New Education Policy (NEP) 2020

Postgraduate/Master's Degree Programme

M.Sc.
in
Life Sciences

Department of Life Sciences
Mizoram University

2022

Course Structure for M.Sc. in Life Sciences

TWO-YEAR COURSE

Course Code	Course Name	Credits
FIRST SEMESTER		**20**
LSC/MJ/500	Cell Biology	3
LSC/MJ/501	Microbiology	3
LSC/MJ/502	Systematics and Biodiversity	3
Interdisciplinary major	[*To be chosen from an MJ course offered by other disciplines*]	3
LSC/MN/503	Foundations of Medical Biology	2
Interdisciplinary minor	[*To be chosen from an MN course offered by other disciplines*]	2
LSC/FP/504	Practical based on DM courses	4
SECOND SEMESTER		**20**
LSC/MJ/550	Biochemistry	3
LSC/MJ/551	Genetics and Molecular Biology	3
LSC/MJ/552	Evolution and Ethology	3
Interdisciplinary major	[*To be chosen from an MJ course offered by other disciplines*]	3
LSC/MN/553	Biology in Human Welfare	2
Interdisciplinary minor	[*To be chosen from an MN course offered by other disciplines*]	2
LSC/FP/554	Practical based on DM courses	4
Exit option with Post-Graduate Diploma after the first year or two semesters with the completion of courses equivalent to 40 credits		
THIRD SEMESTER		**20**
LSC/MJ/600	Biotechniques and Biomolecules	3
LSC/MJ/601	Bioinformatics and Biostatistics	3
LSC/MN/602	Research Methods and Ethics	2
Interdisciplinary minor	[*To be chosen from an MN course offered by other disciplines*]	2
LSC/FP/603	Practical based on DM courses	4
LSC/MJ/649	Dissertation	6
FOURTH SEMESTER	[*One course to be chosen from a pool of MJ/650*]	**20**
LSC/MJ/650-A	Animal Physiology and Endocrinology	4
LSC/MJ/650-B	Immunology	4
LSC/MJ/650-C	Plant Physiology and Biochemistry	4
LSC/MJ/650-D	Plant Anatomy and Embryology	4
LSC/FP/651	Practical based on MJ course	4
LSC/MJ/699	Dissertation	12
	TOTAL CREDITS	**80**

MJ = Disciplinary major MN = Disciplinary minor FP = Field Project

Description on awarding the degrees

1. Exit Option

There will be one exit option in a two-year PG/master's degree programme with Post-Graduate Diploma after completion of one year or two semesters.

2. Two-Year Course

Master's degree will be awarded after completion of a two-year course of four semesters with a course equivalent of 80 credits for those who have obtained a three-year bachelor's degree.

3. One-Year Course

Master's degree will be awarded after completion of the one-year course (two semesters with a course equivalent of 40 credits) for those who have obtained a four-year bachelor's degree (honours/research degree).

Course Evaluation

1. Assessments

a) Each course shall be assessed on the scale of 100 marks.
b) The first component (C1) carrying 20 marks shall be from first 50% of the course contents.
c) C2 carrying 20 marks shall be from the remaining 50% of the course.
d) C3 or end-semester examination will carry 60% of the total marks.

2. Grades

Marks	Letter Grade	Grade Point
90–100	O (Outstanding)	10
85–89	A+ (Excellent)	9
80–84	A (Very Good)	8
70–79	B+ (Good)	7
60–69	B (Above Average)	6
50–59	C (Average)	5
40–49	P (Pass)	4
<40	F (Fail)	0
	Ab (Absent)	0

Grade to percentage = CGPA × 9.5

Cell Biology

LSC/MJ/500 **Credits = 3**

Unit 1 : Structure of ion channels; electrical properties of membrane. P-type pumps; F-type pumps; ABC transporters. RBC membrane; spectrin. Aquaporins and bacteriorhodopsin.

Unit 2 : Nuclear pore complex. Nuclear transport. Vesicular transport. Protein sorting. Molecular chaperones. Endocytosis; pinocytosis; phagocytosis; autophagy; exocytosis.

Unit 3 : Structure of ATP synthase; mitochondrial DNA; kinetoplast. Structure and types of plastids: chloroplast, thylakoid, stomata. Protein import into mitochondrion and chloroplast.

Unit 4 : Cell cycle. Mechanism of cytokinesis. Cell cycle checkpoints. Cyclins and CDKs and regulation of cell cycle; transcriptional regulation of cell cycle – cell cycle inhibitors. Structure and function of telomere; shelterin.

Suggested readings

1. Albert, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2022). *Molecular Biology of the Cell* (7th edition). W. W. Norton & Co Inc.
2. Cooper, G. M., Hausman, R. E. (2019). *The Cell: A Molecular Approach* (8th edition). Oxford University Press.
3. Craig, N., Green, R., Greider, C., Storz, G., Wolberger, C. (2021). *Molecular Biology: Principles of Genome Function* (3rd edition). Oxford University Press.
4. Karp, G. (2020). *Karp's Cell and Molecular Biology: Concepts and Experiments* (9th edition). John Wiley & Sons Inc.
5. Lodish, H., Berck, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H., Matsudaira, P. (2021). *Molecular Cell Biology* (9th edition). W. H. Freeman & Co Ltd.

Microbiology

LSC/MJ/501 **Credits = 3**

Unit 1 : Diversity of bacteria and archaea. Bacterial flagellum. Structure of *E. coli*. Microbial genetics: Griffith's experiment on transformation; Hershey-Chase blender experiment; Beadle-Tatum experiment.

Unit 2 : Biology of *Streptococcus*, *Bacillus anthracis, Clostridium tetani*, *Salmonella enterica, Vibrio cholerae*. Fission, recombination, plasmids, transposons in bacteria. Mechanism of action and resistance of antibiotics. Virulence factors in bacteria.

Unit 3 : Virulence factors in fungi. Biology and importance of *Candida albicans*; aflatoxin-producing *Aspergillus*; *Penicillium*; *Saccharomyces cerevisiae*; actinomycetes. Biology of *Acanthamoeba*.

Unit 4 : Virology – structure, genome, replication. Structure of tobacco mosaic virus, influenza virus, poliovirus. Structure and life cycle of phage λ and bacteriophage MS2.

Suggested readings

1. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., Stahl, D. A. (2021). *Brock Biology of Microorganisms* (14th edition). Pearson.
2. Procop, G. W., Koneman, E. W. (2020). *Koneman's Color Atlas and Textbook of Diagnostic Microbiology* (7th edition). Jones & Bartlett Learning.
3. Slonczewski, J. L., Foster, J. W. (2020). *Microbiology: An Evolving Science* (5th edition). W. W. Norton & Co Inc.
4. Tortora, G. J., Funke, B. R., Case, C. L. (2019). *Microbiology* (12th edition). Pearson.
5. Willey, J., Sherwood, L., Woolverton, C. J. (2019). *Prescott's Microbiology* (11th edition). McGraw-Hill Education.

Systematics and Biodiversity

LSC/MJ/502 **Credits = 3**

Unit 1 : Taxonomy in Renaissance; Linnaean taxonomy; taxonomic ranks. Binomial and binominal nomenclature. Overview and impact of Aristotle's *Historia Animalium* and Linnaeus's *Systema Naturae*.

Unit 2 : Higher level classifications: domains, empires and kingdoms. Species concepts. Concepts of ICN, ICZN, ICNB, ICNCP, ICTV.

Unit 3 : Cladistics: phylogenetic relationships and molecular systematics. Concepts of the tree of life and phylogenetic tree. Molecular tools in taxonomy; protein and nucleotide sequence analysis.

Unit 4 : IUCN: History and features of IUCN Red List; conservation biology. Mass extinction events. Biogeographic realms or ecozones. The Last Universal Common Ancestor.

Suggested readings

1. Margulis L. and Chapman M. J. (2009). *Kingdoms and Domains: An Illustrated Guide to the Phyla of Life on Earth*. Academic Press.
2. Minelli, A. (2012). *Biological Systematics: The State of the Art*. Springer.
3. Pellens, R., Grandcolas, P. (2016). *Biodiversity Conservation and Phylogenetic Systematics*. Springer.
4. Richards, R. A. (2016). *Biological Classification. A Philosophical Introduction*. Cambridge University Press.
5. Watson, M. F., Lyal, C. H. L., Pendry, C. A. (2015). *Descriptive Taxonomy: The Foundation of Biodiversity Research.* Cambridge University Press.

Foundations of Medical Biology

LSC/MN/503 **Credits = 2**

Unit 1 : Miasma theory of diseases; development of physiology from Galen to William Harvey. Germ theory of diseases – contributions of Louis Pasteur and Robert Koch. Magic bullet. Discovery of X rays.

Unit 2 : Discovery of yellow fever virus; malarial parasite. Discovery of cell and organelles; discovery of neurone; discovery of blood groups. History of cancer up to Rudolf Virchow; discovery of carcinogens.

Suggested readings

1. Magner, L. N. (2002). *A History of Life Sciences* (3rd edition). CRC Press.
2. Magner, L. N., Kim, O. (2017). *A History of Medicine* (3rd edition). CRC Press.
3. Sadava, D., Hillis, D. M., Heller, H. C., Berenbaum, M. (2012). *Life: The Science of Biology* (10th edition). W. H. Freeman & Company.

Biochemistry

LSC/MJ/550 **Credits = 3**

Unit 1 : Glycolysis; fermentation; pentose-phosphate pathway; Entner-Doudoroff pathway; HMP shunt. Citric acid cycle and glyoxylate pathway. Oxidative phosphorylation.

Unit 2 : Oxidation of fatty acids. Nitrogen metabolism; urea cycle; biological nitrogen fixation. Biosynthesis of amino acids and porphyrin.

Unit 3 : Enzyme kinetics. Enzyme inhibition; enzyme specificity and regulation. Zymogens, isozymes, allosteric enzymes, coenzymes. Mechanism of lysozyme action.

Unit 4 : Biosynthesis of starch and glucose. Light-dependent reaction, Calvin cycle; carbon fixation, Crassulacean acid metabolism. Structure and functions of carboxysome.

Suggested readings

1. Appling, D. R., Anthony-Cahill, S. J., Mathews, C. K. (2018). *Biochemistry: Concepts and Connections*. Pearson.
2. Berg, J. M., Tymoczko, J. L., Gatto, G. J., Stryer, L. (2019). *Biochemistry* (9th edition). W.H. Freeman & Company.
3. Nelson, D. L., and Cox, M. (2021). *Lehninger Principles of Biochemistry* (8th edition). W.H. Freeman & Company.
4. Rodwell, V. W., Bender, D., Botham, K. M., Kennelly, P. J., Weil, P. A. (2018). *Harper's Illustrated Biochemistry* (31st edition). McGraw-Hill Education.
5. Voet, D., and Voet, J. G. (2021). *Biochemistry* (4th edition). John Wiley & Sons Inc.

Genetics and Molecular Biology

LSC/MJ/551 **Credits = 3**

Unit 1 : DNA replication: Meselson-Stahl experiment; mechanism of replication; extrachromosomal replicons. DNA damage and repair mechanisms; homologous recombination; transposition. Mechanisms of apoptosis.

Unit 2 : Transcription: transcription factors, enzymes, RNA polymerase structure and assembly; transcription activator and repressor. RNA processing; RNA splicing. Translation: factors and their regulations; translational inhibitors. Post-translational modification of proteins.

Unit 3 : Sex determination; SRY; lyonisation. *Drosophila* eye colour. Polygenic inheritance, heritability and its measurements, QTL mapping. Extrachromosomal inheritance. Linkage maps, mapping population in plants. Tetrad analysis in fungi.

Unit 4 : Genetic disorders: hypercholesterolemia; polycystic kidney syndrome; Huntington's disease; Tay-Sachs disease; thalassemia, cystic fibrosis, phenylketonuria; alkaptonuria; fragile X syndrome. Lysosomal disorders.

Suggested readings

1. Hartwell, L., Goldberg, M., Hood, L., Fischer, J. (2020). *Genetics: From Genes to Genomes* (7th edition). McGraw-Hill Education.
2. Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A., Killian D. (2019). *Concepts of Genetics* (12th edition). Pearson.
3. Krebs, J. E., Goldstein, E. S., and Kilpatrick, S. T. (2017). *Lewin's Genes XII*. Jones & Bartlett Publishers.
4. Lodish, H., Berck, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H., Matsudaira, P. (2021). *Molecular Cell Biology* (9th edition). W. H. Freeman & Co Ltd.
5. Pierce, B. (2020). *Genetics: A Conceptual Approach* (7th edition). W.H. Freeman.

Evolution and Ethology

LSC/MJ/552 **Credits = 3**

Unit 1 : Darwinism and neo-Darwinism; mutation theory. Morgan's experiments. Adaptive mutation in *E. coli*. Evo-Devo – *Drosophila Hox* mutations. Hardy-Weinberg law. Neutral evolution. Molecular clocks; horizontal gene transfer; gene duplication.

Unit 2 : Co-evolution – the red queen hypothesis. Origin of mitochondria, kinetoplasts, plastids, apicoplasts, electron transport system. *Mimivirus* and its evolutionary significance.

Unit 3 : Evolution of rhodopsin and vision. Precambrian life. Major transitional fossils – *Pikaia*, *Tiktaalik, Aurornis, Indohyus*, *Archaeopteryx*. Archaic *Homo* and migration. Evolution of human skin colour.

Unit 4 : Antipredation mechanisms – ricin, curare, batrachotoxin, tetrodotoxin, bombardier beetle. Bioluminescence. Circadian clock genes/proteins and clock neurones in bacteria, *Arabidopsis* and *Drosophila*.

Suggested readings

1. Cole, E. (2021). *Understanding Evolutionary Biology*. States Academic Press.
2. Futuyma, D. J. (2017). *Evolution* (4th edition). Sinauer Associates Inc.
3. Bergstrom, C. T., Dugatkin, L. L. (2019). *Evolution* (2nd edition). W. W. Norton & Company.
4. Roberts, L., Hickman Jr., C., Larson, A., Keen, S., Eisenhour, D. (2018). *Animal Diversity* (8th edition). McGraw-Hill Education.
5. Zimmer, C., Emlen, D. J. (2019). *Evolution: Making Sense of Life* (3rd edition). W.H. Freeman & Company.

Biology in Human Welfare

LSC/MN/553 **Credits = 2**

Unit 1 : Discovery of antibiotics – Salvarsan, penicillin, Prontosil, streptomycin. Discovery of quinine, artemisinins, ivermectins. Immunization. London Declaration on Neglected Tropical Diseases. Biowarfare and bioterrorism. History and health effects of tobacco use.

Unit 2 : DNA profiling in forensic, parentage and genealogical tests. Development of modern transplantation. History of IVF; organism cloning. Application of genetic engineering, gene therapy; genetic screening and counselling.

Suggested readings

1. Clark, D. P., Pazdernik, N. J. (2015). *Biotechnology* (2nd edition). Academic Press.
2. Magner, L. N. (2009). *A History of Infectious Diseases and the Microbial World.* Praeger Publishers.
3. Wolff, H.P., Fleckenstein, A., Philipp, E. O. (2012). *Drug Research and Drug Development in the 21st Century: Science and Ethics.* Springer Science & Business Media.

Biotechniques and Biomolecules

LSC/MJ/600 **Credits = 3**

Unit 1 : Principles and applications of light, fluorescence, confocal, scanning and transmission electron microscopes; freeze-etch and freeze fracture; ELISA; RIA; western blot; immunoprecipitation; flow cytometry. Principles of sterilization, isolation and nutrition in microbes.

Unit 2 : Principle and application of PCR; RT-qPCR. Structural genomics, functional genomics, epigenomics; metagenomics. Genome sequencing methods. Genome editing; CRISPR-Cas9. RNA interference.

Unit 1 : General structure of amino acids; structure of proteins. Conformation of proteins. Structure of cellulose and peptidoglycan. Structure, biosynthesis and functions of cholesterol. Neurotransmitters, melanin, chlorophyll, anthocyanin, carotene.

Unit 2 : Biosynthesis of nucleic acids; structure and general functions of A-, B-, C-, Z-DNA; mRNA, rRNA, tRNA; siRNA; snoRNA; microRNA. Base pairing: Watson-Crick base pairs; Hoogsteen base pair; Wobble base pair.

Suggested readings

1. Katoch, R. (2014). *Analytical Techniques in Biochemistry and Molecular Biology*. Springer.
2. Pevsner, J. (2015). *Bioinformatics and Functional Genomics* (3rd edition). Wiley-Blackwell.
3. Plummer, D. (2017). *An Introduction to Practical Biochemistry* (3rd edition). McGraw Hill Education.
4. Hofmann, A., Clokle, S. (2018). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology* (8th edition). Cambridge University Press.
5. Nelson, D. L., and Cox, M. (2021). *Lehninger Principles of Biochemistry* (8th edition). W.H. Freeman & Company.

Bioinformatics and Biostatistics

LSC/MJ/601 **Credits = 3**

Unit 1 : Introduction to bioinformatics and computational biology. History and major developments of NCBI, EBI, UniProt, EMBOSS, University of California Santa Cruz (UCSC) Genome Browser, Ensembl Genome Browser, ExPASy, RefSeq Project, Consensus Coding Sequence Project.

Unit 2 : Nucleic acid and protein sequence analysis: ORF, BLAST, FASTA, PSI-BLAST, MegaBLAST, BLAT, LAGAN, BLASTZ, SSAHA, SIM4 and HMMER. Substitution matrices – PAM matrix and BLOSUM. Multiple sequence alignment – ClustalW, MUSCLE, MAFFT, PRALINE. The T-Coffee module – Expresso; Pfam; PopSet. RFLP, RAPD and AFLP techniques.

Unit 3 : Phylogenetic tree – distance-based, maximum parsimony and maximum likelihood methods. Transcriptomics technologies. Molecular modelling of proteins: Role of wwPDB; RCSB and PDB databases. Protein tertiary structure prediction. Molecular docking.

Unit 4 : Measures of central tendency and dispersal. Probability distributions (binomial, poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; *t*-test; analysis of variance; ANOVA; X^2 test. Introduction to multivariate statistics.

Suggested readings

1. Daniel, W. W., Cross, C. L. (2014). *Biostatistics: Basic Concepts and Methodology for the Health Sciences*. Wiley-Blackwell.
2. Lesk, A. (2019). *Introduction to Bioinformatics* (5th edition). Oxford University Press.
3. Mukhopadhyay, C. S., Choudhary, R. K., Iquebal, M. A. (2017). *Basic Applied Bioinformatics*. Wiley-Blackwell.
4. Pagano, M., Gauvreau, K. (2018). *Principles of Biostatistics*. Chapman & Hall/CRC Press.
5. Saitou, N. (2018). *Introduction to Evolutionary Genomics*. Springer.

Research Methods and Ethics

LSC/MN/602 **Credits = 2**

Unit 1 : Fundamental concepts: Occam's razor; empiricism; inductive reasoning; falsifiability. Scientific papers: types and publication processes. Citation metrics; impact factor. Committee on Publication Ethics.

Unit 2 : Academic plagiarism – national and institutional regulations. Use of animals and humans in scientific experiments; Nuremberg Code; Declaration of Helsinki; The Belmont Report. Overview and components of clinical trials. Euthanasia.

Suggested readings

1. Koepsell, D. (2017). *Scientific Integrity and Research Ethics: An Approach from the Ethos of Science*. Springer.
2. Mayer, T., Steneck, N. (2012). *Promoting Research Integrity in a Global Environment*. World Scientific.
3. Shoja, M. M., Arynchyna, A., Loukas, M., D'Antoni, A. V., Buerger, S. M. (2019). *A Guide to the Scientific Career: Virtues, Communication, Research, and Academic Writing*. Wiley-Blackwell.

Animal Physiology and Endocrinology

LSC/MJ/650-A **Credits = 4**

Unit 1 : Structure and proteins of skeletal muscle. Molecular mechanism of muscle contraction. Structure and functions of motor proteins: myosins; kinesins; dyneins. Structure and functions of cilia and flagella; centrosomes; basal bodies. Non-muscle motility: actin polymerisation.

Unit 2 : Neuroanatomy of the brain and spinal cord. Action potential and propagation of nerve impulse. Structure and function of glial cell**;** myelin sheath. Synaptic transmission; acetylcholine receptor; glutamate-gated ion channels.

Unit 3 : G protein cycle and GPCR interactions. Cyclic AMP pathway; JAK-STAT pathway. Biosynthesis and mechanism of action of NO. Melatonin: structure, biosynthesis and circadian rhythm.

Unit 4 : Structure, mechanism of action and functions of insect hormones. Estrous and menstrual cycles – hormonal regulation; estrous disruptions – Bruce effect; Lee-Boot effect; Vanderbergh effect; Whitten effect.

Suggested readings

1. Barrett, K., Brooks, H., Boitano, S., Barman, S. (2019). *Ganong's Review of Medical Physiology* (26th edition). McGraw-Hill Education.
2. Costanzo, L. S. (2018). *Physiology* (7th edition). Wolters Kluwer.
3. Hill, R. W., Wyse, G. A., and Anderson, M. (2019). *Animal Physiology* (5th edition). Sinauer Associates, Inc.
4. Kramer, I. M. (2015). *Signal Transduction* (3rd edition). Academic Press.
5. Saladin, K. (2020). *Anatomy & Physiology: The Unity of Form and Function* (8th edition). McGraw-Hill Education.

Immunology

LSC/MJ/650-B **Credits = 4**

Unit 1 : Antigens; antigen specificity; pattern recognition receptors; danger-associated molecular patterns. Structure and functions of macrophage. Mechanism of phagocytosis; opsonization. The complement system.

Unit 2 : Structure and functions of natural killer cells. Structure and properties of lymphocytes. Molecular structure of IgG. Antibody diversity; Ig class switching; B cell development and activation.

Unit 3 : Functions of T cells; T cell development and activation. Receptors and co-receptors of B cells, T cells and NK cells. MHC – types, structure, function, polymorphism. Structure and function of dendritic cells. Antigen presentation.

Unit 4 : Interferons; protein kinase R; cytokines. Hypersensitivity – types; autoimmunity and autoimmune diseases. Clonal selection; monoclonal antibodies; antibody engineering. Inflammatory reaction.

Suggested readings:

1. Abbas, A. K., Lichtman, A. H., Pillai, S. (2021). *Cellular and Molecular Immunology* (10th edition). Elsevier.
2. Delves, P. J., Martin, S. J., Burton, D. R., Roitt, I. M. (2017). Roitt's Essential Immunology (13th edition). Wiley-Blackwell.
3. Murphy, K., Weaver, C. (2022). *Janeway's Immunobiology* (10th edition). Garland Science.
4. Owen, J., Punt, J., Stranford, S., Jones, P. (2018). *Kuby Immunology* (8th edition). W. H. Freeman & Co.
5. Sompayrac, L. M. (2019). *How the Immune System Works* (6th edition). Wiley-Blackwell.

Plant Physiology and Biochemistry

LSC/MJ/650-C **Credits = 4**

Unit 1 : Structure, function and synthesis of betalins, β-sitosterol, cholesterol, chlorophyll, carotenoids, brassinosteroids (BRs), stigmasterol, anthocyanins. Plant growth regulators - types and their modes of action. Synthetic growth regulators. Ethylene pathway.

Unit 2 : Photosynthesis: Photosynthetic organelles; Red Drop and Emerson Enhancement effect; Two pigment system; light harvesting complexes; mechanisms of electron transport; photo-protective mechanisms: CO_2 fixation – C_3, C_4 and CAM pathways. Alternate oxidase, photorespiratory pathway.

Unit 3 : Stress physiology: stress conception; factors; general adaptation syndrome in plants. Structure, biosynthesis ad functions of important secondary products; terpenes, phenols, alkaloids and flavonoids.

Unit 4 : Seed dormancy and germination; photomorphogenesis and photoperiodism: structure and function of phytochrome, cryptochromes and phototropins. Vernalization; senescence.

Suggested readings

1. Buchanan, B.B., Gruissem, W., Jones, R.L. (2015). *Biochemistry and Molecular Biology of Plants*. 2nd edition. Wiley-Blackwell.
2. Hopkins, W. G., Huner, N.P.A. (2013). *Introduction to Plant Physiology* 4th edition. John Wiley & Sons Inc.
3. Koelling, C. (2016). *Plant Anatomy, Morphology and Physiology*. Syrawood Publishing House.
4. Mohr, H., Schopfer, P., Lawlor. G., Lawlor, D. W. (2010). *Plant Physiology*. Springer.
5. Taiz, L., Zeiger, E., Møller, I.M., Murphy, A. (2018). *Fundamentals of Plant Physiology*. Sinauer Associates Inc.

Plant Anatomy and Embryology

LSC/MJ/650-D **Credits = 4**

Unit 1 : Plant tissue system, types and functions. Classes and significance of meristems. Structure of xylem, phloem and vascular elements. Primary and secondary growth. Anatomy of *Mirabilis, Bignonia* and *Dracaena* showing anomalous structures.

Unit 2 : Primary and secondary metabolism: structure, biosynthesis ad functions of important secondary products; terpenes, phenols, alkaloids and flavonoids. Important groups of secondary metabolic enzymes. Regulation and expression of secondary metabolism.

Unit 3 : Morphogenesis: unique features; organization of shoot apical meristem (SAM); cell to cell communication; secretory ducts and laticifers. Organization of root apical meristems (RAM); root-microbe interaction; phyllotaxy; genetics of floral organ differentiation. Seed development.

Unit 4 : Pollination: mechanism and vectors; pollen-pistil interaction; self-incompatibility-SSI and GSI; double fertilization. Microsporogenesis; organization of embryo sac. Endosperm developments. Development of typical monocot and dicot embryo; polyembryony; apomixis; embryo culture.

Suggested readings

1. Casey, F. (2020). *Plant Taxonomy: Classical and Modern Methods*. Syrawood Publishing House.
2. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. (2015). *Comparative Embryology of Angiosperms*. *Vol. I and II*. Springer Verlag.
3. Kaplan, D. R., Specht, C. D. (2022). *Kaplan's Principles of Plant Morphology*. CRC Press.
4. Koelling, C. (2016). *Plant Anatomy, Morphology and Physiology*. Syrawood Publishing House.
5. Taiz, L., Zeiger, E., Møller, I.M., Murphy, A. (2018). *Fundamentals of Plant Physiology*. Sinauer Associates Inc.

Practical – LSC/FP/504

LSC/FP/504 **Credits = 4**

Suggested components

Part I

1. Study of prokaryotic and eukaryotic cells from slides/models.
2. Study of cell organelles from slides/models.
3. Study of mitochondria, plastids, apicoplasts and kinetoplasts from slides/models.
4. Preparation of slide from animal/plant tissue using histochemical stains.
5. Study of mitosis
6. Study of meiosis.
7. Estimation of DNA.
8. Estimation of RNA.

Part II

9. Study of *E. coli, Streptococcus*, and *Vibrio cholerae* from slides/models.
10. Study of *Candida albicans*, *Aspergillus* and *Penicillium* from slides/models.
11. Microbial isolation and culture technique.
12. Gram staining, acid-fast staining and spore staining of bacteria.
13. Measurement of microbial growth.
14. Bacterial culture for antibiotic sensitivity test.

Components can be added or modified according to availability of facilities.

Practical – LSC/FP/554

LSC/FP/554 **Credits = 4**

Suggested components

Part I

1. Estimation of proteins.
2. Estimation of carbohydrates.
3. Qualitative detection of starch and glucose.
4. Qualitative detection of phenols and terpenes.
5. Thin layer chromatography of amino acids/carbohydrates.

Part II

6. Preparation of buccal smear for sex chromatin.
7. Karyotyping.
8. Preparation of sex chromosome.
9. Pedigree analysis.
10. DNA/RNA extraction and visualization.

Components can be added or modified according to availability of facilities.

Practical – LSC/FP/603

LSC/FP/603 **Credits = 4**

Suggested components

Part I

1. Estimation of collagen.
2. Cell fractionation using centrifuge.
3. Estimation of free radicals/antioxidants.

Part II

4. Basic statistical software and applications.
5. Excel and data management.
6. Protein and DNA sequence retrieval and biological databases.
7. Detection of introns and exons.
8. Statistical analysis from given data.

Components can be added or modified according to availability of facilities.

Practical – LSC/FP/651

LSC/FP/651 **Credits = 4**

Suggested components

Option A

Part I

1. Measurement of blood pressure, pulse, and BMR.
2. Measurement of Hb.
3. Effect of temperature, pH, substrate on salivary enzyme activity.
1. RBC counting.
2. Total white blood cell count.

Part II

3. Precipitin ring test.
4. Agglutination test.
5. Estimation of cytokine levels in serum.
6. Cell viability study by trypan blue dye.
7. ELISA.

Option B

Part I

1. Detection of phytochemicals.
2. Estimation of plant proteins.
3. Estimation of antioxidant activities.
4. Isolation and estimation of genomic DNA.
5. Haplotyping using mitochondrial gene markers.

Part II

1. Morphological study of flowers from the above prescribed families.
2. Anatomical studies of anomalous structure of stems.
3. Study of pollen morphology and germination pattern from locally available specimen.
4. Study of permanent slides of dicot and monocot embryo.

Components can be added or modified according to availability of facilities.