SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS)
UJIRE – 574 240
DAKSHINA KANNADA, KARNATAKA STATE
(Re-Accredited by NAAC at 'A++' Grade)
Ph: 08256-236221, 236101(O), Fax: 236220
e-Mail:sdmcollege@rediffmail.com, sdmcollege@sdmcujire.in, Website: www.sdmcujire.in

DEPARTMENT OF BIOTECHNOLOGY

Syllabus of

Bachelor's Degree in

Science (BIOTECHNOLOGY)

CHOICE BASED CREDIT SYSTEM

SEMESTER SCHEME

UNDER NEW EDUCATION POLICY 2020

2021-22 ONWARDS

BOS meeting held on 18-08-2023

Academic Council meeting, held on 02-09-2023

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 the domain as well as personalities 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 entries and exit points enabling horizontal and vertical mobility. The Mangalore University implemented the same from the academic year 2021-22. The SDM College being an Autonomous Institute under Mangalore University, as per the regulation Department of Biotechnology is implementing the first year Major/Core syllabus& course structure with minor changes suggested & approved by the Board of Studies.

Salient features are as follows:

1. Discipline Core Course (DCC) or Domain-specific Core Courses in Biotechnology as Major.
2. Discipline Electives Course (DEC) or Domain-specific Elective Courses in the Core Subject.
3. Discipline Open Electives (DOE) are Elective Courses offered to students from non-core Subjects across disciplines.
4. Skill Enhancement Courses (SEC) that are domain-specific or generic.
5. **ONE** hour of Lecture or **TWO** 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. (Honours) 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 concerning applications for human welfare.

PO 6. Apply the knowledge and skills of immunology, bioinformatics, computational modeling 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 concerning food, health, and the 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

Curriculum Structure (Core and Electives) Semesters - I to VI

SEM	DSC	Core Papers
Sem-1	A1 (T)	Cell Biology & Genetics
	A2 (P)	Cell Biology & Genetics - Practical
Sem-2	A3 (T)	Microbiological Methods & Techniques
	A4 (P)	Microbiological Methods & Techniques Practical
Sem-3	A5 (T)	Biomolecules
	A6 (P)	Biomolecules Practical
Sem-4	A7 (T)	Molecular Biology
	A8 (P)	Molecular Biology Practical
Sem-5	A9 (T)	Genetic Engineering
	A10 (P)	Genetic Engineering Practical
	A11 (T)	Plant & Animal Biotechnology
	A12 (P)	Plant & Animal Biotechnology Practical
Sem-6	A13 (T)	Immunology
	A14 (P)	Immunology Practical
	A15 (T)	Bioprocess & Environmental Biotechnology
	A16 (P)	Bioprocess & Environmental Biotechnology Practical

Program Structure for BSc (Basic/Honours)

Biotechnology

Semester	Discipline Core Courses (L + T + P =3 + 1 + 2)				Discipline Open Elective				Ability Enhancement Compulsory Courses 4Hr		Skill Enhancement Courses				
	Code	Paper Title	Credit	Hr/W	Code	Paper Title	Credit	Hr/W	Language	Credit		Skill based	Credit	Value-Based	Credit
I	BTCT 101	Cell Biology & Genetics	4	4	BTOE 101	Biotechnology for Human Welfare	3	3	L1	3	BTSC 101	Biotechnological Skills & Analytical Techniques	2	Phy. Ed. Yoga	1
	BTCP 101	Cell Biology & Genetics	2	4					L2	3				Health & Wellness	1
		DCC B	6												
II	BTCT 151	Microbiological Methods & Techniques	4	4	BTOE 102	Application of Biotechnology in Agriculture	3	3	L1	3				Phy. Ed. Sports	1
	BTCP 151	Microbiological Methods & Techniques	2	4					L2	3				NCC/NSS/ R&R (S&G)/ Cultural	1

		DCC B							EVS	2					
III	BTCT 201	Biomolecules	4	4	BTOE 201	Nutrition and Health			L1	3	BTSC 202		2	Phy. Ed. Sports	1
	BTCP 201	Biomolecules	2	4					L2	3				NCC/NSS/ R&R (S&G)/ Cultural	1
IV	BTCT 251	Molecular Biology	4	4	BTOE 251	Intellectual Property Rights			L1	3				Phy. Ed. Sports	1
	BTCP 251	Molecular Biology	2	4					L2	3				NCC/NSS/ R&R (S&G)/ Cultural	1
V	BTCT 301	Genetic Engineering	4	4							BTST 301	Biotechnology Skills and Analytical Techniques	2		
	BTCT 302	Plant and Animal Biotechnology	4								BTSP 301	Quality Control Methods in Biology	1		
	BTCP 301	Genetic Engineering	2												
	BTCP 302	Plant & Animal Biotechnology	2												

VI	BTCT 351	Immunology	4		BTIP 351	Internship	2								
	BTCT 352	Bioprocess and Environmental Biotechnology	4												
	BTCP 351	Immunology	2												
	BTCP 352	Bioprocess and Environmental Biotechnology	2												

Sri Dharmasthala Manjunatheshwara College (Autonomous), Ujire – 574240

Scheme & Syllabus for B.Sc. (Basic) Biotechnology

Group	Code	Title	Instructional Hours	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
		FIRST						
DCC	BTCT 101	Cell Biology & Genetics	4	2	40	60	100	4
DCC	BTCP 101	Cell Biology & Genetics Practical	4	4	25	25	50	2
DOE	BTOE 101	Biotechnology for Human Welfare	3	2	40	60	100	3
SB	BTSB 101	Biotechnological Skills & Analytical Techniques	3	2	40	60	100	3
		SECOND						
DCC	BTCT 151	Microbiological Methods & Techniques	4	2	40	60	100	4
DCC	BTCP 151	Microbiological Methods & Techniques Practical	3	4	25	25	50	2
DOE	BTOE 151	Application of Biotechnology in Agriculture	3	2	40	60	100	3
		THIRD						
DCC	BTCT 201	Biomolecules	4	2	40	60	100	4
DCC	BTCP 201	Biomolecules Practical	3	4	25	25	50	2
DOE	BTOE 201	Nutrition and Health	3	2	40	60	100	3
		FOURTH						
DCC	BTCT 251	Molecular Biology	4	2	40	60	100	4
DCC	BTCP 251	Molecular Biology Practical	3	4	25	25	50	2
DOE	BTOE 251	Intellectual Property Rights	3	2	40	60	100	3

Group	Code	Title	Instructional Hours	Duration of Exam (Hrs)	Marks			Credits
					IA	Exam	Total	
		FIFTH						
DCC	BTCT 301	Genetic Engineering	4	2	40	60	100	4
DCC	BTCP 301	Genetic Engineering Practical	4	4	25	25	50	2
DCC	BTCT 302	Plant & Animal Biotechnology	4	2	40	60	100	4
DCC	BTCP 302	Plant & Animal Biotechnology Practical	4	4	25	25	50	2
SCC	BTST 301	Biotechnology Skills and Analytical Techniques	2	2	20	30	50	2
SCC	BTSP 301	Quality Control Methods in Biology	2	2	25	-	25	1
		SIXTH						
DCC	BTCT 351	Immunology	4	2	40	60	100	4
DCC	BTCP 351	Immunology Practical	4	4	25	25	50	2
DCC	BTCT 352	Bioprocess & Environment Biotechnology	4	2	40	60	100	4
DCC	BTCP 352	Bioprocess & Environment Biotechnology Practical	4	4	25	25	50	2
DEP	BTIP 351	Internship	90 h	-	25	25	50	2

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 seminars, term papers or MOOCs/ field visits / industrial visits/group activity/simulations/hackathons, etc.

Assessment: Every course needs to include an 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 tests or tests, **Continuous assessment during the project.

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

DISCIPLINE CORE COURSES

SEMESTER – I

CELL BIOLOGY AND GENETICS

DCC A1 (T) **BTCT 101** **4 Credits** **60 hours**

Course Outcomes:

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

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

CO 2. Describe the ultrastructure of cells, structure & function of organelles, cytosol & cytoskeleton

CO 3. Understand phases of the cell cycle, cell division, reductional division in gametes, molecular mechanisms that regulate the life and death of a cell including programmed cell death or apoptosis, and differentiation in plants

CO 4. Comprehend the 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 **(15 hours)**

Cell as a basic unit of living systems and cellular organelles: Concept, Development & Scope of Biotechnology. Historical perspectives. Discovery of a cell, the cell Theory, and Ultrastructure of a eukaryotic cell- (Both plant and animal cells).

Surface Architecture: Structural organization & functions of the plasma membrane; 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 **(15 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 & multistranded hypothesis, folded-fiber, and nucleosome models.

The special type of chromosomes: Salivary gland and Lamp brush chromosomes.

Cell Division: Cell cycle, phases of cell division. Mitosis and meiosis, regulation of cell cycles, cell cycle checkpoints, and enzymes involved in regulation. Significance of cell cycle, achromatic apparatus, synaptonemal complex Cell Cycle. Cell Senescence and programmed cell death.

Unit III **(15 hours)**

Genetics: Introduction and a brief history of genetics.

Mendelian theory: Laws of inheritance - dominance, Law of segregation, Law of independent assortment, test cross, and back cross.

Deviations to Mendelian inheritance: incomplete dominance, codominance with an example.

Gene interaction: factors: comb pattern in fowls. Complementary genes: Flower color in sweet peas. Multiple factors–Skin color in human beings, Epistasis – Plumage color in poultry, Multiple allelism: Blood groups in Human beings.

Maternal Inheritance: Plastid inheritance in *Mirabilis*, Petite characters in yeast, and Kappa particles in Paramecium. Sex-linked inheritance, Chromosome theory of inheritance.

Unit IV **(15 hours)**

Linkage, Crossing over and Chromosome Mapping: Introduction, Coupling & repulsion hypothesis, Linkage in maize, and Drosophila. Mechanism of crossing over and its importance. Crossing over - Measure of genetic distance, Two-point & Three-point Test Cross for developing chromosome mapping-linkage map.

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

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Acquire knowledge about types of biomolecules, their structure, and their functions	√				√							√
Will be able to demonstrate the skills to perform bioanalytical techniques			√								√	√
Apply comprehensive innovations and skills of biomolecules to the biotechnology field	√				√							√

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10

Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

CELL BIOLOGY AND GENETICS PRACTICAL

DCC- A2 (P) BTCP 101 2 Credits

1. Study and maintenance of simple and compound microscope
2. Use of Micrometer and calibration, measurement of onion epidermal cells and yeast
3. Study of divisional stages in mitosis from onion root tips
4. Study of divisional stages in meiosis in grasshopper testes/onion or Rheo flower buds.
5. Mounting of polytene chromosomes
6. Buccal smear – Barr bodies
7. Karyotype analysis – Human (Human – Normal & Abnormal – Down & Turner's syndromes).
8. Isolation and staining of Mitochondria
9. Isolation and staining of Chloroplast
10. RBC cell count by Haemocytometer
11. Simple genetic problems based on the theory

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

Practical assessment

<table>
<tr><th colspan="4">Assessment</th></tr>
<tr><th colspan="2">Formative assessment</th><th>Summative Assessment</th><th rowspan="2">Total Marks</th></tr>
<tr><th>Assessment Occasion/type</th><th>Weightage in Marks</th><th>Practical Exam</th></tr>
<tr><td>Record</td><td>5</td><td rowspan="4">25</td><td rowspan="5">50</td></tr>
<tr><td>Test</td><td>10</td></tr>
<tr><td>Attendance</td><td>5</td></tr>
<tr><td>Performance</td><td>5</td></tr>
<tr><td>TOTAL</td><td>25</td><td>25</td></tr>
</table>

References

1. Alberts B et al. (2002) Molecular biology of the cell, Garland Publications
2. Burke, J D, (1970) Cell Biology, William and Wilkins
3. Clark, CA. (1970) Human Genetics and Medicine, Edward Arnold, London
4. Dale JW. (1990) Molecular genetics of bacteria. John Wiley and Sons.
5. Darnell J. Lodish H, Baltimore D, (1990) Molecular Cell Biology, Scientific American Books
6. De Robertis EDP & Robertis EMF (1980) Cell Biology & Molecular Biology, Saunders College.
7. De Robertis EDP and De Robertis EMF. (1995) Cell and Molecular Biology. 8th E., BI Waverly Pvt. Ltd., New Delhi.
8. Altenburg E. (1970) Genetics, Oxford & IBH publications
9. Gardner E.J., Simmons M.J. and Snustad D.P. (2003) Principles of Genetics, 8th Ed., John Wiley & Son Publications
10. Gupta ML. and ML. Jangir. (2002) Cell Biology-Fundamentals and Applications. Argosies, Jodhpur, India.
11. Gupta, P.K. (2019) Genetics, 5th Ed., Rastogi Publication, Meerut, India
12. Hartl D.L. (1991) Basic Genetics, Jones & Barlett Publishers USA
13. Lewin B. 1994. Genes VII 5th Ed., Oxford University Press, London
14. Lewin B., Genes I, Wiley Eastern Ltd., Delhi
15. Lewin B., Genes II, Wiley & Sons Publications
16. Lewin B., Genes III, Wiley & Sons Publications
17. Lewin B., Genes V, Oxford University Press
18. Old & Primrose, Principles of Gene Manipulations, Black Well Scientific Publications
19. Powar C.B. Cell Biology, Himalaya Publications
20. Powar C.B. Cell Biology 3rd edition. Himalaya Publishing House, Mumbai.
21. Setty R.S. and V. Sreekrishna 2002 Biotechnology -2 (Cell Biology, Genetics, Microbiology). New Age International Publishers, New Delhi.
22. Sharp L.W., Fundamentals of Cytology, McGraw Hill Company
23. Sinnott, L.C. Dunn, Dobzhansky, Principles of Genetics, McGraw-Hill.
24. Smith C., Molecular Biology, Faber & Faber Publications

25. Strickberger M.W., Genetics, Macmillan Publishers, New York
26. Taylor DJ. Green NPO and Stout GW. 1998. Biological Science 3rd Ed., Cambridge University Press, UK.
27. White MJD. Animal cytology and evolution, Cambridge University Publications
28. Willson & Marrison, Cytology, Reinform Publications

OPEN ELECTIVE COURSES SEMESTER – I

BIOTECHNOLOGY FOR HUMAN WELFARE

DOE-A1(T) **BTOE 101** **3 Credits** **45 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 the application of biotechnology in environmental management

CO 3. Describe the application of biotechnology to forensic science

CO 4. Comprehend contributions of biotechnology to biomedical fields, such as diagnostics, genomics, and therapeutics

Unit I **(15 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 **(15 hours)**

INDUSTRY: Application of biotechnology in the industry: Industrial production of alcoholic beverages (wine), antibiotics (Penicillin), and enzymes (lipase). Applications in food, detergent, and pharmaceutical industry.

Unit III **(15 hours)**

FORENSIC SCIENCE: Application of biotechnology in forensic science: Solving crimes of murder and rape; solving claims of paternity and theft by using DNA fingerprinting 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.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

REFERENCES:

1. Bhasin M.K. and Nath, S. (2002). Role of Forensic Science in the New Millennium, University of Delhi, Delhi
2. Crueger W. and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Ed., Panama Publishing Co. New Delhi.
3. Eckert W.G. (1997) Introduction to Forensic Sciences, 2nd Ed., CRC Press, Boca Raton
4. James S.H. and Nordby, J.J. (2005). Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton
5. Joerdening H.-J. and Winter J. (2005). Environmental Biotechnology – Concepts and Applications,
6. Mohapatra, P.K. (2006) Textbook of Environmental Biotechnology, I.K. International Publishing House Pvt. Ltd., New Delhi
7. Nanda B.B. and Tiwari R.K. (2001). Forensic Science in India: A Vision for the Twenty- First Century, Select Publishers, New Delhi
8. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
9. Stanbury P.F, Whitaker A and Hall S.J. (2006). Principles of Fermentation Technology. 2nd Ed., Elsevier Science Ltd.

SEMESTER – II MICROBIOLOGICAL METHODS AND TECHNIQUES

DCC-A3(T) BTCT 151 4 Credits 60 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. Analyze 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 **(15 hours)**

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

Analytical techniques: Working principles & applications: Centrifuge, Ultracentrifuge, Spectrophotometer, Chromatography (Paper and Thin Layer Chromatography (TLC)).

Unit II **(15 hours)**

Sterilization techniques: Definition of terms - sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic agents, and antimicrobial agents.

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 **(15 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 **(15 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,

Antibiotic resistance: MDR, XDR, MRSA, NDM-1.

Antiviral agent: Mechanism of action of Acyclovir, Azidothymidine, Amantadine

Antibiotic sensitivity testing methods: Diffusion methods, Dilution methods, and Diffusion & Dilution methods.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Acquire knowledge about microscopy, microbial techniques, and culturing of Microorganisms	√				√							√
Will be able to demonstrate the skills to perform staining techniques			√									√
Apply comprehensive innovations and skills of microbial techniques in the biotechnology field	√				√							√

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

MICROBIOLOGICAL METHODS AND TECHNOLOGY

PRACTICALS DCC-A4(P) BTCP 151 2 Credits

1. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology and Biotechnology laboratory.
2. Sterilization techniques – dry heat sterilization with hot air over, wet heat sterilization with autoclave, membrane filtration, and assessment for sterility.
3. Preparation of culture media for bacteria, fungi, and their cultivation.
4. Plating techniques:
5. Enumeration techniques – direct microscopic, serial dilution, and standard plate count technique (Spread plate, pour plate) and study of colony characters of isolated microbes.
6. Purification of bacterial and fungal cultures using streak plate technique/mycelial bit transfer.
7. Isolation of bacteria and fungi from soil, water, and air
8. Culture preservation techniques – slant and stab culture.
9. Study of *Rhizopus, Penicillium,* and *Aspergillus* using temporary mounts.
10. Study of colony characteristics bacteria from air exposure plate
11. Staining techniques: Bacteria– Gram, Negative, Capsule, Endospore staining. Fungi – Lactophenol, cotton blue staining.
12. Water analysis – MPN test.
13. Biochemical Tests – IMViC, Starch hydrolysis, Catalase test, Gelatin hydrolysis
14. Bacterial cell motility – hanging drop technique
15. Antibiotic sensitivity test

Practical assessment

<table>
<tr><th colspan="4">Assessment</th></tr>
<tr><th colspan="2">Formative assessment</th><th>Summative Assessment</th><th rowspan="2">Total Marks</th></tr>
<tr><th>Assessment Occasion/type</th><th>Weightage in Marks</th><th>Practical Exam</th></tr>
<tr><td>Record</td><td>5</td><td rowspan="4">25</td><td rowspan="4">50</td></tr>
<tr><td>Test</td><td>10</td></tr>
<tr><td>Attendance</td><td>5</td></tr>
<tr><td>Performance</td><td>5</td></tr>
</table>

TOTAL	**25**	**25**	

REFERENCES

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. Wm C Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th Ed., Prentice Hall
3. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Micro-organisms. 14th Ed., Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology, 5th Ed., Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th Ed., McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th Ed., Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology, 9th Ed., McGraw Hill Higher Education.
10. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual, 9th Ed., Pearson Education Limited
11. Ketchum, P. A. (1984) Microbiology- Concepts and applications, Wiley Publications
12. Frobisher M. (1957) Fundamentals of Microbiology, 6th Ed., W.B. Saunders Toppan Publications
13. Singh, R.B (1990) Introductory Biotechnology, C.B.D. India
14. Salle AJ (2007) Fundamentals of Bacteriology, Dodo Press, USA
15. Bison P.S., (1994) Frontiers in Microbial technology, CBS Publishers.
16. Bull AT, Holt G, Lilly MD. Biotechnology, International Trends, and Perspectives, OECD
17. Powar C.B. (2010) General Microbiology, Himalaya Publishing Co.

OPEN ELECTIVE COURSES SEMESTER – II

APPLICATIONS OF BIOTECHNOLOGY IN AGRICULTURE

DOE-2T BTOE 151 3 Credits 45 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 (15 hours)

Agricultural Biotechnology: Concepts and scope of biotechnology in Agriculture. Plant tissue culture, micropropagation, entrepreneurship in commercial plant tissue culture. Banana Tissue Culture – primary and secondary commercial setups, Small scale bio-enterprises: Mushroom cultivation

Unit II (15 hours)

Transgenic plants: The Genetically Modified (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 (15 hours)

Biotechnology-Based Biopesticides: Baculovirus pesticides, Mycopesticides.

Post-harvest Protection: Antisense RNA technology for extending the shelf life of fruits and the shelf life of flowers.

Genetic Engineering for quality improvement: Seed storage proteins, Flavours– capsaicin, vanillin

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

REFERENCES:

1. Chrispeels M.J. and Sadava D.E. (1994) Plants, Genes and Crop Biotechnology, 2nd Ed., Jones and Bartlett Publishers, Boston.
2. Gamborg O.L. and Philips G.C. (1998) Plant cell, tissue, and organ culture, 2nd Ed., Narosa Publishing House. New Delhi.
3. Gistou, P. and Klu, H. (2004). Handbook of Plant Biotechnology (Vol. I & II). John Publication.
4. Hammond J., McGarvey P. and Yusibov.V. (2000). Plant Biotechnology, Springer Publ.
5. Heldt. H.-W. (1997). Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
6. Kyte, L., Kleyn, J., Scoggins, H., and Bridgen M. (2003) Plants from test tubes. An introduction to micropropagation, 4th Ed., Timber Press, Portland.
7. Murray D.R. (1996) Advanced methods in plant breeding and biotechnology. Panama Publishing Corporation.
8. Nickoloff, J.A. (1995). Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana Press Incorp, USA.
9. Sawahel, W.A. (1997). Plant genetic transformation technology. Daya Publishing House, Delhi.

3rd and 4th Semester Syllabus for B.Sc. Biotechnology

Preamble

The role of education is paramount in nation-building. One of the major objectives of UGC is the maintenance of standards of higher education. Over the past decades, the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of the Choice Based Credit System (CBCS) which further expects the Learning Outcome-Based curriculum to maximize the benefits of the newly designed curriculum. The Learning Outcome-Based Curriculum in Biotechnology will help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. The commission strives to promote the link of students with the society/industry such that the majority of the students engage in socially productive activities during their period of study in the institutions and at least half of the graduate students will secure access to employment/self- employment or engage themselves in pursuit of higher education. The model curriculum envisages catering to the developmental trends in higher education, incorporating multi-disciplinary skills, professional and soft skills such as teamwork, communication skills, leadership skills, and time management skills, and inculcating human values, professional ethics, and the spirit of Innovation/entrepreneurship and critical thinking among students and promote avenues for the display of these talents, linking general studies with professional courses. Besides imparting disciplinary knowledge to the learners, the curriculum should aim to equip the students with competencies like problem-solving, analytical reasoning, and moral and ethical awareness. Introduction of internship and appropriate fieldwork/case studies are embedded in the curriculum for providing wider exposure to the students and enhancing their employability.

Learning outcomes specify what exactly the graduates are expected to know after completing a program of study. The expected learning outcomes are used as reference points to help formulate graduate attributes, qualification descriptors, program learning outcomes, and course learning outcomes. Keeping the above objectives of higher education in mind the Learning Outcome-Based Curriculum Framework (LOCF) for the discipline of Biotechnology has been prepared and presented here.

Program Outcomes: At the end of the program the student should be able to:

(Refer to the literature on outcome-based education (OBE) for details on Program Outcomes)

PO1. Understanding concepts of Biotechnology and demonstrating interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology, and molecular biology

PO2. Demonstrating Laboratory skills in cell biology, and basic and applied microbiology with an emphasis on technological aspects

PO3. Competent to apply the knowledge and skills gained in Plant biotechnology, animal biotechnology, and microbial technology in the pharma, food, agriculture, beverages, herbal, and nutraceutical industries.

PO4. Critically analyze the environmental issues and apply the biotechnology knowledge gained for conserving the environment and resolving the problems.

PO5. 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 concerning applications for human welfare.

PO6. Apply knowledge and skills in immunology, bioinformatics, computational modelling of proteins, drug design, and simulations to test the models and aid in drug discovery.

PO7. Critically analyse, interpret data, and apply tools of bioinformatics and multi-omics in various sectors of biotechnology including health and Food.

PO8. Demonstrate communication skills, scientific writing, data collection, and interpretation abilities in all the fields of biotechnology.

PO9. Learning and practicing professional skills in handling microbes, animals, and plants and demonstrating the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animal handling, intellectual property rights, biosafety, and biohazards.

PO10. Exploring the biotechnological practices and demonstrating innovative thinking in addressing the current day and future challenges concerning food, health, and the environment.

PO11. Thorough knowledge and application of good laboratory and good manufacturing practices in biotech industries.

PO12. Understanding and application of molecular biology techniques and principles in forensic and clinical biotechnology.

PO13. Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up small-scale enterprises or CROs

Syllabus for B.Sc. (Basic / Hons.)

Biotechnology DISCIPLINE CORE COURSES

SEMESTER – III BIOMOLECULES

DCC-A5(T) BTCT 201 4 Credits 60 hours

Course Outcomes:

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

CO 1. Acquire knowledge about types of biomolecules, their structure, and their functions.

CO 2. Will be able to demonstrate the skills to perform bioanalytical techniques.

CO 3. Apply comprehensive innovations and skills of biomolecules to the biotechnology field.

Unit I (15 hours)

a) Carbohydrates:

Introduction, sources, and classification of carbohydrates. Structure, function, and properties of carbohydrates. Monosaccharides – Isomerism and ring structure, Sugar derivatives – amino sugars and ascorbic acid

Oligosaccharides – Sucrose and Fructose

Polysaccharides – Classification as homo and heteropolysaccharides, Homopolysaccharides

- storage polysaccharides (starch and glycogen- structure, reaction, properties), structural polysaccharides (cellulose and chitin-structure, properties), Heteropolysaccharides - glycoproteins and proteoglycans (Brief study).

b) Amino Acids, Peptides, and Proteins

Introduction, classification, and structure of amino acids. Concept of – Zwitterion, isoelectric point, pK values. Essential and nonessential amino acids. Peptide bond and peptide, classification of proteins based on structure and function, Structural organization of proteins [primary, secondary (α, β), tertiary and quaternary]. Fibrous and globular proteins,

Denaturation and renaturation of proteins

c) Nucleic acids

Structures of purines and pyrimidines, nucleosides.

Unit II **(15 hours)**

a) Lipids

Classification and function of lipids, properties (saponification value, acid value, iodine number, rancidity), Hydrogenation of fats and oils Saturated and unsaturated fatty acids. General structure and biological functions of - phospholipids, sphingolipids, glycolipids, lipoproteins, prostaglandins, cholesterol, ergosterol.

b) Enzymes

Introduction, nomenclature and classification, enzyme kinetics, factors influencing enzyme activity, metalloenzymes, activation energy and transition state, enzyme activity, specific activity. Coenzymes and their functions (one reaction involving FMN, FAD, NAD). Enzyme inhibition- Irreversible and reversible (competitive, non-competitive, and uncompetitive inhibition with an example each) Zymogens (trypsinogen, chymotrypsinogen, and pepsinogen),

Isozymes (LDH, Creatine kinase, Alkaline phosphatase, and their clinical significance).

c) Vitamins

Water and fat-soluble vitamins, dietary source and biological role of vitamins Deficiency manifestation of vitamins A, B, C, D, E, and K.

Unit III **(15 hours)**

a) Hormones

Classification of hormones based on chemical nature and mechanism of action. Chemical structure and functions of the following hormones: Glucagon, Cortisone, Epinephrine, Testosterone, and Estradiol.

b) Metabolism 1:

Metabolism: Glycolysis and gluconeogenesis, Kreb's cycle, oxidative phosphorylation. Beta oxidation of fatty acids. Biosynthesis of cholesterol.

c) Metabolism 2:

General aspects of amino acid metabolism: Transamination, deamination, decarboxylation, and the urea cycle.

Nucleotides in DNA Denovo and salvage pathway of purine and pyrimidine synthesis.

Unit IV **(15 hours)**

a) Chromatography :

Principle, procedure, and applications of adsorption chromatography - HPTLC, ion exchange, gel filtration, and affinity chromatography. Gas-liquid chromatography

and High- performance liquid chromatography

b) Electrophoresis:

Principle, procedure, and applications of electrophoresis (Gel electrophoresis - PAGE - Native & SDS, agarose electrophoresis) and isoelectric focusing.

c) Spectroscopy:

UV-Vis spectrophotometry; mass spectroscopy, atomic absorption spectroscopy IR spectrophotometry. NMR

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Acquire knowledge about types of biomolecules, their structure, and their functions	√				√							√
Will be able to demonstrate the skills to perform bioanalytical techniques			√									√
Apply comprehensive innovations and skills of biomolecules to the biotechnology field	√				√							√

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

BIOMOLECULES PRACTICALS

DCC-A6(P) BTCP 201 2 Credit

Content

1. Introduction to basic instruments (Principle, standard operating procedure) with demonstration.
2. Definitions and calculations: 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, and solution of acids. Reagent bottle label reading and precautions.
3. Preparation of standard buffers by Henderson-Hasselbach equation – Acetate, phosphate, Tris and determination of pH of a solution using pH meter.
4. Estimation of maltose by DNS method
5. Determination of α-amylase activity by DNS method
6. Estimation of proteins by Bradford method
7. Estimation of amino acid by Ninhydrin method
8. Extraction of protein from soaked/sprouted green gram by salting out method
9. Separation of plant pigments by circular paper chromatography
10. Separation of amino acids by thin-layer chromatography
11. Native PAGE
12. Determination of iodine number of lipids

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exam**	
Record	5	**25**	**50**
Test	10		
Attendance	5		
Performance	5		
TOTAL	**25**	**25**	

References	
1	Sri Lakshmi B, (2007), Dietetics. New Age International publishers. New Delhi
2	Sri Lakshmi B, (2002), Nutrition Science. New Age International publishers. New Delhi
3	Swaminathan M. (2002), Advanced textbook on food and Nutrition. Volume I. Bappco
4	Gopalan.C., RamaSastry B.V., and S.C.Balasubramanian (2009), Nutritive value of Indian Foods.NIN.ICMR.Hyderabad.
5	Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi

OPEN ELECTIVE COURSES

SEMESTER – III/IV NUTRITION AND HEALTH

DOE-3T BTOE 201 3 Credits 45 hours

Course Outcomes:

At the end of the course the student should be able to:

CO 1. Study the concepts of food, nutrition, diet, and health.

CO 2. To apply the best practices of food intake and dietary requirements.

CO 3. Acquire knowledge about various sources of nutrients and good cooking practices.

Unit I (15 hours)

Introduction: Concepts of nutrition and health. Definition of Food, Diet and nutrition, Food groups. Food pyramids. Functions of food. Balanced diet. Meal planning. Eat the right concept. Functional foods, Prebiotics, Probiotics, and antioxidants

Unit II (15 hours)

Nutrients: Macro and Micronutrients - Sources, functions, and deficiency. Carbohydrates, Proteins, Fats – Sources, and calories. Minerals –Calcium, Iron, Iodine.

Vitamins – Fat-soluble vitamins –A, D, E & K. Water soluble vitamins – vitamin C Thiamine, Riboflavin, Niacin. Water–Functions and water balance. Fiber –Functions, and sources. Recommended Dietary Allowance, Body Mass Index, and Basal Metabolic Rate.

Unit III (15 hours)

Nutrition and Health: Methods of cooking affecting nutritional value. Advantages and disadvantages of Boiling, steaming, pressure cooking. Oil/Fat – Shallow frying, deep frying. Baking. Nutrition through a lifecycle. Nutritional requirement, dietary guidelines: Adulthood, Pregnancy, Lactation, Infancy-Complementary feeding, Pre-school, Adolescence, geriatric. Nutrition-related metabolic disorders- diabetes and cardiovascular disease.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

REFERENCES:

1. Sri Lakshmi B, (2007), Dietetics. New Age International publishers. New Delhi
2. Sri Lakshmi B, (2002), Nutrition Science. New Age International publishers. New Delhi
3. Swaminathan M. (2002), Advanced textbook on food and Nutrition. Volume I. Bappco
4. Gopalan.C., RamaSastry B.V., and S.C.Balasubramanian (2009), Nutritive value of Indian Foods.NIN. ICMR.Hyderabad.
5. Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi.

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

DISCIPLINE CORE COURSES

SEMESTER – IV MOLECULAR BIOLOGY

DCC-A7(T) BTCT 251 4 Credits 60 hours

Course Outcomes:

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

CO 1. Study the advancements in molecular biology with the latest trends.

CO 2. Will acquire the knowledge of structure, and functional relationship of proteins and nucleic acids.

CO 3. Aware of the basic cellular processes such as transcription, translation, DNA replication, and repair mechanisms.

Unit I **(15 hours)**

Molecular Basis of Life and Nucleic Acids

An introduction RNA and experimental proof of DNA as genetic material and types of DNA. Structure and functions of DNA and RNA, Watson and Crick model of DNA and other forms of DNA (A and Z) function of DNA and RNA including ribozymes.

Unit II **(15 hours)**

DNA Replication and Repair

Replication of DNA in prokaryotes and eukaryotes– Enzymes and proteins involved in replication, Theta model, linear and rolling circle model. Polymerases and all enzyme components.

The replication complex: Pre-primming proteins, primosome, replisome, unique aspects of eukaryotic chromosome replication, Fidelity of replication DNA damage and Repair mechanism: photoreactivation, excision repair, mismatch repair, and SOS repair.

Unit III **(15 hours)**

Transcription and RNA Processing

Central dogma, RNA structure and types of RNA, Transcription in prokaryotes RNA polymerase, the role of sigma factor, promoter, Initiation, elongation, and termination of RNA chains.

Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5’ cap formation,

polyadenylation, splicing, rRNA and tRNA splicing.

Unit IV **(15 hours)**

Regulation of Gene Expression and Translation

Genetic code and its characteristics, Wobble hypothesis Translation- in prokaryotes and eukaryotes- ribosome, enzymes, and factors involved in translation. Mechanism of translation-activation of amino acid, aminoacyl tRNA synthesis, Mechanism- initiation, elongation, and termination of a polypeptide chain. Fidelity of translation, Inhibitors of translation. Protein folding and modifications, Post-translational modifications of proteins.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Study the advancements in molecular biology with the latest trends	√				√							
Will acquire the knowledge of structure, and functional relationship of proteins and nucleic acids					√	√						
Aware of the basic cellular processes such as transcription, translation, DNA replication, and repair mechanisms	√				√				√			

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

MOLECULAR BIOLOGY PRACTICALS

DCC-A8(P) BTCP 251 2 Credit

Content

1. Preparation of DNA model
2. DNA isolation from Bacteria, Plant & Animal tissue
3. Estimation of DNA by DPA method
4. Estimation of RNA by Orcinol method
5. Column chromatography – gel filtration (Demo)
6. Extraction and partial purification of protein from plant source by Ammoniumsulphate precipitation.
7. Extraction and partial purification of protein from animal sources by organic solvents.
8. Protein separation by SDS-Polyacrylamide Gel Electrophoresis (PAGE)
9. Charts on- Conjugation, Transformation and Transduction, DNA replication, and Types of RNA.

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exam**	
Record	5	**25**	**50**
Test	10		
Attendance	5		
Performance	5		
TOTAL	**25**	**25**	

References	
1	Glick, B.R and Pasternak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press
2	Howe. C. (1995) Gene cloning and manipulation, Cambridge University Press, USA
3	Lewin, B., Gene VI New York, Oxford University Press
4	Rigby, P.W.J. (1987) Genetic Engineering Academic Press Inc. Florida, USA
5	Sambrook et al (2000) Molecular cloning Volumes I, II & III, Cold Spring Harbor Laboratory Press New York, USA
6	Walker J. M. and Ging old, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7	Karp. G (2002) Cell & Molecular Biology, 3rdEdition, John Wiley & Sons; I

OPEN ELECTIVE COURSES SEMESTER – IV

INTELLECTUAL PROPERTY RIGHTS

DOE-4T BTOE 251 3 Credits 45 hours

Course Outcomes:

At the end of the course the student should be able to:

CO 1. Knowledge about the need and scope of Intellectual property rights.

CO 2. Acquire knowledge about filing patents, processes, and infringement.

CO 3. Knowledge about trademarks, industrial designs, and copyright.

Unit I **(15 hours)**

Introduction to Intellectual property rights (IPR):

Genesis and scope. Types of Intellectual property rights - Patent, Trademark, Copyright, Design, Trade secret, Geographical indicators, Plant variety protection. National and International agencies – WIPO, World Trade Organization (WTO), Trade-Related Aspects of Intellectual Property Rights (TRIPS), General Agreement on Tariffs and Trade (GATT).

Unit II **(15 hours)**

Patenting, process, and infringement

Basics of patents - Types of patents; Patentable and Non-Patentable inventions, Process and Product patent. Indian Patent Act 1970; Recent amendments; Patent Cooperation Treaty (PCT) and implications. Process of patenting. Types of patent applications: Provisional and complete specifications; Concept of "prior art", patent databases (USPTO, EPO, India). Financial assistance, schemes, and grants for patenting. Patent infringement- Case studies on patents (Basmati rice, Turmeric, Neem) Genesis.

Unit III **(15 hours)**

Trademarks, Copyright, Industrial Designs

Trademarks- types, Purpose, and function of trademarks, trademark registration, Protection of the trademark. Copy right- Fundamentals of copyright law, Originality of material, rights of reproduction, industrial Designs: Protection, Kind of protection provided by industrial design. Genesis.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

REFERENCES:

1. Manish Arora. 2007. Universal's Guide to Patents Law (English) 4th Edition) -Publisher: Universal Law Publishing House
2. Kalyan C. Kankanala. 2012. Fundamentals of Intellectual Property. Asia Law House
3. Ganguli, P. 2001. Intellectual Property Rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub
4. World trade organization - http://www.wto.org
5. World Intellectual Property organization – www.wipo.intOffice of the controller general of Patents, Design & Trademarks - www.ipindia.nic.in

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

DISCIPLINE CORE COURSES

SEMESTER – V GENETIC ENGINEERING

Program Name	B.Sc. Biotechnology	Semester	5th Semester
Course Title	**Genetic Engineering (Theory + Practical)**		
Course Code:	**DSC – A9 (T)**	No. of Theory Credits	**04**
Contact hours	**60 hrs**	Duration of ESA/Exam	**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Objectives:

COJ 1. Understand the fundamental principles and techniques of genetic engineering.

COJ 2. Explore the applications of genetic engineering in agriculture, medicine, biotechnology, and environmental science.

COJ 3. Develop practical skills in genetic engineering techniques and laboratory procedures. COJ 4. Gain knowledge of gene expression regulation and genetic modification methods.

COJ 5. Enhance critical thinking and problem-solving skills through discussions and case studies.

COJ 6. Stay updated on emerging trends and advancements in genetic engineering.

Course Outcomes:

CO 1. Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.

CO 2. Apply the knowledge of genetic engineering to diverse applications in agriculture, medicine, biotechnology, and environmental science.

CO 3. Perform laboratory procedures and develop practical skills in genetic engineering techniques.

CO 4. Explain gene expression regulation mechanisms and apply genetic modification methods effectively.

CO 5. Evaluate genetic engineering's ethical, social, and legal implications and propose responsible solutions.

CO 6. Stay updated with recent advancements in genetic engineering, critically evaluate

emerging trends, and assess their potential impact on various fields.

GENETIC ENGINEERING

DCC- A9 (T) BTCT 301 4 Credits 60 hours

Unit I **(14 hours)**

Fundamentals of Genetic Engineering:

Introduction to Genetic Engineering - Definition, scope, and historical overview of genetic engineering. Importance and applications in various fields.

DNA Structure and Manipulation - Structure and organization of DNA molecules. Techniques for DNA isolation and purification. Methods for quantification and characterization of DNA samples.

RNA Analysis and Gene Expression- Types and functions of RNA molecules. Methods for RNA isolation and purification. Analysis of gene expression using techniques such as Northern hybridization. Introduction to Polymerase Chain Reaction (PCR) and its variants for gene expression analysis

Recombinant DNA technology – Introduction to molecular cloning. Overview of cloning vectors. Plasmids, phage, cosmid, BAC, and YAC. Features and applications of cloning vectors in genetic engineering. Enzymes used in recombinant DNA technology: Restriction endonucleases, DNA modifying enzymes, other nucleases, Polymerases, Ligase, kinases, and phosphatases. Techniques for molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.

Unit II **(14 hours)**

Practices in Genetic Engineering:

Techniques – Recombinant Protein Expression and Purification, affinity tags. Techniques for expressing recombinant proteins using bacterial, animal, and plant expression systems. Strategies for protein purification and characterization. Hybridization techniques, Southern, Northern, Western, FISH, Polymerase Chain Reaction (PCR) and its types, molecular probes, DNA sequencing- Sanger's, Next Generation Sequencing

Gene Manipulation Techniques - Methods of gene delivery. Physical, chemical, and biological methods. Transformation, transfection, electroporation, and micro-injection. Gene knockout techniques in bacterial and eukaryotic organisms.

Genome Editing - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis, and other genome editing methods.

Unit III **(14 hours)**

Applications of Genetic Engineering: Introduction to Applications. Overview of the diverse applications of genetic engineering. Gene therapy and its potential in treating genetic disorders. Strategies for gene delivery in therapeutic applications. Diagnostic Applications. DNA fingerprinting and its applications in forensics. Molecular diagnostic techniques and their role in disease diagnosis. Use of genetic engineering in the development of therapeutics and vaccines. Production of biopharmaceuticals using recombinant DNA technology.

Unit IV **(14 hours)**

Advances in Genetic Engineering: Industrial Applications: Industrial applications of genetic engineering, such as enzyme production, biofuel production, and bioremediation. Scale-up techniques and process optimization in industrial settings. Introduction to synthetic biology and its integration with genetic engineering. Design and construction of artificial biological systems

Ethical and Regulatory Considerations - Discussion of ethical implications associated with genetic engineering. Introduction to regulatory guidelines and safety considerations for genetic engineering research and applications

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development. Group discussion and critical analysis of scientific papers related to

transgenic plants.

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	**60 + 40 = 100 marks**

GENETIC ENGINEERING PRACTICALS

DCC-A10(P) BTCP 301 2 Credit

Content of Practical

1. **Introduction to Laboratory Techniques -** Safety guidelines and laboratory protocols Aseptic techniques and proper handling of materials. Basic equipment and instrument operation Preparation of reagents and media
2. **Nucleic Acid Extraction and Quantification-** DNA extraction from different sources (e.g., bacteria, plant, animal). RNA extraction and purification methods. Quality assessment and quantification of nucleic acids (spectrophotometry, gel electrophoresis).
3. **Polymerase Chain Reaction (PCR)** Primer design and optimization PCR setup and cycling conditions. Agarose gel electrophoresis for PCR product analysis.
4. **Cloning and Plasmid Manipulation**
    a. Restriction enzyme digestion
    b. Ligation reactions
    c. Transformation of bacterial cells with recombinant plasmids.
    d. Colony selection and screening for successful cloning.
5. **Gel Electrophoresis and DNA Analysis**
    a. Agarose gel electrophoresis for DNA fragment separation and analysis DNA size determination using molecular weight markers.
    b. DNA band visualization techniques (e.g., ethidium bromide staining, DNA intercalating dyes).

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exam**	
Record	5	**25**	**5**
Test	10		
Attendance	5		

Performance	5		**0**
TOTAL	**25**	**25**	

References	
1.	Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1405156660.
2.	Gene Cloning and DNA Analysis: An Introduction (2019) 7th ed., Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
3.	Genome 4 (2017) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
4.	Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford University Press India, ISBN: 978-0198745891.
5.	Genomics and Personalized Medicine: What Everyone Needs to Know (2016) 1st ed., Snyder, M, OUP-USA, ISBN: 978-0190234768.
6.	Molecular Biology of the Gene (2014) 7th ed., Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M, and Losick, R, Pearson, ISBN: 978-0321762436.
7.	Principles of Gene Manipulation and Genomics (2019) 9th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1119163774.
8.	Genomes (2018) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
9.	Introduction to Genomics and Proteomics (2015) 2nd ed., Burrell, MM, Wiley, ISBN: 978- 0470850075.
10.	Genomics: The Science and Technology Behind the Human Genome Project (2019) 2nd ed., Gibson, G, and Muse, SV, Oxford University Press, ISBN: 978-0198786207.
11.	Genomics and Evolution of Microbial Eukaryotes (2019) 1st ed., Katz, LA, and Bhattacharya, D, Oxford University Press, ISBN: 978-0198830202.
12.	Essentials of Genomic and Personalized Medicine (2016) 2nd ed., Ginsburg, GS, and Willard, HF, Academic Press, ISBN: 978-0124078652.
13.	Genomic Medicine: Principles and Practice (2014) 2nd ed., Ginsburg, GS, and Willard, HF, Oxford University Press, ISBN: 978-0199334468.
14.	Genomic Medicine in Resource-limited Countries: Genomics for Every Nation (2019) 1st ed., Wonkam, A, Puck, JM, and Marshall, CR, Academic Press, ISBN: 978-0128133003.
15.	Molecular Genetics and Genomics (2020) 1st ed., Krebs, JE, and Goldstein, ES, Jones & Bartlett Learning, ISBN: 978-1284154544.
16.	Bioinformatics and Functional Genomics (2015) 3rd ed., Pevsner, J, Wiley-

	Blackwell, ISBN: 978-1118581780.
17.	Genomic Approaches for Cross-Species Extrapolation in Toxicology (2019) 1st ed., Wichard, J, and Maertens, A, CRC Press, ISBN: 978-0815348023.
18.	Introduction to Genetic Analysis (2020) 12th ed., Griffiths, AJF, Wessler, SR, Carroll, SB, and Doebley, J, W.H. Freeman, ISBN: 978-1319149609.
19.	Genetic Engineering: Principles and Methods (2019) 3rd ed., Fowler, MR, CABI, ISBN: 978- 1789240605.

Syllabus for B.Sc. (Basic / Hons.)

Biotechnology DISCIPLINE CORE COURSES

SEMESTER – V

PLANT AND ANIMAL BIOTECHNOLOGY

Program Name	**B.Sc. Biotechnology**	Semester	**5th Semester**
Course Title	**Plant and Animal Biotechnology (Theory + Practical)**		
Course Code:	**DSC – A11 (T)**	No. of Theory Credits	**04**
Contact hours	**60 hrs**	Duration of ESA/Exam	**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Objectives:

1. To understand the fundamental aspects of plant and animal biotechnology.
2. Learn about biotechnological tools and techniques used in plant and animal research.
3. Explore methods of introducing foreign genes into plants and animals through transformation techniques.
4. Gain practical skills in plant tissue culture and animal cell culture for improvement.
6. Design strategies for plant genetic manipulation against biotic and abiotic stressors.
7. Hypothesize strategies to increase plant yield and fruit/seed quality.
8. Apply knowledge to real-world challenges in agriculture, veterinary medicine, conservation, and biomedical research
9. Understand the need for animal biotechnology for human welfare.

Course Outcome:

After completing this course, the student is expected to learn the following:

CO 1: Demonstrate a comprehensive understanding of plant biology, physiology, genetics, and molecular biology.

CO 2: Apply biotechnological tools and techniques used in plant research and agriculture, such as plant tissue culture, genetic engineering and transgenics.

CO 3: Execute plant tissue culture techniques for callus induction, somatic embryogenesis, and micropropagation, and apply them in plant breeding and propagation.

CO 4: Perform plant transformation methods and demonstrate the ability to introduce foreign genes into plants using different techniques.

CO 5: Apply molecular biology techniques, including PCR, DNA sequencing, and gene expression analysis, to investigate and analyze plant genetic information.

CO 6: Understand the biology and characterization of cultured cells, including their adhesion, proliferation, differentiation, morphology, and identification.

CO 7: Gain practical skills in basic mammalian cell culture techniques, measuring growth parameters, assessing cell viability, and understanding cytotoxicity.

CO 8: Learn about germplasm conservation techniques and the establishment of gene banks, along with large-scale culture methods for cell lines.

CO 9: Explore organ and histotypic culture techniques, biotransformation, 3D cultures, whole embryo culture, somatic cell cloning, and the ethical considerations surrounding stem cells and their applications.

PLANT AND ANIMAL BIOTECHNOLOGY

DCC-A11(T) BTCT 302 4 Credits 60 hours

Unit I **(15 hours)**

Plant Tissue Culture Methods: Introduction, history, definition, hypothesis, and concept of totipotency. Principles of plant tissue culture, media and laboratory organization. Types of culture, morphogenesis, differentiation, callus, direct and indirect organogenesis. *In vitro* propagation and micropropagation, Seed culture, embryo culture, bud culture, limitations, applications.

Secondary metabolites: In vitro secondary metabolite production, Suspension cultures, cell cultures, growth vs secondary metabolite production, bioreactors and scaling up of secondary metabolite production, limitations, and applications.

Unit II **(15 hours)**

Transgenic Plants and biosafety: Overview of transgenic plants and their significance in agriculture. - Techniques for introducing foreign genes into plants: Agrobacterium-mediated transformation, biolistics, and other methods. Selection and screening of transformed plants. Applications of Transgenic Plants - Improved crop traits through genetic engineering: pest resistance, herbicide tolerance, disease resistance, and abiotic stress tolerance.

Biosafety assessment of transgenic plants: potential risks and benefits. International regulatory frameworks for releasing and commercializing genetically modified organisms (GMOs). Ethical and socio-economic impacts of transgenic crops. Intellectual property rights and access to transgenic technologies.

Unit III **(15 hours)**

Animal Cell Culture Methods:.History and laboratory organisation, Media. Cell types and culture characters. Pluripotency, Multipotency, Differentiation, Trans differentiation Reprogramming,

Biology and characterization of cultured cells- cell adhesion, proliferation, differentiation, morphology of cells, and identification. The basic technique of mammalian cell culture in vitro, Measuring parameters of growth in cultured cells, cell viability, and cytotoxicity. Large-scale culture of cell lines- monolayer, suspension, and immobilized cultures.

Organ and histotypic culture: Technique, advantages, limitations, applications. Stem cells: types (embryonic, adult, induced pluripotent), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues.

Unit IV(15 hours)

Gene transfer in animals and applications: Gene constructs promoter/ enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase. Transfection of animal cells- calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, Retrovirus, microinjection. Transgene identification methods. Transgenic and genome-edited animals. Ethical issues in transgenesis. Recent advances and applications in the field. Manipulation of animal reproduction and characterization of animal genes, Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues. Production of recombinant vaccines.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Acquire knowledge about types of Transgenic plants												
Will be able to demonstrate the skills to perform Plant Tissue Culture Techniques												
Apply comprehensive innovations and skills of Plant Tissue Culture in the biotechnology field												

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development. Group discussion and critical analysis of scientific papers related to transgenic plants.

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

PLANT AND ANIMAL BIOTECHNOLOGY PRACTICALS

DCC-A12(P) BTCP 302 2 Credit

Content of Practical

1. Laboratory organization of basic and commercial plant tissue culture
2. Media preparation (MS, B5), solid media preparation, and Liquid media preparation
3. Explant preparation – sterilization of Leaf, bud, rhizome, and meristem
4. Synthetic Seed Production.
5. Callus culture- Initiation and establishment of different types of callus cultures
6. Micropropagation – Stage 0. 1, 2, 3, and 4
7. Staining, cell viability, and cell count of cell cultures
8. Preparation of cell culture media: Preparation of basic cell culture media, such as Dulbecco's Modified Eagle Medium (DMEM), supplemented with fetal bovine serum (FBS), antibiotics, and other required additives.
9. Aseptic techniques and sterile handling: Practicing aseptic techniques, including properly handling tools and equipment, working in a laminar flow hood, and maintaining sterility throughout the cell culture process.
10. Filter sterilization: Practice filter sterilization for sensitive media ingredients.
11. Cell counting and viability assessment: Count cells using a hemocytometer or automated cell counter, and perform viability assays (e.g., trypan blue exclusion) to determine the percentage of viable cells.
12. Cell staining and microscopy: Staining the cultured cells using dyes such as hematoxylin and eosin (H&E), and observe them under a light microscope to study cell morphology and structure.
13. Contamination identification and troubleshooting: Learn to identify and troubleshoot common issues in cell culture, such as contamination by bacteria, fungi, or mycoplasma, and implement appropriate corrective measures.

Experimental design and data analysis: Students can design and execute simple experiments, record and analyze data, and interpret the results based on their observations and measurements.

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exam**	
Record	5	**25**	**50**
Test	10		
Attendance	5		
Performance	5		
TOTAL	**25**	**25**	

References	
1	Bhojwani, S.S., and Razdan, M.K. (2004). Plant Tissue Culture: Theory and Practice. Amsterdam: Elsevier Science.
2	Brown, T.A. (2010). Gene Cloning and DNA Analysis: An Introduction. 7th edition. Oxford: Wiley-Blackwell.
3	Gardner, E.J., Simmons, M.J., and Snustad, D.P. (2008). Principles of Genetics. 10th edition. Hoboken, NJ: John Wiley & Sons.
4	Glick, B.R., and Pasternak, J.J. (2018). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th edition. Washington, DC: ASM Press.
5	Raven, P.H., Johnson, G.B., Losos, J.B., and Singer, S.R. (2013). Biology. 10th edition. New York, NY: McGraw-Hill Education.
6	Reinert, J., and Bajaj, Y.P.S. (1997). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Berlin: Springer.
7	Russell, P.J. (2013). iGenetics: A Molecular Approach. 3rd edition. Boston, MA: Benjamin Cummings.
8	Slater, A., Scott, N.W., and Fowler, M.R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
9	Smith, R. (2012). Plant Tissue Culture: Techniques and Experiments. 3rd edition. San Diego, CA: Academic Press.
10	Taiz, L., and Zeiger, E. (2014). Plant Physiology. 5th edition. Sunderland, MA: Sinauer Associates.
11	Vasil, I.K., and Vasil, V. (2007). Molecular Improvement of Cereal Crops. Dordrecht:

	Springer
12	Umesha S. (2018) Plant Biotechnology. TERI Publishers, New Delhi.
13	Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press. ISBN: 978-1316614761.
14	Gahlawat, S.K., Duhan, J.S., Salar, R.K., Siwach, P., Kumar, S., & Kaur, P. (2018). Advances in Animal Biotechnology and its Applications. Springer. ISBN: 978-981-10-4701-5.
15	Primrose, S.B., & Twyman, R.M. (2016). Principles of Gene Manipulation (8th ed.). Blackwell Science. ISBN: 978-1405135442.
16	Verma, A., & Singh, A. (2013). Animal Biotechnology. Elsevier. ISBN: 978-0124160026.
17	Glick, B.R., & Pasternak, J.J. (2009). Molecular Biotechnology (4th ed.). ASM Press. ISBN: 978-1555814984.
18	Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
19	Watson, J.D., Meyers, R.M., AC, A., & AW, J. (2006). Recombinant DNA (3rd ed.). Cold Spring Harbor Laboratory Press. ISBN: 978-0716728665.
20	Clynes, M. (Ed.). (1998). Animal Cell Culture Techniques. Springer.
21	. Masters, J.R.W. (Ed.). (2000). Animal Cell Culture - Practical Approach. Oxford University Press.
22	Freshney, I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (8th ed.). Wiley-Blackwell.
23	Pörtner, R. (Ed.). (2007). Animal Cell Biotechnology: Methods and Protocols. Humana Press.
24	Singh, B., & Gautam, S.K. (2013). Textbook of Animal Biotechnology. The Energy and Resources Institute (TERI).
25	Gupta, P.K. (2018). Animal Biotechnology. Rastogi Publications.
26	Mather, J.P., & Barnes, D. (Eds.). (Year N/A). Animal Cell Culture Methods. In Methods in Cell Biology, Vol. 57. Academic Press.
27	Singh, B.D. (2006). Biotechnology: Expanding Horizons (3rd ed.). Kalyani Publishers.
28	Srivastava A.K. Animal Biotechnology. (2018). Oxford & IBH Publishing Co Pvt. Ltd.

Syllabus for B.Sc. (Basic / Hons.) Biotechnology SKILL ENHANCEMENT COURSES SEMESTER – V

BIOTECHNOLOGSKILLS AND ANALYTICAL TECHNIQUES

Program Name	**B.Sc. Biotechnology**	Semester	**5th Semester**
Course Title	**Plant and Animal Biotechnology (Theory + Practical)**		
Course Code:	**SEC – 1A1 (T)**	No. of Theory Credits	**2 + 1 = 3**
Contact hours	**45 hrs**	Duration of ESA/Exam	**02 Hours**
Formative Assessment Marks	**20**	Summative Assessment Marks	**30**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1.Demonstrate skills as per National Occupational Standards (NOS) of the "Lab Technician/Assistant" Qualification Pack issued by the Life Sciences Sector Skill Development Council-LFS/Q0509.

CO2. Develop knowledge of laboratory safety procedures and protocols and acquire skills in handling and maintaining laboratory equipment and instruments.

CO3. Operate analytical equipment and instruments as per standard operating procedures (SOP) CO4. Knowledge about major activities of the biotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.

CO5. Demonstrate soft skills, such as decision-making, planning, organizing, problem-solving, analytical thinking, critical thinking, and documentation.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-13) **Course Outcomes (COs)/Program Outcomes (POs)**	1		3	4	5	6	7	8		10	11	12	13

Develop knowledge of laboratory safety procedures and protocols and acquire skills in handling and maintaining laboratory equipment and instruments.	✔												
Operate analytical equipment and instruments as per standard operating procedures (SOP)			✔									✔	
Knowledge about major activities of the biotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.											✔		
Demonstrate soft skills, such as decision-making, planning, organizing, problem-solving, analytical thinking, critical thinking and documentation.	✔							✔					

BIOTECHNOLOGY SKILLS AND ANALYTICAL TECHNIQUES

SEC-A4(T) BTSC 301 2 Credits 30 hours

Unit I **(15 hours)**

Insights into the biotechnology industry and basic professional skills:

Biotechnology Industry in Indian and Global Context- Organization in the context of large/medium/small enterprises, their structure, and benefits.

Industry-oriented professional skills: Planning and organizing skills, decision-making, problem- solving skills, analytical thinking, critical thinking, team management, and risk assessment. Interpersonal skills: Writing skills, reading skills, oral communication, conflict resolution techniques, interpretation of research data, and troubleshooting in the workplace.

Digital skills: Basic computer skills (MS Office, excel, power point, internet) for the workplace. Professional E-mail drafting skills and PowerPoint presentation skills. Overview of good manufacturing practices (GMP), Good Documentation practices (GDP), and good laboratory practices (GLP).

Unit II **(15 hours)**

Basic laboratory skills and Analytical Techniques:

Analytical skills in the laboratory: Preparations of 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, and solution of acids. Reagent bottle label reading and precautions.

Analytical techniques: Basic principle, operation, application, maintenance, calibration, validation, and troubleshooting of instruments- Microscope-Simple, compound, TEM, SEM, fluorescence. Centrifuge and different types, Hot air oven, pH meter, different types of pH electrodes Autoclave, Incubator, BOD, COD, cell counter, Laminar airflow. Spectroscopy- Colorimeter, UV-Visible spectroscopy. Electrophoresis- Agarose Gel electrophoresis, SDS-PAGE, PCR, Conductivity meter, and Potentiometer. Biosafety cabinets.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments.

Course title	**Quality control methods in biology (Practical)**	**Practical credits-1**	**5th Semester**
Course No.	**SEC -4**	Contact hours	4hrs/week; **25 Marks**

Unit-I

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 areas, equipment, ventilation area, personal protective requirements Calibration of and use of micropipette

Unit-II

Preparation of Standard Operating Procedure (SOP) for various equipment in the QC Lab, Best practices of using and storing chemicals: Knowledge and practice in handling chemicals, labeling,

and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labeling, storage, and disposal.

Handling and calibration of lab equipment- weighing balance, Autoclave, Hot air Oven, Incubator, Centrifuge, Water bath, Colony Counter, and stability chamber, Preparation of Normality, Molarity, and buffer solutions.

Unit-III

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.

Demonstration, handling, and troubleshooting of High-Performance Liquid Chromatography and Gas chromatography.

Demonstration of Polymerase Chain Reaction (PCR), Hands-on training on colorimeter and spectrophotometer, Industry visit, or analytical laboratory visit.

Note: Semester end examination is only in the theory component; questions from the practical part could be included, if any.

References:

1. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch (2017). "Principles of Instrumental Analysis". Cengage Learning.
2. J. Perry Gustafson (2017). "Analytical Methods and Techniques for Advanced Sciences". CRC Press.
3. Dean F. Martin, William M. Ritchey, and Michael W. Wood (2017). "Laboratory Manual for Principles of General Chemistry". Wiley.
4. Michael Lufaso (2016). "Laboratory Skills for Science and Medicine: An Introduction". CRC Press.
5. David J. Livingstone and Christopher H. Amonette (2016). "Analytical Techniques in Environmental Chemistry: Applications to Air, Water and Soil". CRC Press.
6. Colin A. Ramsden (2014). "Analytical Molecular Biology". Oxford University Press.
7. John M. Walker and Ralph Rapley (2014). "Molecular Biomethods Handbook". Humana Press.
8. Gary D. Christian, Purnendu K. Dasgupta, and Kevin A. Schug (2013). "Analytical Chemistry". Wiley.
9. Roger L. Lundblad and Fiona M. Macdonald (2010). "Handbook of Biochemistry and Molecular Biology". CRC Press.

Syllabus for B.Sc. (Basic / Hons.) Biotechnology DISCIPLINE CORE COURSES

SEMESTER – VI IMMUNOLOGY

Program Name	**B.Sc. Biotechnology**	Semester	**5th Semester**
Course Title	**Immunology (Theory + Practical)**		
Course Code:	**DSC – A13 (T)**	No. of Theory Credits	**04**
Contact hours	**60 hrs**	Duration of ESA/Exam	**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Objectives:

1. To understand the various aspects of immunity, elicitation of immune responses, factors determining the outcome of immune responses and major players of immunity, relevance between nutritional support and immunity, and immunological techniques.
2. To provide knowledge on essential features of antigens and antibodies and their types and different theories of Antibody formation.
3. To acquire knowledge on types of immunity, phagocytosis, interferons, and the complement system.
4. To explain the concept of hypersensitivity, autoimmunity, and transplantation.
5. To provide knowledge on immune deficiencies and several immunological techniques

Course Outcomes:

At the end of the course, the student should be able to:

CO 1. Demonstrate comprehension of the underlying structure and function of the immune system and related disorders.

CO 2. Demonstrate an understanding of the role of cells and molecules in immune reactions and responses

CO 3. Demonstrate technical skills in immunological tools and techniques

CO 4. Apply the domain-specific knowledge and skills acquired in immunology for innovative therapies and Immunotechnologies

CO 5. Understand the fundamental concepts of immunity, and the contributions of the organs and cells in immune responses.

CO 6. Realize how the MHC molecule's function and host encounters an immune insult. CO 7. Understand the antibodies and complement system

CO 8. Understand the mechanisms involved in the initiation of specific immune responses CO 9. Differentiate the humoral and cell-mediated immune mechanisms

CO 10. Comprehend the overreaction by our immune system leading to hypersensitive conditions and its consequences

CO 11. Understand unique properties of cancer cells, immune recognition of tumors, immune evasion of cancers

IMMUNOLOGY

DCC-A13(T) BTCT 351 4 Credits 60 hours

Unit I (15 hours)

Cells and Organs of the Immune System:

Introduction to the Immune System: History of Immunology.

Types of Immunity: the first and second line of defense, innate and acquired/adaptive immunity, specificity, diversity, Self and non-self-recognition.

Cells of the immune system: Antigen-presenting cells (APCs), Role of B and T-lymphocytes in Humoral immunity and cell-mediated immunity, primary and secondary immune response, Immunization, memory.

Organs of the Immune system: Thymus, bone marrow, spleen, Lymph Node, peripheral lymphoid organs

Unit II (14 hours)

Molecules of the Immune System:

Antigens and haptens: Properties (foreignness, molecular size, heterogeneity). Adjuvants. Antigenicity and Immunogenicity. Affinity and Avidity. B and T cell epitopes, superantigens

Immunoglobulins: Classification, structure, and function. Antibody diversity, Monoclonal and polyclonal antibodies. VDJ Gene Segments and DNA rearrangements.

Major histocompatibility complexes: Classification, structure, and function. Antigen processing pathways – Cytosolic and Endocytic, Complement Pathway.

Cytokines: Classification and function

Hypersensitivity: Reactions – Types I, II, and III. Delayed Type Hypersensitive Response.

Unit III(14 hours)

Immunotechniqes and Vaccines: Structure and properties of antigens- iso- and alloantigens, antigen specificity, Cross-reactivity, Precipitation, Immunodiffusion reactions: Radial immunodiffusion, Ouchterlony double diffusion, Immunoelectrophoresis. Agglutination: Agglutination reactions. ELISA, RIA.

Immunocytochemistry, Fluorescent Techniques.

Vaccines: Conventional, peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, and Cancer vaccines.

Unit IV(14 hours)

Transplantation immunology: Phases in graft rejection and immuno-suppressors.

Autoimmune Disorders: Systemic and Organ-specific Autoimmune disorders with

examples **Immunodeficiencies**: Primary and secondary immunodeficiencies; acquired immunodeficiency syndrome.

Cancer and the immune system – immune surveillance, immunological escape, cancer antigens, cancer immunotherapy.

Microbial diseases in humans: Mode of infection, symptoms, epidemiology and control measures of diseases caused by Viruses (Hepatits-B), Bacteria (Typhoid), Fungi (Aspergillosis), Protozoa (Malaria).

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development. Group discussion and critical analysis of scientific papers related to transgenic plants.

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

IMMUNOLOGY PRACTICALS

DCC- 6P BTCP 352 2 Credit

Content of Practical

1. Hemagglutination of ABO Blood groups
2. Determination of Rh factor
3. Whole Count of WBC using a Hemocytometer
4. Cells of the Immune System
5. Radial immunodiffusion
6. Ouchterlony double diffusion
7. ELISA – Demonstrate
8. Serum Immunoelectrophoresis
9. Western Blotting

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exam**	
Record	5	**25**	**50**
Test	10		
Attendance	5		
Performance	5		
TOTAL	**25**	**25**	

References	
1	Textbook of Immunology, Paul Ajoy, Books and Allied (P) Ltd., 2016
2	Kuby Immunology. Kindt T.J. et at., W.H. Freeman & Co. 2018
3	Cellular and Molecular Immunology. Abbas, A.K. et al., Elsevier Saunders Co., 2015
4	Essential Immunology. Riott, I.M., Blackwell Scientific Publications, 1994
5	Handbook of Experimental Immunology, Vol. 1 & 2, Weir D.M., Wiley, 1997
6	Immunology. Riott, I.M., Brostoff J., Male, D. Mosby Pub., 2017

7	Practical Immunology. Hudson L. and Hay F.C., Blackwell Scientific Pub., 1989Immunobiology. Janeway C.A. and Travers, P. Churchill Livingstone Pub., 2016
9	Instant Notes in Immunology. Lydyard PM et al. Viva Books Pvt. Ltd., 2011
10	Abbas AK, Lichtman AH, and Pillai S. (2019). Basic Immunology- Functions and Disorders of the Immune System. Elsevier,
11	Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. W.B. Saunders Publisher. Philadelphia.
12	Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4th edition- Wiley-Liss. New York.
13	Borrebacc, C.A.K. (1995). Antibody Engineering, 2nd edition. Oxford University Press, Oxford.
14	Dimmock, N.J., Primrose, S.B. (1994). Introduction to Modern Virology, Blackwell Science Ltd. Oxford.
15	Hyde, R.M. (1992). Immunology, 2nd edition, Williams and Wilkins, Baltimore.
16	Kuby, J. (2003). Immunology 5th Edition. WH. Freeman and Company, NY.
17	Klaus D. Elgert (1996). Immunology. ELBS, Blackwell Scientific Publishers, London.
18	Roitt, I.M. (2017). Essential Immunology, Thirteenth edition, ELBS, Wiley Blackwell Scientific Publishers, London.
19	Goldsby, R.A, Kindt TJ and Osborne A (2000). Kuby Immunology, 4th edition, W.H. Freeman and Company, New York
20	Tizard I.R. (1995). Immunology, 4thedition, W.B. Saunders Publisher. Philadelphia.
21	Paul W.E (1989). Fundamentals in Immunology, Raven Press. NY.

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

DISCIPLINE CORE COURSES

SEMESTER – VI

BIOPROCESS AND ENVIRONMENT BIOTECHNOLOGY

Program Name	**B.Sc. Biotechnology**	Semester	**5th Semester**
Course Title	**Bioprocess & Environmental Biotech (Theory + Practical)**		
Course Code:	**DSC – A14 (T)**	No. of Theory Credits	**04**
Contact hours	**60 hrs**	Duration of ESA/Exam	**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

DCC- A15(T) BTCT 352 4 Credits 60 hours

Course Objectives:

1. Perform simulations of microbial growth and metabolism
2. Design bioreactors for the production of various products.
3. Present knowledge about major metabolic pathways and those related to biofuel production from microbes.
4. Understand the fundamental concepts and principles of environmental biotechnology and Explore the interrelationship between biotechnology and the environment.
5. Gain knowledge of the various applications of biotechnology in environmental conservation, pollution control, and sustainability.
6. Learn about microbial processes and their role in environmental biotechnology.
7. Understand the principles of bioremediation and its application in the clean-up of environmental pollutants.
8. Explore the potential of bioenergy production and waste management through biotechnological approaches.
9. Identify and characterize the most important contaminants in the Bioprocess and other industrial wastes.
10. Reuse/recycle the biological waste to clean technology such as energy, biofuel, bio fertilizer through bioremediation.

Course Outcomes:

CO 1. Exploitation of microorganisms for industrial use and their improvement, and formulation of media for efficient growth and production of microbial or cell-based products.

CO 2. The design, operation, and specific applications of various bioreactors.

CO 3. Demonstrate a comprehensive understanding of the fundamental concepts and principles of environmental biotechnology.

CO 4. Apply knowledge of biotechnological techniques to address environmental challenges, such as pollution control and waste management.

CO 5. Analyze and evaluate environmental biotechnology case studies, research findings, and real-world applications.

CO 6. Design and implement biotechnological approaches for environmental remediation, utilizing microbial processes and biodegradation principles.

CO 7. Evaluate the ethical and sustainable aspects of environmental biotechnology practices and make informed decisions regarding their application in environmental conservation.

CO 8. Communicate scientific concepts and research findings related to environmental biotechnology effectively, both in written and oral forms, to diverse audiences.

BIOPROCESS AND ENVIRONMENT
BIOTECHNOLOGY

DCC- A15(T) BTCT 353 4 Credits 60

Unit I (15 hours)

Introduction to bioprocess technology. Basic principles components of fermentation technology. Strain improvement of industrially important microorganisms. Types of microbial culture and its growth kinetics– Batch, Fed-batch, and Continuous culture. Principles of upstream processing – Media preparation, Inocula development, and sterilization.

Unit II (15 hours)

Bioreactors: Bioreactors- Significance of Impeller, Baffles, Sparger; Specialized bioreactors- design and their functions: airlift bioreactor, tubular bioreactors, membrane bioreactors, tower bioreactors, fluidized bed reactor, packed bed reactors

Downstream processing: cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization, biosensors-construction and applications, Microbial production of ethanol, amylase and Single Cell Proteins.

Unit III(15 hours)

Fundamentals of Environmental Biotechnology: Introduction to Environmental Biotechnology- Principles of Environmental Science. Role of Biotechnology in Environmental Conservation. Microbial Processes in Environmental Biotechnology.

Pollution and Biotechnology – Major issues in environmental pollution and the role of biotechnology in addressing them. Biotechnological Methods of Pollution Detection-General bioassay methods for pollution detection. Cell biological methods for assessing pollution levels. Use of biosensors in pollution monitoring. Biotechnological Methods in Pollution Abatement-Reduction of CO_2 emission using biotechnological approaches. Addressing eutrophication through biotechnological interventions. Application of cell immobilization techniques in pollution abatement.

Unit IV(15 hours)

Bioremediation and Waste Management: Importance of bioremediation in environmental cleanup. Types of contaminants suitable for bioremediation.

Microorganisms used in bioremediation. *In-situ* Bioremediation Methods. – Bioaugmentation. Biostimulation. Bioventing. Phytoremediation. Ex-situ Bioremediation Methods – Composting, Land farming, Biopile and bio-slurry systems. Xenobiotics. Bio metallurgy and bio-mining.

Wastewater Management. Wastewater Characterization and Composition. Biological Processes in Wastewater Treatment. Activated Sludge Process and Biological Nutrient Removal, Anaerobic Digestion and Biogas Production. Solid Waste Management.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development. Group discussion and critical analysis of scientific papers related to transgenic plants.

Summative Assessment = 60 Marks	
Formative Assessment Occasion/type	Weightage in Marks
Test 1	10
Test 2	10
Debates and Quiz	10
Seminar	10
Total	60 + 40 = 100 marks

BIOPROCESS AND ENVIRONMENTAL BIOTECHNOLOGY PRACTICALS

DCC- P BTCP 353 2 Credit

Content of Practical

1. Bacterial growth curve.
2. Calculation of the thermal death point (TDP) of a microbial sample.
3. Study of fermentor- Demonstration.
4. Production of wine
5. Estimation of the percentage of alcohol, total acidity & volatile acidity in wine.
6. Production and analysis of ethanol.
7. Production and analysis of amylase.
8. Production and analysis of lactic acid.
9. Isolation of industrially important microorganisms from natural resources.

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exam**	
Record	5	**25**	**50**
Test	10		
Attendance	5		
Performance	5		
TOTAL	**25**	**25**	

References	
1	Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2	Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3	Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4	Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5	Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (3rd Edn.).2022 Cambridge University Press. 2002
6	Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
7	Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor &Francis Ltd, UK, 2007.
8	Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001.
9	Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003.
10	Prentice Hall, Engelwood Cliffs, 2002.
11	Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984.
12	Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition,
13	Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2014). Environmental engineering. McGraw-Hill Education
14	Banerjee, S., & Santhosh, C. (2019). Environmental biotechnology: Concepts

	and applications. CRC Press.
15	Mishra, A. K. (2016). Environmental biotechnology: Basic concepts and applications. CRC Press
16	Torres, A. E., & López-González, J. A. (2018). Environmental biotechnology: An introduction. John Wiley & Sons
17	Das, S., & Dash, H. R. (2020). Environmental biotechnology: Principles and applications. Springer
18	Wackett, L. P., & Hershberger, C. D. (2018). Environmental biotechnology: Theory and application. McGraw-Hill Education
19	Foster, C. F., & John, W. D. A. (1987). Environmental biotechnology. Ellis Horwood Limited.
20	Chatterji, A. K. (2002). Introduction to environmental biotechnology. Prentice-Hall of India Pvt. Ltd
21	Ignacimuthu S. (2001). Basic Biotechnology. Rev. Fr. Tata McGraw Hill, New Delhi,
22	Ratledge C. and Kristiansen B. (2002). Basic Biotechnology. Cambridge University Press, UK

Internship for graduate Programme **Course title**	**Internship Discipline specific**
No of contact hours	**90**
No credits	**2**
Method of evaluation	**Presentations/Report submission/Both**

Project Assessment			
Formative Assessment		**Summative Assessment**	
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	**Total Marks**
Data maintenance	10	Presentation/Report/ Both **25**	**50**
Assessment	10		
Attendance	05		
Total	**25**	25	

- Internship shall be Discipline Specific of 90 hours (2 credits) with duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part- time in the
- academic session)
- Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship) to the mentor for
- completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.

(Discipline Core Course) **FIRST** Semester B.Sc. (Basic/Honours) Examination

BIOTECHNOLOGY, Course code – Title

Time: 3 Hours **Max. Marks: 60**

Instruction: Draw labeled diagrams wherever necessary

1	Answer any **TEN** of the following questions	2 X 10 =	20

Unit – I

i)

ii)

iii)

Unit – II

iv)

v)

vi)

Unit – III

vii)

viii)

ix)

Unit – IV

x)

xi)

xii)

Answer any **FOUR** full questions choosing one from each unit: 10 X 4= 40

Unit – I

2 a) 3

b) 7

OR

3 a) 3

b) 7

Unit – II

4 a) 3

b) 7

OR

5 a) 3

b) 7

Unit – III

6 a) 3

b) 7

OR

7 a) 3

b) 7

Unit – IV

8 a) 3

b) 7

OR

9 a) 3

b) 7

******

(Discipline Open Elective Course)

FIRST Semester B.Sc. (Basic/Honours) 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 labeled diagrams wherever necessary

Write any four full questions choosing one from each unit:

Unit – I

1	a)		4
	b)		6
	c)		10
		OR	
2	a)		4
	b)		6
	c)		10

U

Unit – II

3	a)		4
	b)		6
	c)		10

Unit – III

5	a)		4
	b)		6
	c)		10
		OR	
6	a)		4
	b)		6
	c)		10

******