MANGALORE UNIVERSITY

Scheme and Syllabus for B.Sc. (Basic / Hons.) Biotechnology

Preamble:

In keeping with the Govt of India's NEP-2020 vision of a holistic and multidisciplinary Under-Graduate education that equips employable graduates with the required skills in domain as well as personality that are required in the 21st century, the Govt. of Karnataka constituted Subject-wise Committees to work towards envisaging, designing and drafting a common syllabus with hallmarks being multiple entry and exit points enabling horizontal and vertical mobility. This has now been adopted in Mangalore University with minor changes and shall be effective from the academic year 2021-22.

Salient features are as follows:

1. Discipline Core (DSC) or Domain-specific Core Courses in Biotechnology as Major.
2. Discipline Electives (DSE) or Elective Courses in the Core Subject or Discipline.
3. Open Electives (OE) are Elective Courses offered to students from non-core Subjects across disciplines.
4. Skill Enhancement Courses (SEC) that are domain-specific or generic.
5. 1 hour of Lecture or 2 hours of practical per week in a semester is assigned one credit. Core discipline theory courses are of 3/4 credits, while practicals are of 2 credits

Competencies need to be acquired by a candidate securing B.Sc. (Basic) or B.Sc. (Hons) degree in Biotechnology.

Program Outcomes:

By the end of the program the students will be able to:

PO 1. Understand concepts of Biotechnology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology, and molecular biology.

PO 2. Demonstrate the Laboratory skills in cell biology, basic and applied microbiology with emphasis on technological aspects

PO 3. Be competent to apply the knowledge and skills gained in the fields of plant biotechnology, animal biotechnology and microbial technology in pharma, food, agriculture, beverages, herbal and nutraceutical industries.

PO 4. Critically analyze environmental issues and apply the biotechnology knowledge gained for conserving the environment and resolving environmental problems.

PO 5. Demonstrate comprehensive innovations and skills in the fields of biomolecules, cell and organelles, molecular biology, bioprocess engineering and genetic engineering of plants, microbes, and animals with respect to applications for human welfare.

PO 6. Apply the knowledge and skills of immunology, bioinformatics, computational modelling of proteins, drug design and simulations to test models and aid in drug discovery.

PO 7. Critically analyze, interpret data, and apply tools of bioinformatics and multiomics in various sectors of biotechnology including health and food.

PO 8. Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all the fields of biotechnology.

PO 9. Learn and practice professional skills in handling microbes, animals and plants and demonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animals handling, intellectual property rights, biosafety, and biohazards.

PO 10. Explore the biotechnological practices and demonstrate innovative thinking in addressing the current day and future challenges with respect to food, health, and environment.

PO 11. Demonstrate thorough knowledge and application of good laboratory and good manufacturing practices in biotech industries

PO 12. Understand and apply molecular biology techniques and principles in forensic and clinical biotechnology.

PO 13. Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up of small-scale enterprises or CROs

Programme Structure for BSc (Basic/Hons.) Biotechnology

Semester	Discipline Core Courses (Credits) (T+P=4+2; T=4)	Open Elective Courses OE (3)	Ability Enhancement compulsory Courses 4hrs		Skill Enhancement Courses			Total credits
					Skill based	Value Based (Credits) L+T+P		
I	BTC 101 Cell biology and Genetics (4) BTC 101 Cell biology and Genetics (2) (4) (2)	BTC 301 Biotechnology for human welfare (3)	Languages (3+3)		**SEC-1** BTC 701 Biotechnological Skills and Analytical Techniques (2)	Phy. Ed. Yoga (1)	Health & Wellness (1)	25
II	BTC 102 Microbiological methods and techniques (4) BTC 102 Microbiological methods and techniques (2) (4) (2)	BTC 302 Applications of Biotechnology in agriculture (3)	Languages (3+3)	EVS (2)		Phy. Ed. Sports (1)	NCC/NSS/R&R (S&G)/Cultural (1)	25
Exit option with Certificate in Biotechnology (with completion of courses equal to a minimum of 48 credits)								
III	BTC 103 Biomolecules (4) BTC 103 Biomolecules (2) (4) (2)	OE 3	Languages (3+3)		**SEC-2** (2)	Phy. Ed. Sports (1)	NCC/NSS/R&R (S&G)/Cultural (1)	25
IV	BTC 104 Molecular biology (4) BTC 104 Molecular biology (2) (4) (2)	OE 4	Languages (3+3)	Constitution of India (2)		Phy. Ed. Sports (1)	NCC/NSS/R&R (S&G)/Cultural (1)	25
Exit option with Diploma in Biotechnology (with completion of courses equal to a minimum of 96 credits OR continue with Major and Minor)								
V	BTC 105 Genetic Engineering (3) BTC 106 Plant Biotechnology (3) BTC 105 Genetic Engineering (2) BTC 106 Plant Biotechnology (2) (3) (2)	Biotechnology Vocational – 1 (3)			**SEC-3** (2)	Phy. Ed. Sports (1)	NCC/NSS/R&R (S&G)/Cultural (1)	22
VI	BTC 107 Immunology and Medical Technology (3) BTC 108 Bioprocess Technology (3) BTC 107 Immunology and Medical Technology (2) BTC 108 Bioprocess Technology (2)	Biotechnology Vocational-2 (3) **Internship** (2)			**SEC-4** (2)	Phy. Ed. Sports (1)	NCC/NSS/R&R (S&G)/Cultural (1)	24

	(3) (2)							
Exit option with BSc in Biotechnology (with completion of courses equal to a minimum of 140 credits OR continue for Hons)								
VII	BTC 109 Environmental Biotechnology (3) BTC 110 Enzyme Biotechnology (3) BTC 111 Food Biotechnology (3) BTC 110 Environmental Biotechnology (2) BTC 110 Enzyme Biotechnology (2)	Biotechnology E-1 (3) Biotechnology -E 2 (3) Research Methodology (3)						22
VIII	BTC 112 Animal Biotechnology (3) BTC 113 Genomics and proteomics (3) BTC 114 Biosafety, bioethics and IPR (3)	Biotechnology E-3 (3) Biotechnology E-4 (3) Research Project* (6)						21
								189
Award of BSc (Hons.) Degree in Biotechnology (with completion of courses equal to a minimum of 180 credits)								

*In lieu of Research Project, two additional elective papers/ internship may be offered

MANGALORE UNIVERSITY
Scheme and Syllabus for B.Sc. (Basic / Hons.) Biotechnology

SEMESTER - I								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 101	Cell Biology and Genetics	4	3	40	60	100	4
	BTP 101	Cell Biology and Genetics Practical	3	3	25	25	50	2
Open Elective (OE) Courses	BTC 301	Biotechnology for human welfare	3	3	40	60	100	3

SEMESTER - II								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 102	Microbiological methods and techniques	4	3	40	60	100	4
	BTP 102	Microbiological methods and techniques Practical	3	3	25	25	50	2
Open Elective (OE) Courses	BTC 302	Applications of Biotechnology in agriculture	3	3	40	60	100	3

SEMESTER - III								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 103	Biomolecules	4	3	40	60	100	4
	BTP 103	Biomolecules Practical	3	3	25	25	50	2
Open Elective (OE) Courses	BTC 303		3	3	40	60	100	3

SEMESTER - IV								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 104	Molecular Biology	4	3	40	60	100	4
	BTP 104	Molecular Biology Practical	3	3	25	25	50	2
Open Elective (OE) Courses	BTC 304		3	3	40	60	100	3

SEMESTER - V								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 105	Genetic Engineering	3	3	40	60	100	3
	BTC 106	Plant Biotechnology	3	3	40	60	100	3
	BTP 105	Genetic Engineering Practical	3	3	25	25	50	2
	BTP 106	Plant Biotechnology Practical	3	3	25	25	50	2
Vocational			3	3	40	60	100	3

SEMESTER - VI								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 107	Immunology and Medical Biotechnology	3	3	40	60	100	3
	BTC 108	Bioprocess Technology	3	3	40	60	100	3
	BTP 107	Immunology and Medical Biotechnology Practical	3	3	25	25	50	2
	BTP 108	Bioprocess Technology Practical	3	3	25	25	50	2
Vocational			3	3	40	60	100	3
Internship								2

SEMESTER - VII								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 109	Environmental Biotechnology	3	3	40	60	100	3
	BTC 110	Enzyme Biotechnology	3	3	40	60	100	3
	BTC 111	Food Biotechnology	3	3	40	60	100	3
	BTP 109	Environmental Biotechnology Practical	3	3	25	25	50	2
	BTP 110	Enzyme Biotechnology Practical	3	3	25	25	50	2
Discipline Elective (E) Courses			3	3	40	60	100	3
			3	3	40	60	100	3
Research Methodology			3	3	40	60	100	3

SEMESTER - VIII								
Group	Course Code	Title of Courses	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA*	Exam	Total	
Discipline Core (DSC) Courses	BTC 112	Animal Biotechnology	3	3	40	60	100	3
	BTC 113	Genomics and Proteomics	3	3	40	60	100	3
	BTC 114	Biosafety, bioethics and IPR	3	3	40	60	100	3
Discipline Elective (E) Courses			3	3	40	60	100	3
			3	3	40	60	100	3
Research Project			3		40**	60	100	6
							Credits	111

Pedagogy for student engagement is predominantly lectures. However, other pedagogies that enhance better student engagement may be adopted for each course. The list includes active/ experiential learning /course projects/ problem or project-based learning (PBL)/ case studies/ self-study like seminar, term paper or MOOC/ field visits / industrial visits / group activity / simulations / hackathons etc.

Assessment: Every course needs to include assessment for higher order thinking skills (applying/ analyzing/evaluating/creating). These shall necessarily be reflected also in the Question Papers, such that questions of all levels of difficulty are framed. Alternate assessment methods that help formative assessment (i.e. assessment for learning) may also be adopted.

*Based on internal test or tests

**Continuous assessment during project

Syllabus for B.Sc. (Basic / Hons.) Biotechnology
Discipline Core Courses

SEMESTER – I

BTC 101 CELL BIOLOGY AND GENETICS 56 hours

Course Outcomes:
After successful completion of this Course, students will be able to:
CO 1. Understand concepts of Biotechnology and demonstrate knowledge acquired in interdisciplinary skills in cell biology, genetics, biochemistry, microbiology, and molecular biology
CO 2. Describe the ultrastructure of cells, structure and function of organelles, cytosol and cytoskeleton
CO 3. Understand phases of cell cycle, cell division, reductional division in gametes, molecular mechanisms that regulate life and death of a cell including programmed cell death or apoptosis and differentiation in plants
CO 4. Comprehend organization and structure of chromosomes, banding techniques and Mendelian laws of inheritance, deviations and exceptions to these laws.
CO 5. Describe mutations at the molecular level, types of mutations, genetic or hereditary disorders and concepts in population genetics

Unit I (14 hours)
Cell as a basic unit of living systems and cellular organelles: Concept, Development and Scope of Biotechnology. Historical perspectives. Discovery of cell, the cell Theory, Ultra structure of a eukaryotic cell- (Both plant and animal cells), Surface Architecture: Structural organization and functions of plasma membrane and cell wall of eukaryotes. Cellular Organelles: Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin). Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments).

Unit II (14 hours)
Chromosomes and cell division: General Introduction, Discovery, Morphology and structural organization – Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype. Single-stranded and multistranded hypothesis, folded- fibre and nucleosome models. Special type of chromosomes: Salivary gland and Lamp brush chromosomes.
Cell Division: Cell cycle, phases cell division. Mitosis and meiosis, regulation of cell cycles cell cycle checkpoints, and enzymes involved in regulation, Significance of cell cycle, mitosis and meiosis interphase nucleus, achromatic apparatus, synaptonemal complex Cell Cycle and regulation, mitosis and meiosis. Cell Senescence and programmed cell death.

Unit III (14 hours)
Genetics: History of genetics: Introduction and brief history of genetics. Mendelian theory: Laws of inheritance- dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross. Deviations to Mendelian inheritance, complementary, supplementary and interaction of genes (13:3 ratio), epistasis.
Maternal Inheritance: Plastid inheritance in Mirabilis, Petite characters in yeast and Kappa particles in paramecium, Sex-linked inheritance, Chromosome theory of inheritance.
Gene interaction: Supplementary factors: comb pattern in fowls, Complementary genes-

Flower colour in sweet peas, Multiple factors–Skin colour in human beings, Epistasis– Plumage colour in poultry, Multiple allelism: Blood groups in Human beings.

Unit IV **(14 hours)**

Linkage and crossing over: Introduction, Coupling and repulsion hypothesis, Linkage in maize and Drosophila, Mechanism of crossing over and its importance, chromosome mapping-linkage map in maize.

Mutations: Types of mutations, Spontaneous and induced, Mutagens: Physical and chemical, Mutation at the molecular level, Mutations in plants, animals and microbes for economic benefit of man.

Chromosomal variations: A general account of structural and numerical aberrations, chromosomal evolution of wheat and cotton.

Sex Determination in Plants and animals: Concept of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types.

Human Genetics: An overview of human genetics, karyotype in human, inherited disorders – Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down's syndrome and Cri-Du-Chat Syndrome).

Pedagogical Note:

The general pedagogy to be followed for theory and practical are as follows: Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching, Field/Institution/Industrial visits, Hands-on training, Case observations, Models/charts preparations, Problem solving mechanisms, Demonstrations, Project presentations, Experiential documentation, and Innovative methods, Active learning as per LSSSDC (NSDC) LFS/Q0509 (Lab Technician/Assistant-Life Sciences) guidelines, at skill training Level 3, Case studies.

BTC 101 CELL BIOLOGY AND GENETICS PRACTICAL

- Study and maintenance of simple and compound microscope
- Use of Micrometer and calibration, measurement of onion epidermal cells and yeast
- Study of divisional stages in mitosis from onion root tips
- Study of divisional stages in meiosis in grasshopper testes/onion or Rheo flower buds.
- Mounting of polytene chromosomes
- Buccal smear – Barr bodies
- Karyotype analysis – Human and Onion Human – Normal and Abnormal – Down and Turner's syndromes
- Isolation and staining of Mitochondria
- Isolation and staining of Chloroplast
- RBC cell count by Haemocytometer
- Simple genetic problems based on theory

Each student is required to submit 5 permanent slides of mitosis & meiosis

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- Lewin B., *Genes III*, Wiley & Sons Publications
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- Sinnott, L.C. Dunn, Dobzhansky, *Principles of Genetics*, McGraw-Hill.
- Smith C., *Molecular Biology*, Faber & Faber Publications
- Strickberger M.W., *Genetics*, Macmillan Publishers, New York
- Taylor DJ. Green NPO and Stout GW. 1998. *Biological Science* 3rd Ed., Cambridge University Press, UK.
- White MJD. Animal cytology and evolution, Cambridge University Publications
- Willson & Marrison, *Cytology*, Reinform Publications

SEMESTER – II

BTC 102 MICROBIOLOGICAL METHODS 56 hours

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Apply the principles of microscopy to study microorganisms
CO 2. Use analytical techniques for work using microorganisms
CO 3. Comprehend the importance and methods of sterilization in microbiological work
CO 4. Analyse the different types of media, culture methods and staining techniques for isolation, characterization of microbes
CO 5. Classify the types and applications of antimicrobial agents and how to perform anti-microbial assays

Unit I (14 hours)

Microscopy: Principles of Microscopy- resolving power, numerical aperture, working principle and applications of Compound microscope, Dark field microscope, Phase contrast microscope, Fluorescence Microscope, confocal microscope, Electron Microscopes- TEM and SEM.

Analytical techniques: Working principles and applications: Centrifuge, Ultracentrifuge, Spectrophotometer, Chromatography: Paper and TLC

Unit II (14 hours)

Sterilization techniques: Definition of terms-sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic agent and antimicrobial agent. Physical methods of control: Principle, construction and applications of moist heat sterilization Boiling, Pasteurization, Fractional sterilization-Tyndallization and autoclave. Dry heat sterilization-Incineration and hot air oven. Filtration – Diatomaceous earth filter, seitz filter, membrane filter and HEPA; Radiation: Ionizing radiation-γ rays and non-ionizing radiation-UV rays Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents.

Unit III (14 hours)

Culture Media: Components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media

Pure culture methods: Serial dilution and plating methods (pour, spread, streak); cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria

Stains and staining techniques: Principles of staining, Types of stains-simple stains, structural stains and differential stains.

Unit IV (14 hours)

Antimicrobial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1 Antibiotic sensitivity testing methods: Disc and Agar well diffusion techniques

BTC 201 MICROBIOLOGICAL METHODS

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Handle and use instruments used in Microbiology and Biotechnology laboratories
CO 2. Use analytical techniques for work using microorganisms
CO 3. Experiment with various methods of sterilization in microbiological work
CO 4. Prepare different types of media, perform culture methods and staining techniques for isolation, characterization of microbes
CO 5. Handle and use antimicrobial agents and perform anti-microbial assays
CO 6. Demonstrate the Laboratory skills in basic and applied microbiology with reference to technological aspects.
CO 7. Demonstrate knowledge and application of good laboratory and good manufacturing practices in biotech industries

- 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 and Biotechnology laboratory.
- Sterilization techniques – dry heat sterilization with hot air over, wet heat sterilization with autoclave, membrane filtration and assessment for sterility
- Preparation of culture media for bacteria, fungi and their cultivation.
- Plating techniques:
- Enumeration techniques – direct microscopic, serial dilution and standard plate count technique (Spread plate, pour plate) and study of colony characters of isolated microbes
- Purification of bacterial and fungal cultures using streak plate technique/mycelial bit transfer
- Isolation of bacteria and fungi from soil, water and air
- Culture preservation techniques – slant and stab culture
- Study of Rhizopus, Penicillium, Aspergillus using temporary mounts
- Study of colony characteristics bacteria from air exposure plate
- Staining techniques: Bacteria– Gram, Negative, Capsule, Endospore staining. Fungi – Lactophenol, cotton blue staining
- Water analysis – MPN test
- Biochemical Tests – IMViC, Starch hydrolysis, Catalase test, Gelatin hydrolysis
- Bacterial cell motility – hanging drop technique
- Antibiotic sensitivity test

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Open Elective Courses
SEMESTER – I

BTC 301 BIOTECHNOLOGY FOR HUMAN WELFARE 42 hours

Course Outcomes:
After successful completion of this Course, students will be able to:
CO 1. Understand the biotechnological applications in the industry
CO 2. Appreciate application of biotechnology in environmental management
CO 3. Describe application of biotechnology to forensic science
CO 4. Comprehend contributions of biotechnology to biomedical fields, such as diagnostics, genomics and therapeutics

Unit I (14 hours)
Environment: Application of biotechnology in environmental aspects: Degradation organic pollutants – chlorinated and non-chlorinated compounds; degradation of hydrocarbons and agricultural wastes, PHB –production and its futuristic applications.

Unit II (14 hours)
Industry: Application of biotechnology in industry: Industrial production of alcoholic beverages (wine), antibiotics (Penicillin), enzymes (lipase). Applications in food, detergent and pharmaceutical industry.

Unit III (14 hours)
Forensic science: Application of biotechnology in forensic science: Solving crimes of murder and rape; solving claims of paternity and theft by using DNA finger printing techniques
Health: Application of biotechnology in health: Genetically engineered insulin, recombinant vaccines, gene therapy, molecular diagnostics using ELISA, PCR; monoclonal antibodies and their use in cancer; human genome project.

References:

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Open Elective Courses
SEMESTER – II

BTC 302 APPLICATIONS OF BIOTECHNOLOGY IN AGRICULTURE

42 hours

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Understand the biotechnological applications in agriculture
CO 2. Understand the importance of biotechnological methods such as plant tissue culture
CO 3. Comprehend the pros and cons of GM crops and their plant products
CO 4. Appreciate the biotechnological applications for effective pest control and crop improvements

Unit I **(14 hours)**

Agricultural Biotechnology: Concepts and scope of biotechnology in Agriculture. Plant tissue culture, micro propagation, entrepreneurship in commercial plant tissue culture. Banana tissue culture – primary and secondary commercial setups, Small scale bioenterprises: Mushroom cultivation

Unit II **(14 hours)**

Transgenic plants: The GM crop debate – safety, ethics, perception and acceptance of GM crops GM crops case study: Bt cotton, Bt brinjal. Plants as biofactories for molecular pharming; edible vaccines, plantibodies, nutraceuticals.

Unit III **(14 hours)**

BT based pesticides: Baculovirus pesticides, Mycopesticides, Post-harvest Protection: Antisense RNA technology for extending shelf life of fruits and shelf life of flowers. Genetic engineering for quality improvement: Seed storage proteins, Flavours– capsaicin, vanillin

References:

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Skill Enhancement Course
SEMESTER – I

BTC 701: BIOTECHNOLOGICAL SKILLS AND ANALYTICAL TECHNIQUES
14 hours

Course Outcomes:
After successful completion of this Course, students will demonstrate the:
CO 1. Skill enhancement as per National Occupational Standards (NOS) of "Lab Technician/ Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council – LFS/Q0509, Level 3.
CO 2. Knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety (EHS), good laboratory practices (GLP), standard operating procedures (SOP) and GMP as per the industry standards.
CO 3. Soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking, and documentation.

1. **Insights into biotechnology industry**: Biotechnology Industry in Indian and Global context – organization in context of large /medium/ small enterprises, their structure and benefits.
2. **Industry professional skills to be acquired**: Planning and rganizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, risk assessment.
3. **Interpersonal skills:** Writing skills, reading skills, oral communication, conflict-resolution techniques, interpretation of research data, trouble shooting in work place
4. **Digital skills:** Basic Computer Skills (MS Office, Excel, Power point, Internet) for Workplace. Professional Email drafting skills and Powerpoint presentation skills

Analytical Skills in laboratory:
Solutions: Molarity, Molality, Normality, Mass percent % (w/w), Percent by volume (% v/v), parts per million (ppm), parts per billion (ppb), Dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottle label reading and precautions

1. **Methods and practices of cleaning and management of lab**: Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirements for cleaning specific area, equipment, ventilation area, personal protective requirements
2. **Procedure of cleaning and storage of Labware:**
Methodology for storage area, Cleaning procedure and materials to be used for various surfaces. Sign boards, labelling do's & don'ts
Knowledge about standard procedures of cleaning or glass ware, plastic ware. Maintenance of inventory
3. **Principles and practices of lab safety:**
Knowledge about safety symbols and hazard signs. Personal safety gears, utility, and disposal. Equipment safety protocols, chemical safety protocols. Documentation of chemical and equipment usage records. Handling hazardous chemicals.
4. **Best practices of usage and storage of chemicals**:
Knowledge and practice in handling of chemicals, labelling and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labelling, storage, and disposal.
5. **Record maintenance as per SOP's**
Labelling of samples and reagents as per SOP's. Recording detail of work done for research experiments. Importance of study of manuals, health, and safety instructions.

6. **Usage and maintenance of basic equipment of biotechnology lab**: Principles, calibrations, and SOPs of weighing balances, pH meters, autoclaves, laminar flows and biosafety cabinets, basic microscopes, homogenizers, stirrers, colorimeters, UV, and Visible spectrophotometers.
7. **Preparation of solutions and standards**: Properties and uses of chemicals commonly used in life sciences laboratories. Maintaining safety standards for handling various solutions and chemicals. Preparation of test reagents and buffers, Protocols for proper mixing of chemicals. Safety precautions while preparation and storage of incompatible chemicals and reagents.
8. **Preparation of media:** Maintenance and storage of purified water for media (Plant Tissue culture media, Microbiological media, and Animal cell culture media) preparation. Preparation and storage of concentrated stock solutions. Documentation and disposal of expired stocks. Collection of indents of media requirement, preparation, and storage. Media coding, documentation, and purpose of usage.
9. **Practical methods for decontamination and disposal**: Decontamination methods, Safe disposal practices of decontaminated media or materials.
10. **Laboratory record writing**: Method of record writing, data collection and recording, reporting of result, discussion of result, summary writing, effective powerpoint presentation taking any experiment as example
11. Industry visit or Analytical laboratory visit

Pattern for question setting (Theory- Discipline Core Courses)

Unit 1	Marks	Total Marks
Short answer question	4	
Critical notes question	4	
Essay type question	7	15

OR

Short answer question	4	
Critical notes question	4	
Essay type question	7	15

Unit 2	Marks	Total Marks
Short answer question	4	
Critical notes question	4	
Essay type question	7	15

OR

Short answer question	4	
Critical notes question	4	
Essay type question	7	15

Unit 3	Marks	Total Marks
Short answer question	4	
Critical notes question	4	
Essay type question	7	15

OR

Short answer question	4	
Critical notes question	4	
Essay type question	7	15

Unit 4	Marks	Total Marks
Short answer question	4	
Critical notes question	4	
Essay type question	7	15

OR

Short answer question	4	
Critical notes question	4	
Essay type question	7	15

Short answer questions shall be based on basic conceptual understanding etc.
Critical notes questions shall be based on deeper understanding, analytical, problem solving skills etc.
Essay type questions shall be on critical thinking, higher order thinking skills etc.

Model Question paper (Discipline Core Course)

CBCS ___ Semester B.Sc. Examination

BIOTECHNOLOGY
Course code – Title

Time: 3 Hours Max. Marks: 60

Note: A single answer booklet containing 40 pages will be issued and no additional sheets will be issues
Instruction: Draw labelled diagrams wherever necessary

Write any four full questions choosing one from each unit:

Unit 1

1.	a)		4
	b)		4
	c)		7
		OR	
2.	a)		3
	b)		5
	c)		7
	Unit 2		
3.	a)		4
	b)		4
	c)	OR	7
4.	a)		3
	b)		5
	c)		7
	Unit 3		
5.	a)		4
	b)		4
	c)		7
		OR	
6.	a)		3
	b)		5
	c)		7
	Unit 4		
7.	a)		4
	b)		4
	c)		7
		OR	
8.	a)		3
	b)		5
	c)		7