibitor. Cell separation and characterization: Density based, antibody based, magnetic and fluorescence-based cell sorting. Characterization of cells based in morphology, chromosome analysis, DNA content, RNA and protein, cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation.

Unit II

Culturing of specialized cells: Epithelial, mesenchymal, neuro ectodermal, hematopoietic gonad and tumor cells, Lymphocyte preparation, culture of amniocytes, fish cells, confocal microscopy. Cell and Tissue engineering: Three-dimensional culture. Growth factors for *in situ* tissue regeneration, biomaterials in tissue engineering. Haemoglobin based blood substitutes, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering. Historical developments and landmarks in plant tissue culture. Basic techniques & methodology in plant tissue culture. Maintenance of cultures, Environmental Conditions, explants characteristics. Explants selection, sterilization, inoculation, and various media preparations. Concept of totipotency. Callus Induction and clonal propagation. Initiation and maintenance of callus cultures, cell suspensions. Role of plant growth regulators in plant differentiation and morphogenesis.

Unit III

Somatic embryogenesis, organogenesis and Factors affecting somatic embryogenesis and organogenesis. Molecular overview of somatic embryogenesis. Meristem culture, Anther culture, zygotic embryo culture, endosperm culture - importance and applications. Protoplast culture, isolation, purification and methods used for protoplast fusion. Somatic hybridization/cybridization. Synthetic seed production and their applications. Micropropagation: uses and commercial exploitation. Production of haploids using anther, pollen and unfertilized ovule cultures, their characterization and applications. Production of secondary metabolites from cell cultures and hairy root cultures, strategies used for enhanced production of secondary metabolites. Biotransformations using plant cell cultures, germplasm storage in-vitro, cryopreservation. Somaclonal and gametoclonal variations. In-vitro mutant isolation, their characterization and uses. Agrobacterium-mediated transformations.

References

1. Atala, A., Lanza, R., & Lanza, R. P. (Eds.). (2002). *Methods of tissue engineering*. Gulf professional publishing.
2. Baran, T., & Ghosh, B. (2005). Plant Tissue Culture: Basic and Applied. *Orion*, 45-50.
3. Bhojwani, S. S. (Ed.). (2012). *Plant tissue culture: applications and limitations*. Elsevier.
4. Bhojwani, S. S., & Razdan, M. K. (1986). *Plant tissue culture: theory and practice*. Elsevier. BIOTOL (Project), Open Universiteit (Heerlen, & University of Greenwich. (1993). *In vitro cultivation of plant cells*. Butterworth-Heinemann.
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8. Freshney, R. I. (2015). *Culture of animal cells: a manual of basic technique and specialized applications*. John Wiley & Sons
9. Gangal, S. (2007). *Principles and practice of animal tissue culture*. Universities Press
10. Jha, T. B. (2005). *Plant tissue culture: basic and applied*. Universities press.
11. Masters, J. (Ed.). (2000). *Animal cell culture: a practical approach* (Vol. 232). OUP Oxford.
12. Park, S. (2021). *Plant Tissue Culture: Techniques and Experiments*. Academic Press.
13. Verma, A., Verma, M., & Singh, A. (2020). Animal tissue culture principles and applications. In *Animal Biotechnology* (pp. 269-293). Academic Press.

Course Code : PLSTC30020	Type: Core
Title: **MOLECULAR PLANT PATHOLOGY**	Credits: 3
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

After the completion of this course, students will be able to:
CLO1: Describe the detail of various pathogens and pathogenesis.
CLO2: Understand genetic and molecular mechanism of pathogenesis.
CLO3: Understand molecular mechanism involving host-pathogen interactions.
CLO4: Explain how different transgenic models can be used to elucidate specific disease mechanisms.
CLO5: Understand the physiology and biochemistry of plant disease and the plant based molecules involved in disease resistance.
CLO6: Apply genetic engineering tools to manipulate the genome for disease resistance.
CLO7: Gain knowledge about molecular markers in plants for disease resistance.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	2	2	2	2	1	-	-	-
CLO2	3	2	2	2	2	2	1	-	-	-
CLO3	2	1	2	1	2	2	1	-	-	-
CLO4	3	1	2	2	1	1	1	-	-	-
CLO5	2	2	2	1	2	1	1	-	-	-
CLO6	3	1	2	3	2	2	2	-	-	-
CLO7	3	2	1	1	2	1	2	-	-	-

Detailed Syllabus

Unit I

Overview of pathogens and pathogenesis: An overview of nature of pathogens and pests, pathogen penetration, establishment, colonization in host. Hypothesis, Koch postulates, disease epidemics and epidemiology. Genetic and molecular mechanism of pathogenesis: Genetic and molecular basis for disease resistance, Flor's hypothesis- classical and modern concept, molecular determinants of pathogenicity, effectors, elicitors, Plant disease resistance, classes of resistance genes, adapted host resistance and non-adapted host resistance.

Unit II

Host defense responses: Preformed plant defenses, induced host defenses, biochemical and physiological responses, host-pathogen interaction mechanisms, hypersensitive response. Physiology and biochemistry of plant disease: Primary metabolism, Secondary metabolism, role of cell wall in plant defense defensins, phytoalexins, common phenolics, plant cell wall degrading enzymes, host specific toxins, host non-specific toxins.

Unit III

Host-pathogen interaction: hormones and signaling, systemic acquired resistance, induce Systemic acquired resistance, Pathogenesis-related (PR)-proteins. Transgenic and genetic manipulation approaches: Molecular marker approach to tag disease resistance and avirulence genes.

References

1. Agrios, G. N. (2005). *Plant pathology*. Elsevier.
2. Chaube, H. S., & Pundhir, V. S. (2005). *Crop diseases and their management*. PHI Learning Pvt. Ltd.
3. Mehrotra, R. S. (2013). *Fundamentals of plant pathology*. Tata McGraw-Hill Education.
4. Strange, R. N. (2003). *Introduction to plant pathology*. John Wiley & Sons.

Course Code : PLSTD30204	Type: Core
Title: **BIOSTATISTICS & BIOINFORMATICS**	Credits: 2
Prerequisite knowledge: B.Sc. Biology	L-T-P: 3-0-0

The course is aimed at introducing the students to the field of bioinformatics and enable them understand the concepts of statistics in biology. After the completion of this course, students will be able to:

CLO1: Know the theory behind fundamental bioinformatics analysis methods.

CLO2: Be familiar with widely used bioinformatics databases.

CLO3: Know basic concepts of probability and statistics.

CLO4: Be able to describe statistical methods and probability distributions relevant for molecular biology data.

CLO5: Know the applications and limitations of different bioinformatics and statistical methods.

CLO6: Be able to perform and interpret bioinformatics and statistical analyses with real molecular biology data.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	3	3	1	2	2	2	1	1	2
CLO2	3	3	3	3	2	3	3	2	1	2
CLO3	3	3	3	3	2	2	3	2	1	2
CLO4	3	3	3	3	3	2	3	2	1	2
CLO5	3	3	3	2	2	2	2	2	1	2
CLO6	3	3	3	3	3	2	3	2	1	2

Detailed Syllabus

Unit I

Fundamental of biostatistics: Statistical Decision-making Basics and Descriptive Statistics; Sampling and classification of data: Experimental vs. Observational Data ; Continuous vs. Categorical Data; Levels of Measurement: Graphing Methods, Measures of Central Tendency, Dispersion, Skewness, Kurtosis; Empirical Rule, 5 point summary; Regression and Correlation; Statistical tests (Hypothesis testing, Nulls hypothesis and alternative hypothesis, level of significance. Chi-square test, t-test, F-test, ANOVA-one way and two way classifications. Simple correlation and simple regression).

Unit II

Bioinformatics of Nucleic Acids(Nucleic acid databases, Sequence alignment, database search for homologous sequences, BLAST and FASTA versions, Smith-Waterman algorithm, Multiple sequence alignment. Primer designing, Restriction digestion analysis & vector designing tools); Bioinformatics of Proteins(Protein databases, Protein Structure visualization tools, protein motif and domain prediction, comparison and classification); Phylogenetic analysis(Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbour joining, Maximum parsimony, Maximum likelihood).

References

1. Barnes, M. R., & Gray, I. C. (Eds.). (2003). *Bioinformatics for geneticists*. John Wiley & Sons.
2. Baxevanis, A. D., & Ouellette, F. (2001). FB: Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 2nd edn. A John Wiley and Sons. *Inc., Chichester*.
3. Casella, G., & Berger, R. L. (2021). *Statistical inference*. Cengage Learning.
4. Davies, O. L. (1947). Statistical methods in research and production. *Statistical methods in research and production.*

5. Ewens, W. J., & Grant, G. R. (2005). *Statistical methods in bioinformatics: an introduction* (Vol. 15). New York: Springer.
6. Mount, D. W. (2007). Using the basic local alignment search tool (BLAST). *Cold Spring Harbor Protocols*, *2007*(7), pdb-top17
7. Pathak, R. K., Singh, D. B., & Singh, R. (2022). Introduction to basics of bioinformatics. In *Bioinformatics* (pp. 1-15). Academic Press.
8. Waterman, M. S. (2018). *Introduction to computational biology: maps, sequences and genomes*. Chapman and Hall/CRC.

Course Code : PLSPA30111	Type: AECC
Title: **LIFE SCIENCE PRACTICAL-3 (BASED ON THEORY)**	Credits: 2
Prerequisite knowledge: B.Sc. Biology	L-T-P: 0-0-4

After the completion of this course, students will be able to:

CLO1: Isolate and purify plasmid, DNA, RNA and Protein

CLO2: Amplify DNA using PCR technique

CLO3: Clone foreign DNA into a plasmid vector

CLO3: Quantify protein

CLO4: Determine the genotoxicity

CLO5: Perform gel based assay

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	2	1	3	1	1	1	2	-
CLO2	3	3	2	1	2	1	1	1	2	-
CLO3	3	2	3	1	3	1	1	1	2	-
CLO4	3	2	2	1	3	1	1	1	2	-
CLO5	2	2	2	1	2	1	1	1	2	-

List of practical's

1. Isolation of genomic DNA
2. Quantitation of genomic DNA on agarose gel electrophoresis.
3. Estimation of DNA by Diphenylamine method
4. Restriction enzyme digestion of the plasmid DNA and clone verification.
5. Primer designing
6. PCR amplification of genomic DNA and agarose gel electrophoresis of PCR products
7. Isolation of RNA
8. Estimation of RNA by Orcinol method
9. Blotting techniques
10. Isolation of protein
11. Isolation of protein and estimation by using different methods
12. SDS PAGE analysis of protein
13. Regeneration and transformation of tobacco using *Agrobacterium tumefaciens*.
14. Preparation of cell culture media
15. Establishment of primary cell culture- mouse fibroblast extraction
16. Handling mammalian cell lines
17. Cell counting using Hemocytometer
18. Cryopreservation of Cell lines
19. Cell viability test
20. Proliferation assay
21. Immunocytochemistry
22. Immunofluorescence staining and microscopy
23. Mammalian cell Transfection
24. Tissue scaffolding technique
25. Immunohistology
26. Demonstration on dissection of rat/mice and identification of organs
27. Blood collection and separation
28. Excision of all tissues and preservation

29. Tissue embedding and sectioning using microtome
30. Histology of pancreas, liver, and kidney
31. Immunohistochemistry of brain, pancreas and liver
32. Hemoglobin estimation
33. Bleeding time, clotting time
34. Estimation of blood glucose content
35. Estimation of glycogen in liver
36. Determination of Blood cholesterol content
37. Estimation of blood urea content
38. Designing primers for 16S rRNA gene sequence
39. Amplification of 16S rRNA gene sequences by using genomic DNA as well as by colony boiling method
40. Purification of 16S rRNA gene

References

1. Jayaraman, J. (2001). *Laboratory manual in biochemistry*. New Age International.
2. Mu, P., & Plummer, D. T. (2001). *Introduction to practical biochemistry*. Tata McGraw-Hill Education.
3. Oser, B. L. Hawk's physiological chemistry, ed. 14, New York, 1965.
4. Sadasivam, S. (1996). *Biochemical methods*. New Age International.

Semester IV

Course Code: PLSRA40111	AECC
Title of the Course: **PROJECT WORK**	Credits: 19
Prerequisite knowledge: B.Sc Biology	L-T-P: 0-0-38

After the completion of this course, students will be able to:

CLO1: Gain knowledge and hand on experience with multiple equipment's used in research.

CLO2: Understand and able to address scientific experiment.

CLO3: Develop scientific writing.

CLO4: Gain in the capacity for executing independent research.

CLO5: Help in developing critical thinking capacity towards the basic science and designing independent proposal.

CLO6: Help in improving the scientific communication skill.

Mapping Course Learning Outcomes (CLOs) with PLOs

	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	3	3	3	3	2	3	3	3	3
CLO2	3	3	3	3	3	2	3	3	3	3
CLO3	3	3	3	3	3	2	3	3	3	3
CLO4	3	3	3	3	3	2	3	3	3	3
CLO5	3	3	3	3	3	2	3	3	3	3
CLO6	3	3	3	3	3	2	3	3	3	3
CLO7	3	3	3	3	3	2	3	3	3	3

Detailed Syllabus

The overall MSc program course syllabus.

Recent scientific advances in relation to the research topic allotted as per MSc program and in charge faculty research interest.

Reference:

1. Online journals and databases Springer, Elsevier, Science direct**,** etc