



GUJARAT UNIVERSITY

DEPARTMENT OF LIFE SCIENCES,

University School of Sciences

Ahmedabad – 380009, Gujarat, India.

M. Sc. Life Sciences Course

The recent advances in biological Sciences have proved that the present training is inadequate for any meaningful research in present scenario, as all living systems are directly and indirectly interdependent. Interdisciplinary and integrated approach is very necessary for any significant contribution in modern Sciences in general and in Life Sciences in particular. Hence the course which was started in 1982 with same aim, revised regularly according to latest developments and discoveries, which will impart a broad training in various disciplines of Life Sciences, so that a student passing this course will be well equipped to meet challenges of academic and research of Life Sciences. These students will be able to pursue careers in pharmaceutical industries, research laboratories, clinical research organizations, school, colleges and Universities.

Life Sciences Syllabus

M. Sc.

Effective from June 2017

1. There shall be Four papers each of four hours (3+1) duration and two practical each of Nine hours per week.
2. Each Course (Theory & Practical) shall carry 100 (Hundred) marks (Internal 30 marks and External 70 marks). External exam for each theory is of 3 hours and practical exam is of more than 6 hours. Per semester.
3. The major emphasis of this Course is to motivate students for improvement through regular internal assessment. They should be encouraged for self study and seminar according to allotted times of the course per week.
4. Each theory paper is divided into four units. Each unit will have equal weightage of teaching and while setting question paper.
5. Question or its sub question including the options will be set from the same unit.
6. Practical batch will be consisting of maximum 10 students.
7. The elective papers will be offered as per availability of the expert faculty and feasibility of the department and schedule of teaching.
8. There shall be at least one study tour during the span of two years of P.G. study, pertaining to different Life Sciences/ Microbiological/ Environmental/ Biotechnological/ Pharmaceutical industries/ research institutes/ various ecosystems, even outside Gujarat State. The study tour is highly essential for study various concepts, processes and technology pertaining to Life Sciences.

Gujarat University

Design and Structure of Life Sciences; PG Courses for Credit Based Semester system to be implemented from June 2010 (New 2017)

Department	Semester	Course		No. of Hours per week				Course credits
		No	Name	Lectures	Others	Practicals	Total	
Life Science	1	LSC 401	Physical and Biological Chemistry	3	1		4	4
		LSC 402	Principles of Microbial Sciences	3	1		4	4
		LSC 403	Molecular Cell Biology	3	1		4	4
		LSC 404	Developmental and Stem Cell Biology	3	1		4	4
		LSC 405PR	Practical – I +Viva voce			6	6	4
		LSC 406PR	Practical – II +Viva voce			6	6	4
			Total	12	4	12	28	24
	2	LSC 407	Principles of Plant Sciences and Ecology	3	1		4	4
		LSC 408	Mammalian Physiology	3	1		4	4
		LSC 409	Ethology, Evolution and Toxicology	3	1		4	4
		LSC 410	Food Science and Food Microbiology	3	1		4	4
		LSC 411PR	Practical – III +Viva voce			6	6	4
		LSC 412PR	Practical – IV +Viva voce			6	6	4
			Total	12	4	12	28	24
	3	LSC 501	Immunology and Immunotechnology	3	1		4	4
		LSC 502	Analytical and Separation Techniques	3	1		4	4
		LSC 503	Biostatistics, Bioinformatics Bioinstrumentation and Bioassays	3	1		4	4
		LSC 504EA	1.Applied Botany	3	1		4	4
		LSC 504EB	2.Fermentation Technology					
		LSC 504EC	3.Molecular Biology and Animal Biotechnology					
		LSC 504ED	4.Cancer Biology					
		LSC 505PR	Practical – V +Viva Voce			6	6	4
		LSC 506PR	Practical – VI +Viva Voce			6	6	4
		Total	12	4	12	28	24	
	4	LSC 507PT	Dissertation / Project Work				20	16
		LSC 508S	Seminar / Field /Industrial visit				4	4
		LSC 509M	Assignment / Group Discussion				4	4
			Total				28	24

M.Sc. Semester I

Course No.	Course Name	Hours Per Week	Credits	Marks		
				Internal	External	Total
LSC 401	Physical and Biological Chemistry	04	04	30	70	100
LSC 402	Principles of Microbial Sciences	04	04	30	70	100
LSC 403	Molecular Cell Biology	04	04	30	70	100
LSC 404	Developmental Biology and Stem Cell Biology	04	04	30	70	100
LSC 405PR	Practical – I +Viva voce	09	04	30	70	100
LSC 406PR	Practical – II +Viva voce	09	04	30	70	100
	Library	02	-	-	-	-
Total		36	24	180	420	600

M.Sc. Semester II

Course No.	Course Name	Hours Per Week	Credits	Marks		
				Internal	External	Total
LSC 407	Principles of Plant Sciences and Ecology	04	4	30	70	100
LSC 408	Mammalian Physiology	04	4	30	70	100
LSC 409	Ethology, Evolution and Toxicology	04	4	30	70	100
LSC 410	Food Science and Food Microbiology	04	4	30	70	100
LSC 411PR	Practical – III +Viva voce	09	4	30	70	100
LSC 412PR	Practical – IV +Viva voce	09	4	30	70	100
	Library	02	-	-	-	-
Total		36	24	180	420	600

M.Sc. Semester III

Course No.	Course Name	Hour Per Week	Credits	Marks		
				Internal	External	Total
LSC 501	Immunology and Immunotechnology	04	04	30	70	100
LSC 502	Analytical and Separation Techniques	04	04	30	70	100
LSC 503	Biostatistics, Bioinformatics and Bioinstrumentation	04	04	30	70	100
LSC 504	Elective	04	04	30	70	100
504EA	1. Applied Botany					
504EB	2. Fermentation Technology					
504EC	3. Molecular Biology and Animal Biotechnology					
504ED	4. Cancer Biology					
LSC 505PR	Practical – V +Viva Voce	09	04	30	70	100
LSC 506PR	Practical – VI +Viva Voce	09	04	30	70	100
	Library	02	-	-	-	-
Total		36	24	180	420	600

M.Sc. Semester IV

Course No.	Course Name	Hours Per Week	Credit	Marks		
				Internal	External	Total
LSC 507PT	Dissertation / Project Work	24	16	100	300 (200+100)	400
LSC 508S	Seminar / Field /Industrial visit	06	4	50	50	100
LSC 509M	Assignment / Group Discussion	06	4	50	50	100
Total		36	24	200	400	600

M. Sc.

Semester.	Course Name	Hours Per Week	Credit	Marks		
				Internal	External	Total
I	Principles of Life Sciences I	36	24	180	420	600
II	Principles of Life Sciences II	36	24	180	420	600
III	Research Methodology and Elective	36	24	180	420	600
IV	Dissertation & Seminar+ Assignment	36	24	200	400	600
Total		144	96	740	1660	2400

Examinations for the 4th semester

Dissertation

Internal Examination

70 marks are based on day-to-day work of the concern student in terms of experimental designing, Practical performance in the laboratory, interpretation of the results obtained, regularity etc.

Internal 30 marks viva: Presentation of the work in front of the faculty of the department at least 3 times during this project work as follows.

- (1) Deciding of the project and state of the art presentation10 marks
- (2) Discussion of the materials and methods and protocols..... 10 marks
- (3) Presentation of the obtained results10 marks

External Examination

- (1) 200 marks examination of the dissertation by two examiners 100 marks each
- (2) 100 marks viva-voce conducted by examiners

Evaluation of Seminars and Assignments/Training Reports/Study Tour Report etc.

Internal: 50 marks for the presentation of seminar which includes content, presentation slides, explanation, understanding of the topic and response to the raised questions (10 marks each)

External: 50 marks evaluation of the prepared hard copy of the seminar and viva (marks distribution: 30 marks for viva and 20 marks for the report)

SEMESTER I

❖ LSC 401: PHYSICAL AND BIOLOGICAL CHEMISTRY

Unit – 1: Chemical Foundation:

- Chemical bonds and Molecules: Forces within and between molecules
- Properties of water, Solutions, Buffers.
- Organic and Biological Reaction Mechanism
- Physico-chemical properties of the living cell.

Unit – 2: Energy and Thermodynamics:

- Concepts of internal energy, enthalpy, and entropy,
- First and second Law of thermodynamics, bioenergetics
- Enzyme kinetics, Michaelis Menten Equation
- Recent concept of Enzyme actions, Enzyme inhibitors and modifiers,
- Regulatory enzymes and Allosteric enzymes

Unit – 3: Biomolecules – I:

- Classification, Nomenclature, Structure and properties of carbohydrates
- Regulation of Carbohydrate metabolism
- Structure and functions of Lipids – Phospholipids.
- Glycoconjugates - Glycolipids and glycoprotein and their role in biological processes.
- Structure and functions of Steroid, cholesterol metabolism

Unit – 4: Biomolecules – II:

- Structures, physical properties and functions of amino acids.
- Isoelectric points of amino acids.
- Three-dimensional structure of protein: Primary, Secondary, Tertiary and Quaternary configuration, Protein denaturation
- Synthesis and metabolism of Purines and Pyrimidines
- Structure and biosynthesis of different types of RNA.
- Structure and polymorphism of DNA.

❖ LSC 402: PRINCIPLES OF MICROBIAL SCIENCES

Unit – 1 : Introduction to Microbiology and Microorganisms:

- Introduction to Microbiology and its various branches.
- The scopes and avenues of Microbiology.
- Historical developments in Microbiology :
- General characteristics of major group of microorganisms:
a) Bacteria, b) Rickettsia, c) Chlamydia, d) Mycoplasma, e) Actinomycetes,
f) Archaeobacteria . g) Fungi, h) Viruses, i) Sub viral entities like Prions, Viroids,
Virusoids and Satellite RNAs.

Unit – 2 : Microbial Taxonomy:

- Importance and systems of Classification
- Status of Microorganisms into kingdoms
- Basic principles of nomenclature and classification
- Criteria used for classification and identification of microorganisms
- Genetic approaches used for microbial taxonomy.
- Numerical Taxonomy
- Bergey's Manual
- Present State of Bacterial, fungal and Viral taxonomy

Unit – 3 : Morphology, Reproduction and Significance:

- Bacteria – *Staphylococcus* (Gram positive) and *Escherichia* (Gram negative) as model examples
- Moulds – *Rhizopus*, *Penicillium*, *Puccinia* as model examples
- Yeasts – *Saccharomyces* as model example
- Bacterial Viruses – Coliphage T₄ and Lamda phage as model examples
- Animal Viruses – Adenovirus and Influenza virus as model examples
- Plant Viruses – TMV as model example

Unit – 4 : Microbial physiology:

- Principles of microbial nutrition :
 - a) Modes of uptake of nutrients in microorganisms
 - b) Nutritional requirements of microorganisms
 - c) Nutritional classification of microorganisms
- An overview of microbial metabolism
- Microbial growth :
 - a) Growth in prokaryotes and modes of cell division
 - b) Mathematical nature and expression of growth.
 - c) Normal growth curve of microbial population and Diauxic growth.
 - d) Continuous cultivation of microorganisms.
 - e) Methods for measurement of microbial growth.
 - f) Effect of environment on microorganisms

❖ **LSC 403: MOLECULAR CELL BIOLOGY**

Unit – 1: Evolution of the Cell:

- Cell as a unit of living organisms.
- Structure of Prokaryotic and Eukaryotic cells,
- Cell - Cell interactions; Cell adhesions, and cell junctions
- Molecular Basis of the Cell and Macromolecular recognition process,
- Cell Cycle and Division

Unit – 2: Biomembrane and Cytoskeleton:

- Molecular organization of Biomembrane: Ultrastructure and molecular composition of membrane,
- Physical and Dynamic properties of membrane,
- Movement of molecules/ions across Biomembrane and Human perspective-defects in ion channels.
- Cytoskeleton topography: Membrane Cytoskeleton interactions,
- Microtubule and its dynamics, motor proteins,
- Microfilament and its functions, Intermediate filaments and their functions

Unit – 3: Cell Organelles I:

- Molecular organization of Mitochondria
- Respiratory Chain Complexes – Organization and Stoichiometry,
- Q- cycle, Mechanism of Oxidative Phosphorylation, uncouplers and inhibitors;
- Molecular organization of Chloroplast,
- Photosynthetic pigments, Photosystem I & II
- Ultrastructure and Functions of Nucleus, Chromatin chemistry

Unit – 4: Cell Organelles II:

- Molecular Organization and functions of : Endoplasmic reticulum,
- Golgi complex, Lysosomes and Lysosomal disorders;
- Microbodies: Peroxisomes,
- Ribosomes,

❖ **LSC 404 : DEVELOPMENTAL AND STEM CELL BIOLOGY**

Unit –1: Reproduction:

- Histology of Gonads
- Gametogenesis
- Types of Ovum and eggs
- Ultrastructure of Sperm
- Fertilization : External , Internal , artificial , in *Vitro*
- Embryo Transfer

Unit – 2: Development of Embryo:

- Cleavage and its patterns
- Fate maps and their significance
- Gastrulation; - Embryonic germ layer, tracking of Migrating cells,
- Establishing Multicellularity,
- Epithelial Mesenchymal interactions.

Unit-3: Basic Stem Cell Biology:

- Stem cell types, embryonic and adult stem cells
- Stem cell Isolation,
- Stem cell characterization techniques
- Stem cell differentiation, induced pluripotency

Unit – 4: Stem Cell Applications:

- Therapeutic applications, Autologous and allogenic
- Cryopreservation and stem cell banking
- Regulatory guidelines on stem cell therapy and research
- Stem Cell Therapy in Cardiac and Osteogenic regeneration,
- Stem Cell Therapy in Leukaemia,

❖ **LSC 405PR : Practical and Viva voce based on LSC 401 & LSC 402;**

❖ **LSC 406PR : Practical and Viva voce based on LSC 403 & LSC 404;**

SEMESTER II

❖ LSC 407: PRINCIPLES OF PLANT SCIENCES AND ECOLOGY;

Unit – 1: Cell wall and Membrane Systems:

- Plant cell: - Structure, Models and functions of Cell Wall,
- Structure and functions of Plasmodesmata
- Plant vacuole; Tonoplast membrane; functions, Plasmolysis
- Plastids: Chloroplasts, Energetic, Molecular Organizations & Functions; Genome

Unit – 2 : Plant Physiology:

- Growth and Development: Concepts, qualitative – quantitative changes
- Growth regulators, biosynthesis, bioassay, mechanism of action, physiological effects, applications (auxin, cytokinin, gibberellins, ABA, ethylene),
- Physiological effects and role of Jasmonic acid, polyamines, Brassinosteroids, salicylic acid

Unit – 3 : Plant Breeding:

- Plant breeding – objectives, origin, domestication, hybrid vigour
- Principles and methods of plant Breeding, Self pollinated crops, cross pollinated crops, Clonal crops
- Plant Introductions – NBPGR
- Plant Tissue Culture – Basics; Requirements, Techniques and applications

Unit – 4 : Environmental Biology:

- Concept and dynamics of ecosystem – Organization and functions, Types,
- Energy flow, food chain, food web and trophic levels; ecological pyramids;
- Biogeochemical cycles (C, N, P and S)
- Ecological factors: Soil, light, water *etc*, Principle of limiting factors; biotic factors,
- Productivity; – Biomes and productivity including biodiversity,
- Population ecology – concept, types, fluctuation, factors regulating size, autecology, morality, Natalty
- Ecological succession and Niche theory,
- Sustainable Living Environments, Waste Management

❖ LSC 408: MAMMALIAN PHYSIOLOGY;

Unit – 1: Movement and Coordination:

- Organization of Body
- Structure of skeletal, cardiac and smooth
- Physiology of muscle contraction.
- Structure of Brain and Neurons.
- Physiology of nerve impulse conduction, excitability of membranes, electrical and chemical transmission between cells.

Unit – 2: Respiration and Nutrition:

- Physiology of respiration
- Exchange and transport of gases and its regulation.
- Physiology of digestion, regulation of food intake and digestive secretions.
- Nutrition and metabolism
- Chemical coordination - Endocrine organs and Hormones,

Unit – 3: Transport and Defence:

- Physiology of blood – compositions & structure, Haemopoiesis, coagulation,
- Heart: beat, initiation, conduction and regulation
- Physiology of Circulation
- Immune response

Unit – 4 : Excretion and Reproduction:

- Internal structure of Kidney and Nephron
- Fluid and electrolytes balance, Acid Base balance,
- Physiology of Excretion, Roles of kidney in body water regulation.
- Male Reproductive functions
- Female Reproductive functions

❖ **LSC 409: ETHOLOGY, EVOLUTION AND TOXICOLOGY**

Unit – 1: General aspect of Behaviour:

- Introduction of Behaviour
- Evolutionary approach to Behaviour, Levels of Natural selection
- Genetic basis of behaviour, Hereditary and Behaviour
- Sensory world of animals – Physical stimulus and Behavioural equipments

Unit – 2: Interactive Behaviour:

- Behavioural patterns -Individual and
- Reproductive behavioural patterns, Courtship, Mating and Parental cares,
- Stickle Back behaviour
- Social organization and Behaviours – Dominance, Territoriality, Aggression and social facilitation,
- Animal communication systems and role of pheromones in communication
- Human ethology - General aspects.

Unit – 3: Evolution:

- Adaptation- various types, Habitat preference,
- Natural selection, Evolution in Action;
- Concept of Species – Speciation, Genetic drift, Hardy-Weinberg law;
- Mimicry; Polymorphism, Molecular phylogeny;
- Biodiversity and Plant animal Coevolution

Unit – 4: Animal Toxicology:

- General Principles and terminology,
- Types of toxicity, Factors affecting toxicity,
- Acute, subacute and chronic toxicity,
- Classification of toxicants, Estimation of toxicity; LD₅₀; LC₅₀;
- Teratogens, Food additives and contaminations; Air, water and soil pollutants
- Genotoxicity

❖ **LSC 410: FOOD SCIENCE AND FOOD MICROBIOLOGY**

Unit – 1: Foods, Nutrients and Human Nutrition:

- Food needs and Components of Foods,
- Fate of major nutrients in human body,
- Food and Energy,
- Dietary allowances for Indians [ICMR and WHO Recommendation],
- Balanced Diets,
- Types of natural food stuffs and their nutritional contents,

Unit – 2 : *Quality Criteria and Safety of Foods:*

- Introduction and Types of Criteria
- ICMSF Sampling plans
- Plan Stringency and Problems involved,
- HACCP approach,
- Quality Assurance and Production Control,

Unit – 3 : *Principles of Food Microbiology:*

- Scope and development of Food microbiology,
- Sources of Microorganisms in food,
- Factors influencing Microbial growth in Food,
- Microbial Examination of Food,
- Beneficial activities of microbes in foods : Fermented foods, Probiotics,
- Microbial spoilage of foods
-

Unit – 4 : *Principles of Food Preservation:*

- Practice of Cleaning and Sanitation,
- Use of high temperature and Canning in Food Preservation,
- Use of Low temperature in Food Preservation,
- Use of Drying , Irradiation, Modified Atmosphere and Chemical preservatives,
- Hurdle Concept

❖ **LSC 411PR : Practical and Viva voce based on LSC 407 & LSC 408;**

❖ **LSC 412PR : Practical and Viva voce based on LSC 409 & LSC 410;**

SEMESTER III

❖ LSC 501 : IMMUNOLOGY AND IMMUNOTECHNOLOGY

Unit – 1 : Basic Immunology I:

- History and Significance of Immunology,
- Immunity and its types,
- Introduction to Immune system, Cells and Organs involved,
- Complement system,
- Cytokines and their significance,
- Cancer and Immune responses (Tumour Immunology),

Unit – 2 : Basic Immunology II:

- Antigens – General Properties and Criteria for antigens, Types of Antigens
- Antigenicity, MHC and HLA complex,
- Immunoglobulins : Basic structure, types and their functions
- Immunogenetics : Genetic basis of Clonal selection and Generation of antibody diversity,
- *In vivo* antigen-antibody interactions,

Unit – 3 : Immunotechnology:

- *In-vitro* antigen-antibody reactions and diagnostic significance ,
- Agglutination tests,
- Precipitation and Immunodiffusion tests,
- Modern tests like ELISA, (RIA), RAST, FAT, MIA
- Hybridoma technology and applications of Monoclonal antibodies,
- Vaccines and immunotherapy,

Unit – 4 : Dysfunction Immunity

- Hypersensitivity reactions,
- Tolerance and auto-immunity; Auto immune diseases,
- Immunodeficiency and their consequences, - HIV
- Transplantation Immunology,
- Hazards of Vaccine,

❖ LSC 502 : ANALYTICAL AND SEPARATION TECHNIQUES

Unit – 1 : Basic Analytical Techniques:

- Principles of Biophysical Methods;
- Electrochemistry: pH meter – Principles and applications,
- Dissociation and Ionization of acid and Base, pKa, Buffer and Buffering System, Henderson Hassel Balch equation, Dissociation of amino acids, Normality, Molarity and Molality.
- Beer-Lambert law, Types of emission spectra, light absorption and its transmittance and application of extinction coefficient, application of visible and UV spectroscopic techniques (structure elucidation and numerical excluded)
- X-ray Crystallography,

Unit – 2 : Analytical Techniques:

- Basic Principles of Electrophoresis, Factors affecting Separation,
- Theory and Applications of Paper, Starch, Agarose and Polyacrylamide (Native and SDS) Gel Electrophoresis
- Gradient Gel Electrophoresis; Iso-electric focussing, 2D and Capillary electrophoresis,
- Blotting Techniques

Unit – 3 : Separation Techniques:

- Principles of Chromatographic Separation, Solvent extraction;
- Theory, principle and applications of Paper, Gel-permeation(Size exclusion), Ion-exchange and Affinity chromatography; Thin layer chromatography (TLC),
- HPTLC, HPLC and Gas chromatography; Super critical fluid Chromatography;
- Theory and Principles of Centrifugation, Sedimentation velocity and Sedimentation Equilibrium; Types of Centrifugation and centrifuge machines:- Preparative and Analytical, Differential Centrifugation, Density Gradient Centrifugation
- Ultracentrifugation (velocity and buoyant density),

Unit – 4 : Radio-isotopic Techniques:

- Type of radio isotopes used in Biochemistry, Isotopes commonly used in biochemical studies: 32-P, 35-S, 14-C, and 125-I),
- Techniques used to measure radioactivity (gas ionization and liquid scintillation counting),
- Autoradiography.
- Biological hazards of radiation and safety measures in handling radioisotopes. Biological applications.
- Radioimmunoassay

❖ LSC 503 : *BIostatISTICS, BIOinformatics, BIOinstrumentation AND BIOassays***Unit – 1 : Biostatistics:**

- Introduction, Sample and Sample techniques, Types and Presentation of Data, Concepts of population, Measures of central tendency: Mean, Mode and Median,
- Standard deviation and standard error, Basic of Probability theory and theory of distribution, Simple linear correlation and regression,
- Tests of significance, 't' test, chi square and applications; ANOVA-one way and two way analysis,
- Entrepreneurship and marketing - starting and managing an enterprise,
- Entrepreneurship, advertising, marketing.

Unit – 2 : Research Methodology & Bioinformatics:

- Research methodology: Meaning, objectives and types of research, significance of research. Definition and identification of a research problem, justification, theory and hypothesis.
- Research design: Features of a good design, concepts of variables, experimental and control groups. Hypothesis testing, Interpretation: Meaning of interpretation and techniques. Interpretation of tables and figures. Reporting: Significance of report writing, steps in report writing and types of reports
- **Introduction to Bioinformatics**, Basic concepts of biological databases; Protein and Genome Information Resources, Computer in Life Sciences
- Structure prediction and quality assessment
- Virtual screening of drug molecules,
- Molecular dynamic simulation

Unit – 3 : Microscopy:

- Principles, working and application of Bright field and Dark field,
- Phase contrast and Interference, Differential Interference Contrast Microscope,
- Fluorescence Microscopy; Immunofluorescence, Confocal Microscopy,
- Specimen fixation, processing and staining in Light Microscopy,
- Electron Microscopy; TEM, SEM, and STEM, Cryoelectron microscopy;
- Processing of Biological sample for EM, Special Techniques in EM: Negative staining,
- Shadow casting and Freeze fracture deep etch replication techniques;

Unit – 4 : *Bioinstrumentation & Bioassays in Drug discovery:*

- PCR & qRT-PCR
- Flow cytometry (principle and clinical applications)
- Sanger sequencing (principle and clinical applications)
- Next generation sequencing (principle and clinical applications)
- Microarray (principle and clinical applications)
- MS and MALDI-TOF
- Viability and cytotoxicity assays (MTT, SRB etc); Functional assays
- In-vitro model for drug screening; In-vivo animal models

❖ **LSC 504EA : ELECTIVE: APPLIED BOTANY**

Unit - 1. *General Anatomy:*

- Shoot and Root Apical Meristem, Cellular manifestation and factors affecting development, Shoot apex of Pteridophyta, Gymnosperm and Angiosperm, lateral roots, root hairs
- Epidermis, stomata, trichomes, types, role
- Secretory Ducts and Laticifers, types, development, function.

Unit - 2. *Mendelian Genetics:*

- Genetics – principles of inheritance, pea as a model hybrid
- Gene interactions, linkage and crossing over, genetic mapping
- Extra chromosomal inheritance, chloroplast, Mitochondria, genome and genes.

Unit - 3. *Phytoresources:*

- Origins of agriculture, World centers of primary diversity of domesticated Plants;
- Origin, evolution, botany, cultivation and uses of Food, forage-fodder fuel, Fiber, furnishings, flavours, Medicinal plants, and oil-yielding plants of Gujarat and India.
- Non-wood forest products (NWFPs): Raw materials for paper – making, Gums and Resins, Dyes.
- Plant Tissue Culture – Introduction, requirements, methods and applications

Unit – 4. *Ethnobotany and Conservation:*

- Basic methods and approaches to study traditional knowledge, various sub disciplines
- Scope, voucher specimen, verification, screening and potential applications
- Conservation, principles, strategies, *in situ* – *ex situ*, protected areas, gene – seed banks, initiatives (international/ national), IUCN.

❖ **LSC 504EB : ELECTIVE: FERMENTATION TECHNOLOGY**

Unit – 1 : *Elements of Microbial Technology:*

- Concept of fermentation, Range of fermentation products and processes,
- Sources of Industrial Microbes: Isolation, Selection and Screening of industrially important microbes,
- Strain improvement programme,
- Media formulations for fermentation process,
- Bioreactor design,
- Optimization and control of fermentation process parameters,
- Scale-up and scale-down in bioprocess,

Unit – 2 : *Upstream and Downstream Processing:*

- Sterilization of bioreactor, air and media,
- Inoculum development,
- Aeration and agitation,

- Foam control,
- Recovery and purification of products,
- Fermentation Economics,
- Quality Assurance,

Unit – 3 : *Typical Microbial Fermentation Products:*

- Antibiotics : Penicillin,
- Enzymes : Amylase,
- Organic acids : Citric acid,
- Organic solvents : Ethanol,
- Amino acids : Lysine,
- Vitamins : B12,

Unit – 4 : *Microbial Biomass and Eco-Friendly Biotechnological Processes:*

- Biofertilizers,
- Bioinsecticides,
- Bio foods : Edible mushrooms , SCP (Single Cell Protein) , Edible algae,
- Biopolymers : Bioplastic, Xanthan , Dextran,
- Biofuels : Gasohol, Biogas, Hydrogen,
- Bioleaching and MEOR (Microbial Enhanced Oil Recovery),

❖ **LSC 504EC: ELECTIVE: MOLECULAR BIOLOGY AND ANIMAL BIOTECHNOLOGY**

Unit – 1 : *Molecular Biology:*

- Chromatin chemistry,
- DNA, Histones, Non-histone proteins,
- Organization of Chromosomes:
- DNA Replication and Regulation, DNA Repair mechanism,
- Transcription and Regulation of Gene Expression
- Cytogenetics and Molecular genetics of Cancer; Oncogenes,
- Cellular Communication: Intra cellular interactions,
- Receptor ligand interaction;
- Signal transduction, role of second messengers and G-proteins, Signalling Molecules

Unit – 2 : *Molecular Genetics:*

- Isolation and Purification of DNA,
- Chemical synthesis of DNA and Sequencing,
- Recombinant DNA techniques, Types of vectors,
- Gene cloning, Restrictions enzymes,
- Introduction of DNA/Gene into living cell,
- PCR system and gene amplification,
- Blotting techniques, RFLP and DNA fingerprinting, Applications in present perspective.
- Human genome Project, Gene therapy, Microarrays; FISH

Unit – 3 : *Animal Cell Culture:*

- Laboratory, equipments and Conditions for Animal cell culture,
- Cell dissociations and preparations of primary cell culture,
- Cell synchronization of animal cells and Characterization – Measurement of Viability and Cytotoxicity, Growth parameters
- Culture media for animal cell culture and their requirements
- Risks and Safety in the animal cell culture,

Unit – 4 : *Animal Biotechnology:*

- Short-term and mass cultivations,
- Cultivation of specialized cells *i.e.* Nerve cell, skin cells and Haemopoetic stem cell (bone marrow);
- Cell Banks, Stem cells and their applications,
- Techniques of Isolation and Purification of Enzymes
- Various techniques used for the Immobilization of enzymes,
- Applications of immobilized enzyme in Biotechnology.

❖ **LSC 504ED: ELECTIVE: CANCER BIOLOGY**

Unit-1: *Dynamics of Cell Growth:*

- Cell cycle, Cell division -molecular aspects, mechanics, regulation,
- Cell growth; Growth factors, Cell aggregation
- Cell ageing (senescence), Cell death, apoptosis, autophagy

Unit-2: *Cancer Biology-I:*

- Normal and cancerous cells
- Types of Cancer and Metastasis
- Cancer Hallmarks; Chromosome and Cancer
- Carcinogens and Carcinogenesis
- Cancer Biomarkers, oncogenes and tumour suppressor genes
- Signal transduction pathways

Unit-3: *Cancer Biology-II:*

- Principle of cancer therapies, radiation, chemotherapy, immunotherapy and targeted therapy
- Biological therapy
- Cancer stem cells
- Drug resistance

Unit - 4 : *Cancer Drug Discovery:*

- Cancer drug targets identification and validation
- In-vitro screening
- In-vivo models in cancer
- Cancer clinical trials

❖ **LSC 505PR : Practical and Viva voce based on LSC 501 & LSC 502;**

❖ **LSC 506PR : Practical and Viva voce based on LSC 503 & LSC 504;**

SEMESTER IV

❖ LSC 507PT : DISSERTATION/ PROJECT WORK

Students are supposed to carryout field / laboratory training cum experimental works and prepare a comprehensive report along with a research proposal for future career. The area should include from basics to latest developments and discoveries, which will impart a broad training in various disciplines of Life Sciences and Biotechnology, These students will be able to pursue careers in pharmaceutical industries, research laboratories, clinical research organizations, school, colleges and Universities as researcher or academician.

❖ LSC 508S : SEMINAR / FIELD / INDUSTRIAL VISIT

Students should deliver seminar and attend the same at regular basis from syllabus, topics from recent advances in the subject and from prepared review of few research articles from research Journals. Students are also required to visit nature for diversity, research institutes and industries for real exposure in subject and qualitative interactions to understand applications of the subject. If possible a study tour during the span of two years may be organized pertaining to different Life Sciences/ Microbiological/ Environmental/ Biotechnological/ Pharmaceutical industries/ research institutes/ various ecosystems, even outside Gujarat State. The study tour is highly essential for study various concepts, processes and technology pertaining to Life Sciences.

❖ LSC 509M : ASSIGNMENT AND GROUP DISCUSSION

Department will allocate the assignment from the subject and related areas to each student every week and arrange every week group discussion between students and also between faculties and students.

❖ SUGGESTED READINGS:

All important Scientific and Research Journals are to be referred for latest development in the subject and field of Life Sciences and Biotechnology along with following books.

Sr. No	Book	Author	Publisher	Year
1.	A manual of Ethnobotany	S.K. Jain	Scientific Publisher, Jodhpur	Latest
2.	A manual of Laboratory Experiences in cell Biology	C. Edward Gasque	Univ. Book Stall, N. Delhi	1990
3.	An introduction to Embryology	B. I. Balinsky	A East West Press, N Delhi	2004
4.	An Introduction to Embryology	B.I. Ballinsky	EWPress ND	2004
5.	An Introduction to Genetic Analysis	Griffiths et al.	W. H. Freeman & Co., NY	2004
6.	Anatomy and Physiology	Thibodeau G.A. & Patton K.T.	Mosby	1996
7.	Animal Behaviour	McFarland D.		
8.	Animal Behaviour & Evolutionary Approach	Alcok J.		
9.	Animal Cell Culture Methods (Methods in Cell Biology, Vol.57)	J.P. Mather and D. Barnes	Academic Press, NY	Latest
10.	Animal Cell Culture, Practical Approach,	J. R. E. Masters,	Oxford Uni. Press, Oxford	Latest
11.	Animal watching	Desmond Morris	Jonathan Cape, London	1990
12.	Applied Molecular Genetics.	Miesfield	Wiley & Sons Publication	1999
13.	Applied Statistics	Mukhopadhyay	Books and Allied (P.) Ltd.	2000
14.	Basic Genetics	R. F. Weaver & P. W. Hedrick	Wm C. Brown Pub, Oxford	1995
15.	Biochemistry	C.K. Mathews, K. E. vanHolde, K. G. Ahern	Pearson Education , N Delhi	2003
16.	Biochemistry	J. M. Berg, J. L. Tymoczko & L. Stryer	W.H.Freewan & Co., NY	2004

18.	Biochemistry and Mol. Biology	W.H. Elliott & D.C. Elliott	Oxford Press, Oxford	2005
19.	Biodiversity of Microbial Life	Ed. J.T. Staley <i>et al</i>		
20.	Bioinformatics	Higgins & Taylor		2000
21.	Bioinformatics – A Primer,	P. Narayanan	New Age Internat. Pub.	2005
22.	Bioinformatics. Methods and Protocols.	Misner & Krawetz	Humana Press, NJ	2000
23.	Biostatistics	A.E. Lewis		Latest
24.	Biotechnology	U. Satyanarayana	New Central Book, India	2006
25.	Carleton's Histological Techniques	R. A. B. Drury & E.A. Willington	Oxford Univ. Press, Oxford	1980
27.	Cell and Molecular Biology	De Robertis, E.D.P. and De Robertis E M F		
26.	Cell and Molecular Biology	Garald Karp	J. Wiley & Sons, NY	2008
28.	Cell Biology – Structure and Function	David E. Sadawa,	Jones and Barttett Pub., IND.	1993
29.	Cell Biology LabFax	G.B.Dealtry & D. Rickwood	Bios Scientific Pub.	1992
30.	Cell Biology, Genetics, Molecular Biology, Evolution and Ecology	P.S. Verma, V.K. Agarwal	S. Chand Pub., N Delhi	2004
31.	Cell Growth and Division, A Practical Approach.	R. Basega,	IRL Press, Oxford Univ.	Latest
32.	Cell in Development and inheritance	EB Wilson	MacMilan, NY	Latest
33.	Chemistry for Life Sciences	Sutto R., Rockett B. & Swindells P	Taylor & Francis, London	2000
34.	Chromosomes	Archana Sharma	Oxford & IBH Pub. N Delhi	1995
35.	Commercial Floriculture	S. Prasad and U.Kumar,	Agrobotanica	1998
36.	Commercial flower Production	Utpal Banerjee	Mangal Deep Pub., Jaipur.	2001
37.	Comparative animal Behaviour	Donald A. Dewsbury	McGraw Hill Book	1978
38.	Concept of Ecology	Kormondy E. J.		
39.	Confocal Laser Scanning Microscopy	C.J.R. Sheppard & D. M. Shotton	BIOS Scientific Pub., UK	1997
40.	Culture of Animal Cells	R.I. Freshney,	A. R. Liss Inc., NY	1987
41.	Current concepts in Fertility Regulation and Reproduction	Chander P. Puri, Paul F. A. vanLook	Wiley Eastern, N. Delhi	1994
42.	Dairy Microbiology	H. A. Modi	Aaviskar Pub, Jaipur	2009
43.	Developmental Biology	Scott F. Gilbert	Sinauer Associate. Inc.	1991
44.	Developments In Food Microbiology	R. Davis	Applied Sci. Publ., London	2004
45.	DNA Science	Micklos & Freyer	Cold Spring Harbor Lab. Press, NY	1990
46.	Ecology	Krebs C. J		
47.	Economic Botany	A.V.S.S Samba Murthy and N.S Subramanyam	Wiley Estern Ltd	Latest
48.	Economic Botany	Bendre and Kumar		Latest
49.	Electron Microscopy in Molecular Biology	J. Sommerville & U. Scheer	IRL Press, Washington DC	1987
50.	Elementary Microbiology, Vol. 1 & 2	H. A. Modi	Akta Prakasan, Nadiad	1996
51.	Elements of Biotechnology	P.K. Gupta,	Rastogi R. Co., Meerut	1994
52.	Endocrinology, Vol. 1,2,3	L. J. Degroot.	W. B. Saunders Co., UK	1989
53.	Environmental Science	Santra S. C.	New Central Book Agency	2001
54.	Enzymes –Biochem, Biotech, Clin. Chem.	Trevor Palmer	A East West Press, N. Delhi	2004
55.	Essential Endocrinology	J. F. Laylook & P. H. Wise	ELBS, Oxford Univ. Press	1983
56.	Essentials of Immunology ,	I. M. Roitt,	ELBS, Oxford Univ. Press	1998
57.	Essentials Reproduction	M. Johnson and B. Everitt.	Blackwell Sci. Pub., Oxford	1980

58.	Ethnobotany	Rajiv K. Sinha and Shweta Sinha	Surbhi Publication, Jaipur	Latest
59.	Evolution	Eaton H.		
60.	Evolution	Strickberger	Prentic Hall	2002
61.	Fermentation Technology Vol. I & II	H. A. Modi	Pointer Pub, Jaipur	2008
62.	Floriculture in India	G. S. Randhawa and A. Mukhopdhyay	Allied Publishers Limited	1998
63.	Flow Cytometry	M.G. Ormerod	Oxford Univ. Press, Oxford	1994
64.	Food Microbiology	M.R. Adams and M.O. Moss,	The Royal Society of Chemistry ; Cambridge	2000
65.	Forensic Medicine and Toxicology	Krishan Vjj	Elsvier India	2005
66.	Fundamental of Biochemistry	D. Voet, J. G. Voet & C. W. Pratt	John Wiley & Sons , Asia	2006
67.	Fundamentals of Analytical Chemistry	D. A. Skoog, D. M. West, F.J. Holler, & S. R. Crouch	Thomson Brooks / Cole, USA	2005
68.	Fundamentals of Biostatics – Practical Approach	Dutta	Kanishka Publ., N Delhi	2002
69.	Fundamentals of Ecology	Odum E.P.	W. B. Saunders Co. Lt	Latest
70.	Fundamentals of Enzymology	Nicholas C. Price & Lewis Steven	Oxford Univ. Press, Oxford	2003
71.	Fundamentals of Statistics	S. Gupta	Himalaya Pub. House,	2005
72.	Gene Cloning – An Introduction	Brown	Stanley Thornes	1995
73.	General Microbiology	M. M. Michael, J. Stanier <i>et al</i>		Latest
74.	Genes VIII	B. Lewin	Oxford Univ. Press, UK	2004
75.	Genetic Engineering	S. Rastogi & N. Pathak	Oxford Uni. Press, ND	2009
76.	Genetics and origin of species	Dobzhansky		
77.	Growth of Bacterial Cell	Ingraham <i>et. Al.</i>	Sinauer Asso. Inc., NY	1983
78.	Harper`s Biochemistry	R.K. Murray, D.K. Granner, A. A. Mayes. And V. W. Rodwell	MacGraw Hill, Asia	2003
79.	How the internet works	Priston Grall & Techmich		Latest
80.	HPLC Of Macromolecules	R.W.A. Oliver	IRL Press, Oxford Univ. Press, NY	1989
81.	Human Chromosomes. Manual of Basic Techniques	Verma & Babu	Pergamon Press. USA	1989
82.	Human Cytogenetics – A practical approach (Vol. I & II)	Rooney & Czepulkowski	IRL Press at Oxford University Press, NY	1992
83.	Hybridoma technology in the Biosciences and Medicine	T. A. Sringer	Plenum Press, NY	Latest
84.	Immunology	Ivan M. Roitt, Jonathan Brostoff and David K. Male	Glomer Medical Pub. Mosley / London	2000
85.	Immunology (Kuby)	R.A. Goldsby, T. J. Kindt, B. A. Osborne, J. Kuby	W. H. Freeman & Co. NY	2002
86.	Immunology and Immunotechnology	A.K.Chakravarty		Latest
87.	Integral animal behaviour	David E Davis.	MacMillian Co, NY	1967
88.	Introduction to Practical Molecular Biology	P.D. Dabre,	John Wiley & Sons, NY	1988
89.	Introductory Food Microbiology	H.A. Modi	Aavishkar Pub., Jaipur	2007
90.	Light Microscopy in Biology	A. J. Lacey	IRL Press, Oxford Univ. Press, New York,	1989
91.	Manipulation & Expression of Recombinant DNA	Robertson et al.	Academic Press, NY	1997
92.	Manual of cultivated plants	L.H.Bailey	The Macmillan CO., NY	1958
93.	Marshall's Physiology of Reproduction Vol 1 and 2	G. E. Lamming.	Churchill Livingstone	1990
94.	Medicinal Plants Of India Vol-I & II	T. Pulliah		
95.	Methods of Enzymology vol. 185 (Gene expression)	D.V. Goeddel	Academic press, NY	1990
96.	Methods of Enzymology vol. 152(Molecular cloning)	S. L. Berger and A.R. Kimmel	Academic Press, NY	1998

97.	Microbial diversity	D. Colwd		
98.	Microbial physiology	Dawes & Southerland	Hall State Press, NY	1976
99.	Modern Genetic Analysis,	Griffiths, Gilbert, Miller, Lewontin,	W.H. Freeman & CO, NY	1999
100.	Modern Toxicology, Vol. 1-3	P. K. Gupta & D. K. Salunkhe	Metropolitan	1985
101.	Molecular Bio methods Hand book	Rapley & Walker		Latest
102.	Molecular Biology LabFax	T.A. Brown	Bios Sci. Publ., Oxford	1991
103.	Molecular Biology of the Cell	B. Albert, A. Johnson, J. Levis, M. Raff, K. Roberts, & P. Walter.	Garland Science	2002
104.	Molecular Biology of the Reproductive System	Decretser.	Academic Press, NY	Latest
105.	Molecular Biotechnology	S. B. Primrose	Blackwell Sci. Pub., Oxford	1994
106.	Molecular Cell Biology	H. Lodish, D. Baltimore, A. Berk, S. L. Zipursky, P. Matsudara and J. Darnell,	Scientific American books, USA	1995
107.	Molecular Cloning : A Laboratory Manual	J. Sambrook, E. F. Fritsch, & T. Maniatis	ColdSpring Harbor Lab. Presss, NY	2000
108.	Molecular Endocrinology	F. F. Bolander.	Academic Press, NY	1989
109.	Monoclonal Antibodies : Principles and Practice	J. W. Golding	Academic Press, NY	Latest
110.	Perspectives in Nutrition	Gordon Wardlaw & Paul Insel	Mosby, Toronto	1993
111.	Plant Breeding	B.D. Singh		
112.	Plant Physiology	Taiz L & Zeiger E		
113.	Plant Tissue Culture	Razdan M. K.		
114.	Practical biochemistry	Plummer D. T.	Tata McGraw Hill Pub. ND	1990
115.	Prenatal Diagnosis :The Human Side	Lenore Abramsky & Jean Chapple	Chapman & Hall, UK	1994
116.	Principles & Techniques of Biochemistry and Molecular Biology	K. Wilson & J. Walker	Cambridge University Press, NY	2006
117.	Principles and Methods of Toxicology	Hayes	Taylor and Francis	2000
118.	Principles of Anatomy and physiology	Tortora G.J. & Grabowski S. R.		2001
119.	Principles of Cell Biology	L. J. Kleinsmith & V.M.Kish	Harper & Row Pub. NY	1988
120.	Principles of Fermentation Technology	P. Stanbury, A. Whitaker & S. Hall	Butterworth Heinemann	1995
121.	Principles of Genetics	E. J. Gardner, M. J. Simmons & D. P. Snustad	John Wiley & Sons, NY	2001
122.	Principles of Genetics	Robert H. Tamarin	Tata McGraw Hill, N Delhi	2002
123.	Principles of Microbiology	R. M. Atlas		
124.	Protein Purification	Robert K. Scopes	Springer (India), N Delhi	2004
125.	Recent Advances in Bioinformatics	Khan & Kanum	Ukraaz Publications	2003
126.	Recombinant DNA	Watson et al.	W. H. Freeman & Co, NY	1992
127.	Recombinant DNA and Biotechnology	Krenzer & Massey	ASM Press, USA	2000
128.	Recombinant DNA Principles and Methodology	James J Greene & Venigalla B. Rao		Latest
129.	Some beautiful Indian Climbers and Shrubs	N.L.Bor and M.B.Raizada	Oxford University Press	Latest
130.	Some beautiful Indian Trees	E. Blatter and Walter S. Millard	Oxford University Press	1997
131.	Statistics & Experimental Design	Geoffrey M. Clarke	Edward Arnold, UK	1994
132.	Techniques in Microscopy and Cell Biology	A. K. Sharma	Tata MacGraw Hill Pub. Co., N Delhi	1991
133.	Textbook of Biotechnology	H.K. Das		Latest

134.	Textbook of Medical physiology	Guyton A.C. and Hall. J.E.		
135.	The Biochemistry of Cell Signalling	E. J. M.Helmreich	Oxford Univ.Press, N Delhi	2005
136.	The Cell: A Molecular Approach	Cooper & Hausman	A.S.M. Press, USA	2006
137.	The Eukaryotic Chromosome	Bostoc & Sumner	Elsevier	1980
138.	The Physiology of Reproduction Vol. 1 and 2	E. Knobil and J. D. Neill.	Raven Press, NY	1988
139.	Theory & Practice of Histological Techniques	Bancroft & Stevens	Churchill Livingstone, NY	1990
140	Toxicology	Niesink et. Al.	CRC Press	1995

Current references will be added whenever necessary. For each topic the current references will be given as and when needed
