JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
(AUTONOMOUS)
OOTY ROAD, MYSORE – 25.

CURRICULUM FOR

For B.Sc., (Basic/ Hons.) Degree

BIOTECHNOLOGY

(As per NEP-2020 Model Curriculum)

Implementation Year 2023-24

2023-24

B.Sc., (Basic/ Hons.) Degree

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSORE

Scheme of study for B.Sc. Biotechnology As per NEP-2020 Model from 2021-22

YEAR	SEMESTER	CORE COURSE	COURSE CODE	TITLE OF THE PAPER	NO. OF CREDITS	LECTURE/ PRACTICAL/ HOUR/WEEK	TOTAL TEACHING HOURS
I BSc	I	DSC -1:Theory	FSA460	Cell biology & genetics	4	4	56
		DSC -1:Pract	FSA460	Cell biology & genetics	2	4	56
		OE-1:Theory	FSA900	Biotechnology for human welfare	3	3	42
		SEC-1: Theory		Biotechnological Skills and Analytical Techniques	1	1	14
	II	DSC-2:Theory	FSB460	Microbiological Methods and Techniques	4	4	56
		DSC-2: Pract	FSB460	Microbiological Methods and Techniques	2	4	56
		OE-2:Theory	FSB900	Applications of Biotechnology in Agriculture	3	3	42
II BSc	III	DSC -3:Theory	FSC460	Biomolecules	4	4	56
		DSC -3:Pract	FSC460	Biomolecules	2	4	56
		OE-3:Theory	FSC900	Nutrition and Health	3	3	42
	IV	DSC -4:Theory	FSD460	Molecular Biology	4	4	56
		DSC -4:Pract	FSD460	Molecular Biology	2	4	56
		OE-4:Theory	FSD900	Intellectual Property Rights	3	3	42
III BSc	V	DSC:Theory	FSE460	Genetic Engineering	4	4	60
		DSC:Pract	FSE461	Genetic Engineering	2	4	60
		DSC:Theory	FSE462	Plant and Animal Biotechnology	4	4	60
		DSC:Pract	FSE463	Plant and Animal Biotechnology	2	4	60
	VI	DSC:Theory	FSF460	Immunology	4	4	60
		DSC:Pract	FSF461	Immunology	2	4	60
		DSC:Theory	FSF462	Bioprocess and Environmental Biotechnology	4	4	60
		DSC:Pract	FSF463	Bioprocess and Environmental Biotechnology	2	4	60

Scheme of Examination for B.Sc. Biotechnology As per NEP-2020 Model from 2021-22

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSORE
Scheme of Examination Programme – B.Sc., ZBt ; Programme code –BScBtZ30

Year	Semester	Core course	Course code	Title of the paper	credits	Maximum Marks in exam/Assessment				Exam Duration	
					L:T:P	IA			Total	Th	Pr
						C-1	C-2	C-3			
I B.Sc	I	DSC -1:Theory	FSA460	Cell biology & genetics	4: 0: 0	20	20	60	100	2½h	3h
		DSC -1:Pract	FSA460	Cell biology & genetics	0: 0: 2	10	15	25	50		
		OE -1:Theory	FSA900	Biotechnology for human welfare	3:0:0	20	20	60	100	2½h	-
	II	DSC-2:Theory	FSB460	Microbiological Methods and Techniques	4: 0: 0	20	20	60	100	2½h	3h
		DSC-2: Pract	FSB460	Microbiological Methods and Techniques	0: 0: 2	10	15	25	50		
		OE-2:Theory	FSB900	Applications of Biotechnology in Agriculture	3:0:0	20	20	60	100	2½h	-
II B.Sc	III	DSC-3:Theory	FSC460	Biomolecules	4: 0: 0	20	20	60	100	2½h	3h
		DSC-3: Pract	FSC460	Biomolecules	0: 0: 2	10	15	25	50		
		OE-3:Theory	FSC900	Nutrition and Health	3:0:0	20	20	60	100	2½h	-
	IV	DSC-4:Theory	FSD460	Molecular Biology	4: 0: 0	20	20	60	100	2½h	3h
		DSC-4: Pract	FSD460	Molecular Biology	0: 0: 2	10	15	25	50		
		OE-4:Theory	FSD900	Intellectual Property Rights	3:0:0	20	20	60	100	2½h	-
III B.Sc	V	DSC :Theory	FSE460	Genetic Engineering	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE461	Genetic Engineering	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSE462	Plant and Animal Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE463	Plant and Animal Biotechnology	0: 0: 2	10	15	25	50	-	3h
	IV	DSC :Theory	FSF460	Immunology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF461	Immunology	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSF462	Bioprocess and Environmental Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF463	Bioprocess and Environmental Biotechnology	0: 0: 2	10	15	25	50	-	3h

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSORE

Scheme of Examination Programme – B.Sc., CBt ; Programme code –BScChBt37

Year	Semester	Core course	Course code	Title of the paper	credits	Maximum Marks in exam/Assessment				Exam Duration	
					L:T:P	IA			Total	Th	Pr
						C-1	C-2	C-3			
I B.Sc	I	DSC -1:Theory	FSA460	Cell biology & genetics	4: 0: 0	20	20	60	100	2½h	3h
		DSC -1:Pract	FSA460	Cell biology & genetics	0: 0: 2	10	15	25	50		
		OE -1:Theory	FSA900	Biotechnology for human welfare	3:0:0	20	20	60	100	2½h	-
	II	DSC-2:Theory	FSB460	Microbiological Methods and Techniques	4: 0: 0	20	20	60	100	2½h	3h
		DSC-2: Pract	FSB460	Microbiological Methods and Techniques	0: 0: 2	10	15	25	50		
		OE-2:Theory	FSB900	Applications of Biotechnology in Agriculture	3:0:0	20	20	60	100	2½h	-
II B.Sc	III	DSC-3:Theory	FSC460	Biomolecules	4: 0: 0	20	20	60	100	2½h	3h
		DSC-3: Pract	FSC460	Biomolecules	0: 0: 2	10	15	25	50		
		OE-3:Theory	FSC900	Nutrition and Health	3:0:0	20	20	60	100	2½h	-
	IV	DSC-4:Theory	FSD460	Molecular Biology	4: 0: 0	20	20	60	100	2½h	3h
		DSC-4: Pract	FSD460	Molecular Biology	0: 0: 2	10	15	25	50		
		OE-4:Theory	FSD900	Intellectual Property Rights	3:0:0	20	20	60	100	2½h	-
III B.Sc	V	DSC :Theory	FSE460	Genetic Engineering	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE461	Genetic Engineering	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSE462	Plant and Animal Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE463	Plant and Animal Biotechnology	0: 0: 2	10	15	25	50	-	3h
	IV	DSC :Theory	FSF460	Immunology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF461	Immunology	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSF462	Bioprocess and Environmental Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF463	Bioprocess and Environmental Biotechnology	0: 0: 2	10	15	25	50	-	3h

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSORE
Scheme of Examination Programme – B.Sc., BcBt ; Programme code –BScBtBc40

Year	Semester	Core course	Course code	Title of the paper	credits	Maximum Marks in exam/Assessment				Exam Duration	
					L:T:P	IA			Total	Th	Pr
						C-1	C-2	C-3			
I B.Sc	I	DSC - 1:Theory	FSA460	Cell biology & genetics	4: 0: 0	20	20	60	100	2½h	3h
		DSC -1:Pract	FSA460	Cell biology & genetics	0: 0: 2	10	15	25	50		
		OE -1:Theory	FSA900	Biotechnology for human welfare	3:0:0	20	20	60	100	2½h	-
	II	DSC-2:Theory	FSB460	Microbiological Methods and Techniques	4: 0: 0	20	20	60	100	2½h	3h
		DSC-2: Pract	FSB460	Microbiological Methods and Techniques	0: 0: 2	10	15	25	50		
		OE-2:Theory	FSB900	Applications of Biotechnology in Agriculture	3:0:0	20	20	60	100	2½h	-
II B.Sc	III	DSC-3:Theory	FSC460	Biomolecules	4: 0: 0	20	20	60	100	2½h	3h
		DSC-3: Pract	FSC460	Biomolecules	0: 0: 2	10	15	25	50		
		OE-3:Theory	FSC900	Nutrition and Health	3:0:0	20	20	60	100	2½h	-
	IV	DSC-4:Theory	FSD460	Molecular Biology	4: 0: 0	20	20	60	100	2½h	3h
		DSC-4: Pract	FSD460	Molecular Biology	0: 0: 2	10	15	25	50		
		OE-4:Theory	FSD900	Intellectual Property Rights	3:0:0	20	20	60	100	2½h	-
III B.Sc	V	DSC :Theory	FSE460	Genetic Engineering	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE461	Genetic Engineering	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSE462	Plant and Animal Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE463	Plant and Animal Biotechnology	0: 0: 2	10	15	25	50	-	3h
	IV	DSC :Theory	FSF460	Immunology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF461	Immunology	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSF462	Bioprocess and Environmental Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF463	Bioprocess and Environmental Biotechnology	0: 0: 2	10	15	25	50	-	3h

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSORE
Scheme of Examination Programme – B.Sc., MbBt ; Programme code –BScMbBt41

Year	Semester	Core course	Course code	Title of the paper	credits	Maximum Marks in exam/Assessment				Exam Duration	
					L:T:P	IA			Total	Th	Pr
						C-1	C-2	C-3			
I B.Sc	I	DSC - 1:Theory	FSA460	Cell biology & genetics	4: 0: 0	20	20	60	100	2½h	3h
		DSC -1:Pract	FSA460	Cell biology & genetics	0: 0: 2	10	15	25	50		
		OE -1:Theory	FSA900	Biotechnology for human welfare	3:0:0	20	20	60	100	2½h	-
	II	DSC-2:Theory	FSB460	Microbiological Methods and Techniques	4: 0: 0	20	20	60	100	2½h	3h
		DSC-2: Pract	FSB460	Microbiological Methods and Techniques	0: 0: 2	10	15	25	50		
		OE-2:Theory	FSB900	Applications of Biotechnology in Agriculture	3:0:0	20	20	60	100	2½h	-
II B.Sc	III	DSC-3:Theory	FSC460	Biomolecules	4: 0: 0	20	20	60	100	2½h	3h
		DSC-3: Pract	FSC460	Biomolecules	0: 0: 2	10	15	25	50		
		OE-3:Theory	FSC900	Nutrition and Health	3:0:0	20	20	60	100	2½h	-
	IV	DSC-4:Theory	FSD460	Molecular Biology	4: 0: 0	20	20	60	100	2½h	3h
		DSC-4: Pract	FSD460	Molecular Biology	0: 0: 2	10	15	25	50		
		OE-4:Theory	FSD900	Intellectual Property Rights	3:0:0	20	20	60	100	2½h	-
III B.Sc	V	DSC :Theory	FSE460	Genetic Engineering	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE461	Genetic Engineering	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSE462	Plant and Animal Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSE463	Plant and Animal Biotechnology	0: 0: 2	10	15	25	50	-	3h
	IV	DSC :Theory	FSF460	Immunology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF461	Immunology	0: 0: 2	10	15	25	50	-	3h
		DSC :Theory	FSF462	Bioprocess and Environmental Biotechnology	4: 0: 0	20	20	60	100	2½h	
		DSC :Pract	FSF463	Bioprocess and Environmental Biotechnology	0: 0: 2	10	15	25	50	-	3h

MODEL CURRICULUM

Name of the Degree Program	**:**	**B.Sc. (Basic/Hons.)**
Discipline Core	**:**	**Biotechnology**
Total Credits for the Program	**:**	**B.Sc. Basic - 136 and B.Sc. Hons. - 176**
starting year of implementation	**:**	**2021-22**

Program Outcomes:

Competencies need to be acquired by the candidate securing B.Sc. (Basic) or B.Sc. (Hons)

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

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

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

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

3. 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.

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

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

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

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

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

9. Learning and practicing 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.

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

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

12. Understanding and application of molecular biology techniques and principles in forensic

and clinical biotechnology.

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

Continuous Formative Evaluation/ Internal Assessment

Total Marks for each course = 100%
Continuous assessment (C1) = 20% marks
Continuous assessment (C2) = 20% marks
Semester End Examination (C3) = 60% marks.

a) The first component (C1) of assessment is for 20% marks. This shall be based on test, assignment, seminar, case study, field work, project work etc. This assessment and score process should be completed after completing 50% of syllabus of the course/s and within 45 working days of semester program.
b) The second component (C2) of assessment is for 20% marks. This shall be based on test, assignment, seminar, case study, field work, internship / industrial practicum / project work etc. This assessment and score process should be based on completion of remaining 50 percent of syllabus of the courses of the semester.
c) During the 17th – 19th week of the semester, a semester end examination shall be conducted by the University for each Course. This forms the third and final component of assessment (C3) and the maximum marks for the final component will be 60%.
d) The outline for continuous assessment activities for Component-I (C1) and Component-II (C2) of a course shall be as under.

Continuous assessment activities and marks allotment are as follows for Semester I-VI

Outline for continuous assessment activities for C1 and C2

Activities	**C1 (% marks)**	**C2 (% marks)**	**C1 + C2 (% marks)**	**C3 (% marks)**
Session Test	10	10	20	-
Assignment	10	10	20	-
Semester end Examination	-	-	-	60
Total	20	20	**40**	**60**

Practical assessment

Assessment

Formative assessment				
Assessment type	Test C1	Test C2	Record	**Total**
Marks	10	10	5	**25**
Summative Assessment				
Practical Exam				
Marks	**25**			**25**
Total				**50**

- For practical course of full credits, Seminar shall not be compulsory. In its place, marks shall be awarded for Practical Record Maintenance. (the ratio is 50% : 50%)
- Conduct of Seminar, Case study / Assignment, etc. can be either in C1 or in C2 component at the convenience of the concerned teacher.
- The teachers concerned shall conduct test / seminar / case study, etc. The students should be informed about the modalities well in advance. The evaluated courses/assignments during component I (C1) and component II (C2) of assessment are immediately provided to the candidates after obtaining acknowledgement in the register by the concerned teachers(s) and maintained by the Chairman in the case of a University Post-Graduate Department and the Principal / Director in the case of affiliated institutions. Before commencement of the semester end examination, the evaluated test, assignment etc. of C1 and C2 shall be obtained back to maintain them till the announcement of the results of the examination of the concerned semester.

e) The marks of the internal assessment shall be published on the notice board of the department / college for information of the students.
f) The Internal assessment marks shall be communicated to the Registrar (Evaluation) at least 10 days before the commencement of the University examinations and the Registrar (E) shall have access to the records of such periodical assessments.
g) There shall be no minimum in respect of internal assessment marks.
h) Internal assessment marks may be recorded separately. A candidate, who has failed or rejected the result, shall retain the internal assessment marks.

Curriculum Structure for the Undergraduate Degree Program

Total Credits for the Program : 176
Starting year of implementation : 2021-22
Name of the Degree Program :B.Sc. (Basic/Hons.) BIOTECHNOLOGY
Discipline/Subject : Biotechnology

Program Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory etc. Elective courses may be listed separately

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project-based learning/ case studies/self-study like seminar, term paper or MOOC

Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

BSc Biotechnology (Basic / Hons.) Semester 1

Course Title: DSC- Cell Biology and Genetics

Total Contact Hours: **60** Course Credits: **4+2**

Formative Assessment Marks:**40%** Duration of ESA/Exam: 2½ **Hrs**

Model Syllabus Authors: **Curriculum Committee** Summative Assessment Marks: **60%**

Course Pre-requisite(s): Mention only course titles from the curriculum that are needed to be taken by the students before registering for this course.

Course Outcomes (COs):

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

(Write 3-7 course outcomes. Course outcomes are statements of observable student actions that serve as evidence of knowledge, skills and values acquired in this course)

1. Would be able to comprehend the structure of a cell with its organelles
2. *Can explain the organization of genes and chromosomes, chromosome morphology and its aberrations

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

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Would be able to comprehend the structure of a cell with its organelles	*	*			*							
2. Can distinguish between the Structure of prokaryotic and eukaryotic cell.	*	*			*							
3. Can explain the organization of genes and chromosomes, chromosome morphology and its aberrations	*	*			*							

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark ‘X’ in the intersection cell if a course outcome addresses a particular program outcome.

BSc Biotechnology (Basic / Hons.)

Semester 1

Title of the Courses:
Course 1 : DSC- Cell Biology and Genetics
Number of Theory Credits-**4** Number of lecture hours/semester-**60**

Course 2 : OE -Biotechnology for human welfare
Number of Theory Credits-**3** Number of lecture hours/semester-**60**

Course 3 : SEC- Biotechnological Skills and Analytical Techniques

Number of Theory Credits-**1** Number of lecture hours/semester-**14**

Content of Course 1: Theory: DSC- Cell Biology and Genetics 60 Hrs

Unit – 1: Cell as a Basic unit of Living Systems and Cellular Organelles 14Hrs

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

Unit- 2. Chromosomes and Cell Division 14Hrs

General Introduction, Discovery, Morphology and structural organization – Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype. Single-stranded and multi- stranded hypothesis, folded- fibre and nucleosome models.
Special type of chromosomes: Salivary gland and Lampbrush chromosmes.
Cell Division: Cell cycle, phases of cell cycle. Mitosis and meiosis, Regulation of cell cycle-, checkpoints and enzymes involved. Significance of cell cycle, interphase nucleus, achromatic apparatus, synaptonemal complex. Cell Senescence and programmed cell death.

Unit-3.Genetics: **14Hrs**

History of genetics Mendelian Genetics: Introduction and brief history of genetics. Mendelian theory: Laws of inheritance- dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross. Deviations to Mendelian inheritance- Complementary, Supplementary and Gene interaction factors: comb pattern in fowls, Complementary genes- Flower colour in sweet peas, Multiple factors–Skin colour in human beings, Epistasis– Plumage colour in poultry (13:3 ratio), Multiple allelism: Blood groups in Humans- ABO and Rh.
Maternal Inheritance: Plastid inheritance in Mirabilis, Petite characters in yeast and Kappa particles in Paramecium.
Sex-linked inheritance- Colour blindness, hemophilia, Y-linked traits.

Unit-4. Linkage and crossing over 14Hrs

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

maize.

Mutations: Types of mutations, Spontaneous and induced, Mutagens: Physical and chemical, Mutation at the molecular level, Applications of mutations- plants, animals and microbes.

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: Karyotype in man, inherited disorders – Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down syndrome and Cri-Du-Chat Syndrome).

Epigenetics: Plant and humans.

Course 1: Practical: DSC- Cell Biology and Genetics

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 stages in mitosis from onion root tips
4) Study of stages in meiosis in grasshopper testes/onion or Rhoeo flower buds.
5) Mounting of polytene chromosomes
6) Buccal smear – Barr bodies
7) Karyotype analysis - Human and Onion
   Human – Normal and Abnormal – Down and 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 theory

Text Books / References

Reference:

1. Molecular Biology of Cell - Bruce Alberts et al, Garland publications.
2. Animal Cytology and Evolution- MJD, White Cambridge University Publications
3. Molecular Cell Biology-Daniel, Scientific American Books
4. Cell Biology - Jack d Bruke, The William Twilkins Company
5. Principles of Gene Manipulations- Old & Primrose, Black Well Scientific Publications
6. Cell Biology-Ambrose &Dorothy M Easty, ELBS Publications
7. Fundamentals of Cytology- L. W. Sharp, McGraw Hill Company
8. Cytology-Willson & Marrison, Reinform Publications
9. Molecular Biology- Christopher Smith, Faber & Faber Publications
10. Cell Biology & Molecular Biology – EDP De Robertis & EMF Robertis, Saunde College.
11. Cell Biology- C.B Powar, Himalaya Publications
12. Basic Genetics- Daniel L. Hartl, Jones & Barlett Publishers USA
13. Human Genetics and Medicine lark Edward Arnold PLondon
14. Genetics – Monroe W Strickberger, Macmillain Publishers, NewYork
15. Genes V - Benjamin Lewin, Oxford University Press.
16. Genes I - Benjamin Lewin, Wiley Eastern Ltd., Delhi
17. Principles of Genetics- Sinnott, L.C. Dunn, Dobzhansky, McGraw-Hill.
18. Genetics – Edgar Altenburg Oxford & IBH publications
19. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley & Son Publications
20. Genetics- P.K.Gupta, Rastogi Publication, Meert, India

Course 2: Theory: OE – Biotechnology for Human Welfare 42Hrs

Unit – 1: Industry 14Hrs

Introduction, Scope, branches and applications of Biotechnology.

Biotechnology in industry: Industrial production of alcoholic beverage (wine), antibiotic (Penicillin), enzyme (lipase)

Applications of biotechnology in food, detergent and pharmaceutical industries

Unit – 2: Environment 14Hrs

Application of biotechnology in environmental aspects:

Bioremediation: Degradation organic pollutants, hydrocarbons and agricultural wastes, Superbug Bioplastics and Biofuels.

Unit – 3: Forensic and Health Sciences 14Hrs

Application of biotechnology in forensic science:

Solving crimes of murder and rape, paternity testing and theft using DNA finger printing techniques

Application of biotechnology in health:

Genetically engineered insulin, recombinant vaccines, gene therapy, diagnostics-ELISA and PCR, human genome project.

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

References:

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

Course 3: Theory: SEC -Biotechnological Skills and Analytical Techniques

LEARNING OUTCOMES

- Skill enhancement as per National Occupational Standards (NOS) of Lab Technician/ Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council - LFS/Q0509, Level 3.
- Knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety (EHS), good laboratory practices (GLP), standard operating procedures (SOP) and GMP as per the industry standards.
- Demonstrate soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking, and documentation.

Course 3: Theory: SEC - Biotechnological Skills and Analytical Techniques **14Hrs**

1. **Insights into biotechnology industry:**

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

2. **Industry professional skills to be acquired:**

   Planning and organizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, risk assessment.

3. **Interpersonal skills:**

   Writing skills, reading skills, oral communication, conflict-resolution techniques, interpretation of research data, trouble shooting in workplace

4. **Digital skills:**

   Basic Computer Skills (MS Office, Excel, PowerPoint, Internet) for Workplace. Professional Email drafting skills and PowerPoint presentation skills

Analytical Skills in laboratory:

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

Course 3 : Practicals: SEC- Biotechnological Skills and Analytical Techniques

1. **Methods and practices of cleaning and management of lab**

   Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirements for cleaning specific area, equipment, ventilation area, personal protective requirements

2. **Procedure of cleaning and storage of Lab ware:**

   Methodology for storage area, Cleaning procedure and materials to be used for various surfaces. Sign boards, labelling do's& don'ts

   Knowledge about standard procedures of cleaning or glass ware, plastic ware. Maintenance of inventory

3. **Principles and practices of lab safety:**

   Knowledge about safety symbols and hazard signs. Personal safety gears, utility, and disposal. Equipment safety protocols, chemical safety protocols. Documentation of chemical and equipment usage records. Handling hazardous chemicals.

4. **Best practices of usage and storage of chemicals:**

   Knowledge and practice in handling of chemicals, labelling and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labelling, storage, and disposal.

5. **Record maintenance as per SOPs**

   Labelling of samples and reagents as per SOPs.

   Recording detail of work done for research experiments. Importance of study of manuals, health and safety instructions.

6. **Usage and maintenance of basic equipment of biotechnology lab**: Principles, calibrations, and SOPs of weighing balances, pH meters, autoclaves , laminar flows and biosafety cabinets (levels), basic microscopes, homogenizers, stirrers, colorimeters, UV, and Visible spectrophotometers.
7. **Preparation of solutions and standards -** Properties and uses of chemicals commonly used in life sciences laboratories. Maintaining safety standards for handling various solutions and chemicals. Preparation of test reagents and buffers,
   Protocols for proper mixing of chemicals. Safety precautions while preparation and storage of incompatible chemicals and reagents.

8. **Preparation of media**: Maintenance and storage of purified water for media (Plant Tissue culture media, Microbiological media, and Animal cell culture media) preparation.
   Preparation and storage of concentrated stock solutions. Documentation and disposal of expired stocks.

   Collection of indents of media requirement, preparation, and storage. Media coding, documentation, and purpose of usage.

9. **Practical methods for decontamination and disposal**:

   Decontamination methods, Safe disposal practices of decontaminated media or materials.

10. Laboratory record writing

Method of record writing , data collection and recording , reporting of result, discussion of result , summary writing, effective power point presentation taking any experiment as example

11. Industry visit or Analytical laboratory visit

Pedagogy:

The general pedagogy to be followed for theory and practicals are as under. Lecturing, Tutorials, Group/Individual, Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial visits, Hands on training, Case observations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation, and Innovative methods.

Active learning as per LSSSDC (NSDC) LFS/Q0509 guidelines, at skill training Level

Case studies about application of microbial biomolecules in various industries. Seminar on topics of microbial biochemist

BSc Biotechnology (Basic / Hons.) Semester 2

Title of the Courses:

Course 1 : DSC- Microbiological Methods and Techniques
Number of Theory Credits-**4** Number of lecture hours/semester-**60**

Course 2 : OE- Applications of Biotechnology in Agriculture

Number of Theory Credits-**3** Number of lecture hours/semester-**42**

Content of Course: DSC-Microbiological Methods and Techniques 60 Hrs

Unit - 1 General Microbiology and Instrumentation 14Hrs

Microscopy: Principles of Microscopy- resolving power, numerical aperture, working principle and applications of Compound microscope, Dark field microscope, Phase contrast microscope, Fluorescence Microscope, confocal microscope, Electron Microscopes- TEM and SEM. Analytical techniques:
Working principles and applications: Centrifuge, Ultracentrifuge, Spectrophotometer, Chromatography: Paper and TLC.

Unit - 2 Sterilization techniques 14Hrs
Definition of terms-sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic agent and antimicrobial agent.
Physical methods of control: Principle, construction and applications of moist heat sterilization Boiling, Pasteurization, Fractional sterilization-Tyndallization and autoclave. Dry heat sterilization-Incineration and hot air oven. Filtration – Diatomaceous earth filter, seitz filter, membrane filter and HEPA ; Radiation : Ionizing radiation-γ rays and non ionizing radiation- UVrays
Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents.

Unit – 3: Microbiological techniques 14Hrs

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 – 4: Antimicrobial agents 14Hrs

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

Course 1: Practicals: DSC- Microbiological Methods and Techniques

1. To study the principle and applications of important instruments (biological safetycabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pHmeter) used in the microbiology and Biotechnology laboratory.
2. Sterilization of medium using Autoclave and assessment for sterility
3. Sterilization of glassware using Hot Air Oven and assessment for sterility
4. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
5. Preparation of culture media for bacteria, fungi and their cultivation.
6. Plating techniques: Spread plate, pour plate and streak plate.
7. Isolation of bacteria and fungi from soil, water and air
8. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts
9. Colony characteristics study of bacteria from air exposure plate
10. Staining techniques: Bacteria– Gram, Negative, Capsule, Endospore stainingFungi – Lactophenol cotton blue staining
11. Water analysis - MPN test
12. Biochemical Tests – IMViC, Starch hydrolysis, Catalase test, Gelatin hydrolysis
13. Bacterial cell motility - hanging drop technique

Text Books / References

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004).Microbiology.
5. 5th edition Tata McGraw Hill.
6. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
7. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition Mc Millan.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
11. Microbiology- Concepts and applications by Paul A. Ketchum, Wiley Publications
12. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications
13. Introductory Biotechnology-R.B Singh C.B.D. India(1990)
14. Fundamentals of Bacteriology -Salley
15. Frontiers in Microbial technology-P.S. Bison, CBS Publishers.
16. Biotechnology, International Trends of perspectives A. T. Bull,G.
17. General Microbiology –C.B. Powar

Course 2: Theory: OE- Applications of Biotechnology in Agriculture 42 Hrs

Unit – 1: Agricultural Biotechnology 14 Hrs

Concepts and scope of biotechnology in Agriculture. Plant tissue culture, micro propagation, entrepreneurship in commercial plant tissue culture. Banana tissue culture - primary and secondary commercial setups, Small scale bio enterprises: Mushroom cultivation

Unit – 2: Transgenic plants 14 Hrs

The GM crop debate – safety, ethics, perception and acceptance of GM crops

GM crops case study: Bt cotton, Bt brinjal, Biopesticides: Baculovirus pesticides, Mycopesticides Genetic Engineering for quality improvement: Golden rice, Seed storage proteins, Flavours– capsaicin, vanillin

Unit – 3: Molecular pharming and post-harvest protection 14 Hrs

Plants as bio factories for molecular pharming: edible vaccines, plant bodies, nutraceuticals

Post-harvest Protection:

Antisense RNA technology for extending shelf life of fruits and shelf life of flowers.

Biosafety, bioethics and IPR.

References

1. Chrispeels M.J.et al. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.1994.
2. Gamborg O.L. and Philips G.C.Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. NewDelhi.1998
3. Hammound J, P McGravey &Yusibov.V. Plant Biotechnology, Springerverlag.2000
4. Heldt. Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.1997
5. Lydiane Kyte and John Kleyn.. An introduction to Plants from test tubes.
6. Micropropagation (3 rd. Ed.). Timber Press, Portland.1996
7. Murray D.R. Advanced methods in plant breeding and biotechnology. Panima Publishing Corporation.1996
8. NickoloffJ.A. Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana press incorp, USA.1995.
9. Sawahel W.A. Plant genetic transformation technology. Daya Publishing House, Delhi.1997
10. Gistou, P and Klu, H.Hand book of Plant Biotechnology (Vol. I & II).John Publication.2004
11. Sateesh M.K. 2008. Biosafety and Bioethics. Oxford and IBH Publishers, New Delhi.

BSc Biotechnology (Basic / Hons.) Semester 3

Title of the Courses:

Course 1 : DSC-Biomolecules
Number of Theory Credits-**4** Number of lecture hours/semester-**60**

Course 2 : OE- Nutrition and Health

Number of Theory Credits-**4** Number of lecture hours/semester-**60**

Course Pre-requisite (s):

Course Outcomes (COs): At the end of the course the student should be able to:
1. Acquire knowledge about types of biomolecules, structure, and their functions
2. Will be able to demonstrate the skills to perform bioanalytical techniques
3. Apply comprehensive innovations and skills of biomolecules to biotechnology field

Content **56 Hrs**

Unit–I **14**

Carbohydrates: Introduction, sources, 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 7 properties),Heteropolysaccharides - glycoproteins and proteoglycans (Brief study). Metabolism : Glycolysis and gluconeogenesis, Kreb's cycle, oxidative phosphorylation.

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,), tertiary and quaternary]. Fibrous and globular proteins,Denaturation and renaturation of proteins General aspects of amino acid metabolism: Transamination, deamination, decarboxylation and urea cycle.

Unit–II **14** Hrs

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. Metabolism: Beta oxidation of fatty acids. Biosynthesis of cholesterol.

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).

Unit–III **14** Hrs

Water and fat soluble vitamins, dietary source and biological role of vitamins Deficiencymanifestation of vitamin A, B, C, D, E and K

a) Nucleic acids

Structures of purines and pyrimidines, nucleosides, nucleotides in DNA Denovo and salvage pathway of purine and pyrimidine synthesis.

b) Hormones

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

Unit–IV **14** Hrs

Bioanalytical tools :

a) Chromatography :

Principle, procedure and applications of - paper chromatography, thin layer chromatography, adsorption chromatography, ion exchange chromatography,

gel filtration chromatography, affinity chromatography, gas liquid chromatography and high performance liquid chromatography.

b) Electrophoresis:

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

c) Spectroscopy:

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

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, structure, and their functions	□				□							□
Will be able to demonstrate the skills to perform bioanalytical techniques			□								□	□
Apply comprehensive innovations and skills of biomolecules to biotechnology field	□				□							□

Practical Content

1. Introduction to basic instruments (Principle, standard operating procedure) with demonstration.
2. Definitions and calculations: Molarity, Molality, Normality, Mass percent % (w/w), Percent byvolume (% v/v), parts per million (ppm), parts per billion (ppb), Dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottlelabel reading and precautions.
3. Preparation of standard buffers by Hendersen-Hasselbach equation – Acetate, phosphate, Tris and determination of pH of 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 pigmentsby circular paper chromatography
10. Separation of amino acids by thin layer chromatography

11. Native PAGE
12. Determination of iodine number of lipids

References

1. An Introduction to Practical Biochemistry, 3rd Edition, (2001), David Plummer; Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
2. Biochemical Methods,1st Edition, (1995), S.Sadashivam, A.Manickam; New Age International Publishers, India
3. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing. House, New Delhi, ISBN 81-7319-302-9
4. Experimental Biochemistry: A Student Companion, Beedu SasidharRao& Vijay Despande(ed).I.K International Pvt. LTD, New Delhi. ISBN 81-88237-41-8
5. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, LudhianaISBN 81-7663-067

OE- Nutrition and Health

Number of Theory Credits-**3** Number of lecture hours/semester-**42**

Course Pre-requisite(s):

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

1. Study the concepts of food, nutrition, diet and health
2. To apply the best practices of food intake and dietary requirements
3. Acquire knowledge about various sources of nutrients and good cooking practices

Content **42 Hrs**

Unit–I – Introduction **14** Hrs

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

Unit -II – Nutrients **14** Hrs

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. Fibre –Functions and sources. Recommended Dietary Allowance, Body Mass Index and Basal Metabolic Rate.

Unit -III – Nutrition and Health **14** Hrs

Methods of cooking affecting nutritional value. Advantages and disadvantages. Boiling, steaming, pressure cooking. Oil/Fat – Shallow frying, deep frying. Baking. Nutrition through 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 and Assignments

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 text book 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

BSc Biotechnology (Basic / Hons.) Semester 4

Title of the Courses:

Course 1 : DSC-Molecular Biology
Number of Theory Credits-**4** Number of lecture hours/semester-**60**

Course 2 : OE- Intellectual Property Rights
Number of Theory Credits-**3** Number of lecture hours/semester-**42**

Course Pre-requisite (s):

Course Outcomes (COs): At the end of the course the student should be able to:
1. Study the advancements in molecular biology with latest trends.
2. Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids.
3. Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms.

Content **56 Hrs**

Unit–I **14** Hrs

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) functions of DNA and RNA including ribozymes.

Unit–II **14** Hrs

DNA Replication and Repair

Replication of DNA in prokaryotes and eukaryote– 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 ofeukaryotic chromosome replication, Fidelity of replication DNA damage and Repair mechanism: photo reactivation, excision repair, mismatch repair and SOS repair.

Unit–III **14** Hrs

Transcription and RNA processing

Central dogma, RNA structure and types of RNA, Transcription in prokaryotes RNA polymerase, 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 **14** Hrs

Regulation of gene expression and translation
Genetic code and its characteristics, Wobble hypothesisTranslation- 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 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 latest trends	□				□							□
Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids					□	□						□
Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms	□				□				□			□

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

Course Title- **Molecular Biology** Practical Credits-**2** Contact hours-48

Content

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

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 PressNew 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

Course 2 : OE- Intellectual Property Rights

No. of Theory Credits -3 **Contact hours -42 h**

Course Pre-requisite(s):

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

1. Knowledge about need and scope of Intellectual property rights
2. Acquire knowledge about filing patents, process, and infringement
3. Knowledge about trademarks, industrial designs, and copyright

Content **42 Hrs**

Unit–I - Introduction to Intellectual property rights (IPR): **14** Hrs

Genesis and scope. Types of Intellectual property rights - Patent, Trademarks, 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 - Patenting, process, and infringement **14** Hrs

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)

Unit -III - Trademarks, Copy right, industrial Designs **14** Hrs

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

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

B.Sc. Biotechnology 5th Semester

Course Title- **Genetic Engineering (Theory)**
No. of Theory Credits **-04** Contact hours-**60 hrs**

Course Objectives

1. Understand the fundamental principles and techniques of genetic engineering.
2. Explore the applications of genetic engineering in agriculture, medicine, biotechnology, and environmental science.
3. Develop practical skills in genetic engineering techniques and laboratory procedures.
4. Gain knowledge of gene expression regulation and genetic modification methods.
5. Enhance critical thinking and problem-solving skills through discussions and case studies.
6. Stay updated on emerging trends and advancements in genetic engineering.

Course Outcomes:

1. Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.
2. Apply the knowledge of genetic engineering to diverse applications inagriculture, medicine, biotechnology, and environmental science.
3. Perform laboratory procedures and develop practical skills in geneticengineering techniques.
4. Explain gene expression regulation mechanisms and apply geneticmodification methods effectively.
5. Evaluate genetic engineering's ethical, social, and legal implications andpropose responsible solutions.
6. Stay updated with recent advancements in genetic engineering, criticallyevaluate emerging trends, and assess their potential impact on various fields.

Genetic Engineering - Content of Theory **60 hrs**

Unit I- Fundamentals of Genetic Engineering **15**

Definition, scope, and historical overview of genetic engineering. Importance and applications in various fields.

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

RNA Analysis and Gene Expression- Methods for RNA isolation and purification. Analysis of gene expression.

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, Polymerases, Ligase, kinases, and phosphatases. Techniques for molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.

Unit II- Practices in Genetic Engineering **15**

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- Applications of Genetic Engineering **15**

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- Advances in Genetic Engineering and Ethics **15**

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

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

Course Title- **Genetic Engineering**

Practical Credits-**02** Contact hours-**60 hrs**

Practical Content

1. **Introduction to Laboratory Techniques -** Safety guidelines and laboratory protocols
   Aseptic techniques and proper handling of materials. Basic equipment and instrumentoperation
   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**
   Isolation of Plasmid Restriction
   enzyme digestionLigation reactions
   Transformation of bacterial cells with recombinant plasmidsColony
   selection and screening for successful cloning
5. **Gel Electrophoresis and DNA Analysis**
   Agarose gel electrophoresis for DNA fragment separation and analysis DNA sizedetermination using molecular weight markers
   DNA band visualization techniques (e.g., Ethidium bromide staining,
   DNA intercalating dyes)

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.

B.Sc. Biotechnology 5th Semester

Course Title: **DSC- Plant and Animal Biotechnology (Theory)**

No. of Theory Credits-**04** Contact hours-**60 hrs**

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.
5. Design strategies for plant genetic manipulation against biotic and abiotic stressors.
6. Hypothesize strategies to increase plant yield and fruit/seed quality.
7. Apply knowledge to real-world challenges in agriculture, veterinary medicine, conservation, and biomedical research
8. Understand the need for animal biotechnology for human welfare.

Course Outcomes:

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

1. Demonstrate a comprehensive understanding of plant biology, physiology, genetics, and molecular biology.
2. Apply biotechnological tools and techniques used in plant research and agriculture, such asplant tissue culture, genetic engineering and transgenics.
3. Execute plant tissue culture techniques for callus induction, somatic embryogenesis, and micropropagation, and apply them in plant breeding and propagation.
4. Perform plant transformation methods and demonstrate the ability to introduce foreign genesinto plants using different techniques.
5. Apply knowledge about ethical considerations and regulatory frameworks associated with plant biotechnology and genetically modified crops.
6. Understand the biology and characterization of cultured cells, including their adhesion, proliferation, differentiation, morphology, and identification.
7. Gain practical skills in basic mammalian cell culture techniques, measuring growth parameters, assessing cell viability, and understanding cytotoxicity.
8. Learn about germplasm conservation techniques and the establishment of gene banks, along with large-scale culture methods for cell lines.
9. Explore organ and histotypic culture techniques, biotransformation, 3D cultures, whole embryo culture, somatic cell cloning, and the ethical considerations surrounding stem cellsand their applications.

Plant and Animal Biotechnology - Content of Theory **60 hrs**

Unit–I – Plant Tissue culture methods **15**

Introduction, history, definition, hypothesis, and concept of totipotency. Principles of plant tissue culture, media and laboratory organization, types of culture, morphogenesis, differentiation, callus, direct, indirect organogenesis, and somatic embryogenesis, synthetic seeds.*In vitro* propagation and micropropagation, Seed culture, embryo culture, Meristem culture, bud culture, limitations and 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 Transgenic Plants and biosafety **15**

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 throughgenetic engineering: pest resistance, herbicide tolerance, disease resistance, and abiotic stress tolerance. Biosafety assessment of transgenic plants: potential risks and benefits. International regulatoryframeworks for releasing and commercializing genetically modified organisms (GMOs). Ethical and socio-economic impacts of transgenic crops. Intellectual property rights and access to transgenictechnologies.

Unit–III Animal Cell culture methods **15**

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 Gene transfer in animals and applications **15**

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.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development.

Course Title- **Plant and Animal Biotechnology (**Practical)
Practical Credits-**2** Contact hours-**60 hrs**

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 – Leaf, bud, rhizome, and meristem
4. Synthetic seed production
5. Callus culture- Initiation and establishment of different types of callus cultures
6. Micropropagation with a suitable example – 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 properlyhandling 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 percentageof viable cells.
12. Cell staining and microscopy: Staining the cultured cells using dyes such as hematoxylin andeosin (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.
14. 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.

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). Genetics: A Molecular Approach. 3rd edition. Boston, MA: BenjaminCummings.
8. Slater, A., Scott, N.W., and Fowler, M.R. (2008). Plant Biotechnology: The GeneticManipulation 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: SinauerAssociates.
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 MolecularBiology (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). Advancesin 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 (3rded.). ColdSpring 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. OxfordUniversityPress.
22. Freshney, I. (2016). Culture of Animal Cells: A Manual of Basic Technique andSpecializedApplications (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. TheEnergy andResources 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. InMethods inCell 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.

Course Title- **SEC- Biotechnology Skills and Analytical Techniques**

No. of Theory Credits- **2+1 (Theory+Practical)** Contact hours-**45 hrs**

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

1. 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.
2. Develop knowledge of laboratory safety procedures and protocols and acquire skills in handling and maintaining laboratory equipment and instruments.
3. Operate analytical equipment and instruments as per standard operating procedures (SOP)
4. 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.
5. 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)/ProgramOutcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12	13
Develop knowledge of laboratorysafety procedures and protocolsand acquire skills in handling and maintaining laboratory equipment and instruments.	✓	✓											
Operate analytical equipment andinstruments as per standard operating procedures (SOP)		✓	✓									✓	
Knowledge about major activitiesof the biotech industry, regulationsand compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industrystandards.		✓							✓		✓		
Demonstrate soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking and documentation.	✓	✓						✓	✓				

Biotechnology Skills and Analytical Techniques Content **30 Hrs**

Unit-I Insights into the biotechnology industry and basic professional skills **15**

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 Basic laboratory skills and Analytical Techniques **15**

Analytical skills in the laboratory: Preparations of solutions, molarity, molality, normality, masspercent % (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

Practical Content

Unit-1

Methods and practices of cleaning and management of lab: Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirements for cleaning specific areas, equipment, ventilation area, personal protective requirements Calibration of and use of micropipette.

Unit-2

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-3

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 Chromatographyand 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 ofInstrumental 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 forPrinciples of General Chemistry". Wiley.
4. Michael Lufaso (2016). "Laboratory Skills for Science and Medicine: An Introduction". CRCPress.
5. David J. Livingstone and Christopher H. Amonette (2016). "Analytical Techniques inEnvironmental 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". HumanaPress.
8. Gary D. Christian, Purnendu K. Dasgupta, and Kevin A. Schug (2013). "AnalyticalChemistry". Wiley.
9. Roger L. Lundblad and Fiona M. Macdonald (2010). "Handbook ofBiochemistry andMolecular Biology". CRC Press.

B.Sc. Biotechnology 6th Semester

Course Title: **DSC- Immunology (Theory)**

No. of Theory Credits-**04** Contact hours- **60 hrs**

Course Objectives:

1 To understand the various aspects of immunity, elicitation of immuneresponses, 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 antibodiesand 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:

i. Demonstrate comprehension of the underlying structure andfunction of the immune system and related disorders.
ii. Demonstrate an understanding of the role of cells and molecules inimmune reactions and responses
iii. Demonstrate technical skills in immunological tools and techniques
iv. Apply the domain-specific knowledge and skills acquired in immunology for innovative therapies and Immuno technologies
v. Understand the fundamental concepts of immunity, and thecontributions of the organs and cells in immune responses.
vi. Realize how the MHC molecule's function and host encounters an immune insult.
vii. Understand the antibodies and complement system
viii. Understand the mechanisms involved in the initiation of specific immune responses
ix. Differentiate the humoral and cell-mediated immune mechanisms
x. Comprehend the overreaction by our immune system leading to hypersensitiveconditions and its consequences
xi. Understand unique properties of cancer cells, immune recognition of tumors, immune evasion of cancers

Immunology - Content of Theory 60 Hrs

Unit–I Cells and Organs of the Immune System 15

Introduction to the Immune System: History of Immunology, Types of Immunity: first and second line of defense, innate and acquired/adaptive immunity, specificity, diversity.
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 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, super antigens Immunoglobulins: Classification, structure, and function. Antibody diversity, Monoclonal andpolyclonal antibodies.
Major histocompatibility complexes: Classification, structure, and function. Antigen processing pathways – Cytosolic and Endocytic, Complement Pathways, Cytokines: Classification and function, Hypersensitivity: Reactions – Types I, II, and III. Delayed Type Hypersensitive Response.

Unit -III Immunotechniques and vaccines

Structure and properties of antigens- iso- and allo-antigens, antigen specificity, Cross-reactivity, Precipitation, Immunodiffusion reactions: Radial immunodiffusion, Ouchterlony double diffusion,Immuno electrophoresis. Agglutination: Agglutination reactions. ELISA, RIA. Immunocytochemistry, Fluorescent Techniques.
Vaccines: Conventional, peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, ediblevaccines, plant bodies, and Cancer vaccines.

Unit – IV

Transplantation immunology: Phases in graft rejection and immuno-suppressors. Autoimmune Disorders: Systemic and Organ-specific Autoimmune disorders with examples Immuno deficiencies: Primary and secondary immune deficiencies; acquired immunodeficiencysyndrome
Cancer and the immune system – immune surveillance, immunological escape, cancer antigens,cancer immuno therapy
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).

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

Course Title -**Immunology (Practical)**

Practical Credits-**02** Contact hours-**60 hrs**

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

References

1. Textbook of Immunology, Paul Ajoy, Books and Allied (P) Ltd., 2016
2. Cellular and Molecular Immunology. Abbas, A.K. et al., Elsevier Saunders Co., 2015
3. Essential Immunology. Riott, I.M., Blackwell Scientific Publications, 1994
4. Handbook of Experimental Immunology, Vol. 1 & 2, Weir D.M., Wiley, 1997
5. Immunology. Riott, I.M., Brostoff J., Male, D. Mosby Pub., 2017
6. Immunobiology. Janeway C.A. and Travers, P. Churchill Livingstone Pub., 2016
7. Practical Immunology. Hudson L. and Hay F.C., Blackwell Scientific Pub., 1989
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.

Paul W.E (1989). Fundamentals in Immunology, Raven Press. NY.

Course Title: **DSC- Bioprocess and Environmental Biotechnology (Theory)**

No. of Theory Credits-04 Contact hours -**60 hrs**

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 application of biotechnology in environmentalconservation, 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 out comes:

1. Exploitation of microorganisms for industrial use and their improvement, and formulation of media for efficient growth and production of microbial orcell-based products.
2. The design, operation, and specific applications of various bioreactors.
3. Demonstrate a comprehensive understanding of the fundamental conceptsand principles of environmental biotechnology.
4. Apply knowledge of biotechnological techniques to address environmental challenges, such as pollution control and waste management.
5. Analyze and evaluate environmental biotechnology case studies, research findings, and real-world applications.
6. Design and implement biotechnological approaches for environmental remediation, utilizing microbial processes and biodegradation principles.
7. Evaluate the ethical and sustainable aspects of environmental biotechnology practices and make informed decisions regarding their application in environmental conservation.
8. Communicate scientific concepts and research findings related to environmental biotechnology effectively, both in written and oral forms, to diverse audiences.

Bioprocess and Environmental Biotechnology – Content of Theory 60 hrs.

UNIT- I – Introduction to bioprocess technology 15

Basic principle 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-Bioreactors and downstream processing

Bioreactors- Significance of Impeller, Baffles, Sparger; Specialized bioreactors- design and their functions: airlift bioreactor, tubular bioreactors, membrane bioreactors, tower bioreactors, fluidizedbed 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- 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 biotechnologicalapproaches. Addressing eutrophication through biotechnological interventions. Application of cell immobilization techniques in pollution abatement.

Unit IV-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 bioslurry systems. Xenobiotics. Bio metallurgy and bio- mining. Waste water Management. Waste water Characterization and Composition. Biological Processes inWaste water Treatment. Activated Sludge Process and Biological Nutrient Removal, Anaerobic Digestion and Biogas Production. Solid Waste Management.

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

Course Title- **Bioprocess and Environmental Biotechnology(Practical)**

Practical Credits-**02** Contact hours- **60 hrs**

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.
10. Standard analysis of Water.

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. 2ndedition, Elsevier Science Ltd.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (3rd Edn.).2022
6. Cambridge University Press. 2002.
7. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs,1991.
8. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor &Francis Ltd, UK, 2007.
9. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001.
10. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003.
11. Prentice Hall, Engelwood Cliffs, 2002.
12. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984.
13. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition,
14. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2014). Environmental engineering. McGraw-Hill Education.
15. Banerjee, S., & Santhosh, C. (2019). Environmental biotechnology: Concepts andapplications. CRC Press.
16. Mishra, A. K. (2016). Environmental biotechnology: Basic concepts and applications. CRCPress.
17. Torres, A. E., & López-González, J. A. (2018). Environmental biotechnology: An introduction. John Wiley & Sons.
18. Das, S., & Dash, H. R. (2020). Environmental biotechnology: Principles and applications. Springer.
19. Wackett, L. P., & Hershberger, C. D. (2018). Environmental biotechnology: Theory and application. McGraw-Hill Education.
20. Foster, C. F., & John, W. D. A. (1987). Environmental biotechnology. Ellis HorwoodLimited.
21. Chatterji, A. K. (2002). Introduction to environmental biotechnology. Prentice-Hall of IndiaPvt. Ltd.
22. Ignacimuthu S. (2001). Basic Biotechnology. Rev. Fr. Tata McGraw Hill, New Delhi,
23. Ratledge C. and Kristiansen B. (2002). Basic Biotechnology. Cambridge University Press,UK

PATTERN OF THEORY EXAMINATION

B.Sc – BIOTECHNOLOGY

Theory Question Paper Pattern for DSC, DSE, and OE Courses

Duration: 2 Hours **Maximum: 60 Marks**

All questions are compulsory
Draw neat labeled diagrams wherever necessary

I Answer any EIGHT of the following 2X8=16
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)

II Answer any SIX of the following 4X6=24
(11)
(12)
(13)
(14)
(15)
(16)
(17)
(18)

III Answer any TWO of the following 10X2=20
(19)
(20)
(21)
(22)

PATTERN OF PRACTICAL EXAMINATION

Practical examination – B. Sc BIOTECHNOLOGY

Duration: 3 hours	**Max. Marks: 25**
Q. 1 Major question	08 Marks
Q. 2 Minor question	04 Marks
Q. 3 Identify and comment	2X4 = 08Marks
Q. 4 Viva-voce	05 Marks

PATTERN OF FORMATIVE

ASSESMENT – PRACTICALS	**Max. Marks: 25**
1 IA 1	10 Marks
2 IA 2	10 Marks
3 Record	05 Marks
