Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce, and Science College, Ahmednagar

(Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

National Education Policy (NEP)

Choice Based Credit System (CBCS)

Programme Skeleton and Syllabus of

S. Y. B.Sc. Biotechnology (Major)

Implemented from

Academic Year 2024-25

Credit Distribution: B.Sc. Biotechnology (Major) including Minor and OE and other courses.

	Type of Courses	III Yr	IV Yrs (Honours)	IV Yrs Research
Major Marathi	Discipline-Specific Courses (DSC)	46	74	66
	Discipline Specific Elective (DSE)	08	16	16
	Skill Enhancement Courses (SEC)	06	06	06
	Vocational Skill Courses (VSC)	08	08	08
	On-Job Training (OJT)	04	08	04
	Field Project (FP)	04	04	04
	Community Engagement and Service (CEP)	02	02	02
	Research project	00	00	12
	Research Methodology	00	04	04
	Indian Knowledge System	02	02	02
	Total (I, II and III Year)	80	124	124
Minor	Minor	20	20	20
Other Courses	Open Elective (OE)/ Multidisciplinary Courses	12	12	12
	Co-Curricular Courses	08	08	08
	Ability Enhancement Courses	08	08	08
	Value Education Courses	04	04	04
	Total	132	176	176

B. Sc. Programme Framework: Credit Distribution

Year	Semester	Level	Major											Minor	OE	CC	AEC	VEC	Total
			DSC		DSE		SEC		VSC		FP/OJT		IKS						
			T	P	T	P	T	P	T	P	T	P		T/ P	-	-	-	-	-
I	I	4.5	4	2	-	-	-	2	-	-	-	-	2	03	3	2	2	2	22
			6	-	-	-		2	-	2	-	-		03	3	2	2	2	22
Exit Option: Award of UG Certificate in Major with 44 credits and an additional 4 credit core NSQF course /Internship or Continue with Major and Minor																			
II	III	5.0	6	2	-	-		2	-	-	-	2		03	3	2	2	-	22
II	IV	5.0	6	2	-	-		-	-	2	-	2		03	3	2	2	-	22
Exit Option: Award of UG Diploma in Major with 88 credits and an additional 4 credit core NSQF course /Internship or Continue with major and minor																			
III	V	5.5	8	2	2	2	-	-	-	2		2		04	-	-	-	-	-	22
III	VI	5.5	6	2	2	2	-	-	-	2		4		04	-	-	-	-	-	22
Exit Option: Award of UG Degree in Major and Minor with 132 credits or continue with Major for a 4-year Degree																			
IV	VII	6.0	8	6	2	2	RM-4		-	-	-	-		-	-	-	-	-	-	-	22
IV	VII I	6.0	8	6	2	2	-	-	-	-	-	4		-	-	-	-	-	-	-	22
Four Year UG Degree(Honours) with Major and Minor with 176 credits																			
IV	VII	6.0	6	4	2	2	RM-4		-	-	-	4		-	-	-	-	-	-	-	22
IV	VII I	6.0	6	4	2	2	-	-	0	-	-	8		-	-	-	-	-	-	-	22
Four Year UG Degree (Honours with Research) with Major and Minor with 176 credits																			

B. Sc. Programme Framework: Course Distribution

Year	Semester	Level	Major											Minor		OE	CC	AEC	VEC	Total
			DSC		DSE		SEC		VSC		FP/OJT /IN/CEP		IKS							
			T	P	T	P	T	P	T	P	T	P		T	P					
I	-	-	T	P	T	P	T	P	T	P	T	P		T	P	-	-	-	-	-
I	I	4.5	**2**	**1**	-	-	-	1	-	-	-	-	1	1		1	1	1	1	10
	II	4.5	**2**	-	-	-		1	-	**1**	-	-		1		1	1	1	1	09
Exit Option: Award of UG Certificate in Major with 44 credits and an additional 4 credit core NSQF course /Internship or Continue with major and minor																				
II	III	5.0	**2**	**1**	-	-		**1**	-	-	-	**1**		1		1	1	1	-	09
II	IV	5.0	**2**	**1**	-	-		-	-	**1**	-	**1**		1		1	1	1	-	09
Exit Option: Award of UG Diploma in Major with 88 credits and an \additional 4 credit core NSQF course /Internship or Continue with major and minor																				
III	V	5.5	**2**	**1**	**1**	**1**	-	-	-	**1**		**1**		1		-	-	-	-	08
III	VI	5.5	**2**	**1**	**1**	**1**	-	-	-	**1**		**1**		1		-	-	-	-	08
Exit Option: Award of UG Degree in Major and Minor with 132 credits or continue with Major for a 4-year Degree																				
IV	VII	6.0	**3**	**3**	**1**	**1**	**0**	**1**	-	-	-	-		-	-	-	-	-	-	09
IV	VIII	6.0	3	**3**	**1**	**1**	-	-	-	-	-	**1**		-	-	-	-	-	-	09
Four Year UG Degree(Honours) with Major and Minor with 176 credits																				
IV	VII	6.0	**2**	**2**	**1**	**1**	**0**	**1**	-	-	-	**1**		-	-	-	-	-	-	08
IV	VIII	6.0	**2**	**2**	**1**	**1**	-	-	-	-	-	**1**		-	-	-	-	-	-	07
Four Year UG Degree (Honours with Research) with Major and Minor with 176 credits																				

Programme Framework (Course Distribution): B.Sc. Biotechnology (Major)

Year	Semester	Level	Major											Total	
			DSC		DSE		SEC		VSC		FP/OJT /IN/CEP/PR		IKS		
			T	P	T	P	T	P	T	P	T	P	T	T	P/PR
I	I	4.5	2	1	-	-	-	1	-	-	-	-	01	03	02
I	II	4.5	2	-	-	-		1	-	1	-	-		02	02
II	III	5.0	2	1	-	-		1	-	-	-	1		02	03
II	IV	5.0	2	1	-	-		-	-	1	-	1		02	03
III	V	5.5	2	1	1	1	-	-	-	1		1		03	04
III	VI	5.5	2	1	1	1	-	-	-	1		1		03	04
B.Sc. Honours															
IV	VII	6.0	3	3	1	1	RM-1		-	-	-	-		05	04
IV	VIII	6.0	3	3	1	1	-	-	-	-	-	1		04	05
B.Sc. Honours with Research															
IV	VII	6.0	2	2	1	1	RM-1		-	-	-	1		04	04
IV	VIII	6.0	2	2	1	1	-	-	-	-	-	1		03	04

Programme Framework (Credit Distribution): B.Sc. Biotechnology (Major)

Year	Semester	Level	Major											Total
			DSC		DSE		SEC		VSC		FP/OJT /IN/CEP/RP		IKS	
			T	P	T	P	T	P	T	P	T	P	**T**	
I	I	4.5	4	2	-	-	-	2	-	-	-	-	02	10
I	II	4.5	6	-	-	-		2	-	2	-	-		10
II	III	5.0	6	2	-	-		2	-	-	-	2		12
II	IV	5.0	6	2	-	-		-	-	2	-	2		12
III	V	5.5	8	2	2	2	-	-	-	2		2		18
III	VI	5.5	6	2	2	2	-	-	-	2		4		18
IV	VII	6.0	8	6	2	2	RM-4		-	-	-	-		22

IV	VIII	6.0	8	6	2	2	-	-	-	-	-	4		22
IV	VII	6.0	6	4	2	2	RM-4	-	-	-	-	4		22
IV	VIII	6.0	6	4	2	2	-	-	-	-	-	8		22

Programme Framework (Courses and Credits): B.Sc. Biotechnology (Major)

Sr. No.	Year	Sem	Level	Course Type	Course Code	Title	Credits
1.	I	I	4.5	DSC-1	BS-BT111T	Microbiological Techniques	02
2.	I	I	4.5	DSC-2	BS-BT112T	Biomolecules	02
3.	I	I	4.5	DSC-3	BS-BT113P	Practicals in Microbiological Techniques	02
4.	I	I	4.5	SEC-1	BS-BT114P	Practicals in Biomolecules	02
5.	I	I	4.5	IKS-1	BS-BT115T	Biotechnology – Indian Perspective	02
6.	I	II	4.5	DSC-4	BS-BT121T	Basics in Plant and Animal Sciences	03
7.	I	II	4.5	DSC-5	BS-BT122T	Bioinstrumentation	03
8.	I	II	4.5	SEC-2	BS-BT123P	Practicals in Animal and Plant Sciences	02
9.	I	II	4.5	VSC-1	BS-BT124P	Bioinstrumentation Techniques	02
10	II	III	5.0	DSC-6	BS-BT231T	Cell Biology	03
11	II	III	5.0	DSC-7	BS-BT232T	Genetics and Immunology	03
12	II	III	5.0	DSC-8	BS-BT233P	Practicals in Cell Biology	02
13	II	III	5.0	SEC-3	BS-BT234P	Practicals in Genetics and Immunology	02
14	II	III	5.0	FP-01	BS-BT235P	-	02

15	II	IV	5.0	DSC-9	BS-BT241T	Animal and Plant Development	03
16	II	IV	5.0	DSC-10	BS-BT242T	Molecular Biology	03
17	II	IV	5.0	DSC-11	BS-BT243P	Practicals in Animal and Plant Development	02
18	II	IV	5.0	VSC-2	BS-BT244P	Practicals in Molecular Biology	02
19	II	IV	5.0	CEP-01	BS-BT245P	-	02
20	III	V	5.5	DSC-12	BS-BT351T	Animal and Plant Tissue Culture	04
21	III	V	5.5	DSC-13	BS-BT352T+P	Ecology and Environtmental Biotechnology	04
22	III	V	5.5	DSC-14	BS-BT353P	Practicals in Animal Tissue Culture	02
23	III	V	5.5	DSE-01	BS-BT354T(A) BS-BT354T(B)	Metabolism OR Biodiversity and Evolution	02
24	III	V	5.5	DSE-02	BS-BT355P(A) BS-BT355P(B)	Practicals in Metabolism OR Practicals in Biodiversity and Evolution	**02**
25	III	V	5.5	VSC-3	BS-BT356P	Practicals in Plant Tissue Culture	02
26	III	V	5.5	FP-02	BS-BT357Pr	--	02
27	III	VI	5.5	DSC-15	BS-BT361T	Microbial Biotechnology	03
28	III	VI	5.5	DSC-16	BS-BT362T	Recombinant DNA Technology	03
29	III	VI	5.5	DSC-17	BS-BT363P	Practicals in Microbial Biotechnology	**02**
30	III	VI	5.5	DSE-03	BS-BT364T(A)	Enzyme Technology OR Food Biotechnology	02

					BS-BT364T(B)		
31	III	VI	5.5	DSE-04	BS-BT365P(A)	Practicals in Enzyme Technology	02
					BS-BT365P(B)	OR Practicals in Food Biotechnology	
32	III	VI	5.5	VSC-4	BS-BT366P	Practicals in Recombinant DNA Technology	02
33	III	VI	5.5	OJT-01	BS-BT367P	-	04

B.Sc. Biotechnology (Major with Honours)

34.	IV	VII	6.0	DSC-18	BS-BT471T	Plant Biotechnology	03
35.	IV	VII	6.0	DSC-19	BS-BT472T	Advanced Biological Chemistry	03
36.	IV	VII	6.0	DSC-20	BS-BT473T	Bioinformatics	02
37.	IV	VII	6.0	DSC-21	BS-BT474P	Practicals in Plant Biotechnology	02
38.	IV	VII	6.0	DSC-22	BS-BT475P	Practicals in Advanced Biological Chemistry	02
39.	IV	VII	6.0	DSC-23	BS-BT476P	Practicals in Bioinformatics	02
40.	IV	VII	6.0	DSE-05	BS-BT477T(A)	Nanobiotechnology	02
						OR	
					BS-BT477T(B)	Pharmaceutical Biotechnology	
41.	IV	VII	6.0	DSE-06	BS-BT478P(A)	Practicals in Nanobiotechnology	02
						OR	
					BS-BT478P(B)	Practicals in Pharmaceutical Biotechnology	
42.	IV	VII	6.0	RM-01	BS-BT479T/P	Research Methodology	04

43.	IV	VIII	6.0	DSC-24	BS-BT481T	Animal Biotechnology	03
44.	IV	VIII	6.0	DSC-25	BS-BT482T	Advanced Bioanalytical Techniques	03
45.	IV	VIII	6.0	DSC-26	BS-BT483T	Large Scale Manufacturing Process	02
46.	IV	VIII	6.0	DSC-27	BS-BT484P	Practicals in Animal Biotechnology	02
47.	IV	VIII	6.0	DSC-28	BS-BT485P	Practicals in Advanced Bioanalytical Techniques	02
48.	IV	VIII	6.0	DSC-29	BS-BT486P	Practicals in Large Scale Manufacturing Process	02
49.	IV	VIII	6.0	DSE-07	BS-BT487T(A) BS-BT487T(B)	Environmental Biotechnology OR Biostatistics	02
50.	IV	VIII	6.0	DSE-08	BS-BT488P(A) BS-BT488P(B)	Practicals in Environmental Biotechnology OR Practicals in Biostatistics	02
51.	IV	VIII	6.0	OJT-02	BS-BT489P	--	04

B.Sc. Biotechnology (Major Honours with Research)

34.	IV	VII	6.0	DSC-20	BS-BT471T	Plant Biotechnology	03
35.	IV	VII	6.0	DSC-21	BS-BT472T	Advanced Biological Chemistry	03
36.	IV	VII	6.0	DSC-22	BS-BT473P	Practicals in Plant Biotechnology	02
37.	IV	VII	6.0	DSC-23	BS-BT474P	Practicals in Advanced Biological Chemistry	02
38.	IV	VII	6.0	DSE-05	BS-BT475T(A) BS-BT475T(B)	Bioinformatics OR Pharmaceutical Biotechnology	02

39.	IV	VII	6.0	DSE-06	BS-BT476P(A) BS-BT476P(B)	Bioinformatics OR Practicals in Pharmaceutical Biotechnology	02
40.	IV	VII	6.0	RM-01	BS-BT477T/P	Research Methodology	04
41.	IV	VII	6.0	RP-01	BS-BT478P	Project	04
42.	IV	VIII	6.0	DSC-20	BS-BT481T	Animal Biotechnology	03
43.	IV	VIII	6.0	DSC-21	BS-BT482T	Advanced Bioanalytical Techniques	03
44.	IV	VIII	6.0	DSC-22	BS-BT483P	Practicals in Animal Biotechnology	02
45.	IV	VIII	6.0	DSC-23	BS-BT484P	Practicals in Advanced Bioanalytical Techniques	02
46.	IV	VIII	6.0	DSE-07	BS-BT485T(A) BS-BT485T(B)	Environmental Biotechnology OR Biostatistics	02
47.	IV	VIII	6.0	DSE-08	BS-BT486P(A) BS-BT486P(B)	Practicals in Environmental Biotechnology OR Practicals in Biostatistics	02
48.	IV	VIII	6.0	RP-02	BS-BT487Pr	Project	08

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Board of Studies in Biotechnology

Sr. No.	Name	Designation
1.	Dr. Shubhangi S. Moharekar	Chairman
2.	Dr. Sanjay T. Moharekar	Member
3.	Dr. Sarika R. Deshmukh	Member
4.	Mr. Ashish S. Wani	Member
5.	Dr. Bimalendu B. Nath	Vice-Chancellor Nominee
6.	Prof. Dr. Nitin S. Desai	Academic Council Nominee
7.	Dr. Jyoti P. Jadhav	Academic Council Nominee
8.	Mr. Nitin Shirole	Industry Expert
9.	Mr. Sachin R. Adsare	Alumni
10.	Dr. Aparnna A. Kulkarni	Member (co-opt)
11.	Mr. Girish P. Kukreja	Member (co-opt)

1. Prologue/ Introduction of the programme:

Biotechnology has expanded and established as an advanced interdisciplinary applied science. The study of Life itself is at the core of it and the interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted to not only current "Century of Knowledge" but also on to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work. The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies

from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on. The ce and application of these studies on living organisms and their bioprocesses is extensively covered in this field with the help of technology. Green revolution and white revolution was possible in India thanks to the deeper and intrinsic understanding of biotechnology.

The restructures syllabus is a choice based credit system with semester pattern. Biotechnology has grown extensively in last couple of decades. The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of technological as well as the economical aspects of modern biology. The proposed credit based curriculum ensures the requirement of academia and industry. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions) without any additional training. Thus, the universit*y/*college itself will be developing the trained and skilled man-power. Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical and biological sciences along with developing advanced technology.

Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

The basic aim of the revised course curriculum is to integrate various disciplines of life sciences which will cater the needs of human resources in academia and industry. The Overall objective of the Program is to promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in academics, government organization, biomedical sectors, health and nutrition settings for ultimate benefit of society and sustainable development.

2. Programme Outcomes (POs)

Students enrolled in the program complete a curriculum that exposes and trains students in a full range of essential skills and abilities. They will have the opportunity to master the following objectives.

The objectives of the course curriculum are:

- To introduce the concepts in various allied subjects
- To enrich students' knowledge in basic and applied aspects of life sciences.
- To help the students to build interdisciplinary approach in teaching/ learning and in research.
- To inculcate the sense of scientific responsibilities and social awareness
- To help students build-up a progressive and successful career in academia and industry.

The present course curriculum will generate skilled human resource required in academia and Industry. In general, as a result of this program, the student will be able to achieve basic and advance knowledge based proficiency in applied subjects of life sciences, create and develop students with interdisciplinary mind set for learning science, improve problem solving aptitude using scientific methods in biotechnology and allied subjects, will adopt scientific approach for implications of biotechnology in society, environment and education, will demonstrate knowledge and learn various biological processes at cellular and molecular level and get expertise in the different techniques used in the fields of Biotechnology.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar

(Autonomous)

Syllabus

B.Sc. Biotechnology (Major)

Title of the Course: Cell biology								
Year: II				**Semester: III**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-6	BS-BT231 T	03	00	03	45	30	70	100

Learning Objectives:

1. To learn the scope and importance of cell biology.
2. To learn the cell cycle phases and their control.
3. To understand the process of cell signaling.
4. To learn the process of cell death.

Course Outcomes (Cos):

1. Students will learn different types of cells, functional and structural similarities and differences between them.
2. Students will understand structure and function of organelles.
3. Students will learn membrane and its transport system.
4. Students will understand cell communication and other cellular components.

Detailed Syllabus:

Unit I: Introduction to Cell **5**

Discovery of cell and cell theory

Exceptions to cell theory, phages, viroids, mycoplasma, prions,

Types of cell: Prokaryotic and eukaryotic cell

Plant and animal cell and their features

Cellular diversity

Unit II: Cell membrane **6**

Chemical components of biological membranes

Fluid mosaic model, membrane as a dynamic entity

Functions of cell membrane

Membrane transport: Active and passive transport with one example

Bulk transport: exocytosis, endocytosis

Unit III: Structure, components and functions of cell organelle:

Nucleus **7**

Mitochondria

Chloroplast

Lysosome and Vacuole

Rough endoplasmic reticulum and smooth endoplasmic reticulum

Golgi Bodies

Ribosome

Glyoxysome and peroxisome

Unit IV: Cell communication **10**

Cell junctions: Gap junction, adherens junction, anchoring junction, tight junction, desmosome, hemidesmosome and plasmodesmata

Extracellular matrix: Structure, Types (Basement membrane, Interstitial matrix), Composition (Glycosaminoglycans, glycoproteins, fibrous protein) and function

Cytoskeleton: Structure and function of microfilaments, microtubules, intermediate filaments

Unit V: Cell cycle and Cell division **5**

Introduction to cell cycle

Phases and check points of cell cycle

Cell division in plant and animal: Mitosis and Meiosis

Unit VI: Cell signaling **9**

Signalling molecules: cyclic AMP (cAMP), cyclic GMP (cGMP), 1,2-diacylglycerol (DAG), inositol 1,4,5-trisphosphate (IP3) and Ca^{2+}

Signalling receptors: Cell surface receptors

Autocrine, syncrine, paracrine and juxtacrine signalling

G-protein signalling

Calcium signalling

Unit VII: Cell death **3**

Aging, necrosis, senescence and apoptosis

Neoplasia

Autophagy

Ferroptosis

Pyroptosis

Suggested Readings:

1. Molecular Cell Biology. 8th Edition, (2016) Lodish H., Berk A, Kaiser C., K Reiger M. Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA General Chemistry
2. Cell Biology and, 9th edition, (2019) Gerald Karp. John Wiley & Sons., USA
3. Karp, G. 2013. Cell and Molecular Biology: Concepts and Experiments. 7th Edition. John Wiley & Sons. Inc.
4. Cooper, G.M. and Hausman, R.E. 2018. The Cell: A Molecular Approach. Eighth edition. ASM Press& Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Molecular Cell Biology. 9th Edition, (2021) Lodish H., Berk A, Kaiser C., K Reiger M. Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA General Chemistry, 1st edition (2000), C.N. R. Rao, Macmillan Publishers, India

Title of the Course: Genetics and Immunology								
Year: II				**Semester: III**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-7	BS-BT 232T	03	00	03	45	30	70	100

Learning Objectives:

1. To understand basic principles of inheritance
2. To understand chromosomal aberrations, mutation, linkage and recombination
3. To study different cells and organs of immune system
4. To study different techniques of Immunology
5. To study Autoimmunity and Hypersensitivity

Course Outcomes (COs):

1. Students are able to understand the basic principles of inheritance biology.
2. They get in-depth knowledge about gene interaction, epistasis and pleiotropism.
3. Students will study the mechanisms Linkage, recombination and genetic disorders.
4. Students will learn the scope and importance of immune system and immunology.
5. Students will learn different types of immunity, immune cells, antigen, antibody and its interactions, vaccines and its types,

Detailed Syllabus:

Genetics

Unit I: Mendelian Genetics: **07**

Variations, Heredity, Pre- Mendelian Concept, Importance of Genetics Mendel's Experiments, Mendel's Laws, Monohybrid and Dihybrid cross, Deviation from Mendel's Law- Incomplete Dominance, Co Dominance, Gene Interaction- Epistasis, Multiple Allele

Unit II: Chromosomal aberrations and Mutation - **08**

Numerical aberrations - euploidy, aneuploidy, polyploidy, mosaics, trisomy and monosomy. Structural aberrations: translocation, inversion, duplication, deletion. Classification and types, molecular basis of mutations, Mutagens and their action,

hot spot mutations.

Unit III: Linkage and Recombination- **08**

Discovery of Linkage, Complete and incomplete linkage, crossing over, two-point cross, Recombination Frequency and Map Distance

Genetic Disorders -

Sickle Cell Anemia, Hemophilia, Colour Blindness, Albinism, Down's and Kleinfelter's Syndrome, Genetic Counseling

Immunology

Unit IV: Introduction to Immunology **09**

Antigens: Types and properties
Types of immunity: Innate and acquired immunity
Organization of Immune system
Hematopoiesis, Structure and function of the cells of immune system
Structure and function of Primary (Thymus, Bone marrow) and Secondary lymphoid organs (Lymph, Lymph node, Spleen)

Unit V: Humoral and Cell mediated immune response **07**

B and T cell activation and proliferation
Humoral immune response
Immunoglobulin: Properties and function of different Immunoglobulin classes.
Cell mediated immune response
Cytokines: Types, properties and their function

Unit VI: Antigen and Antibody Interactions **06**

Agglutination, Precipitation, Immunodiffusion, ELISA
Concept of Autoimmunity and Hypersensitivity
Vaccine and its types

Suggested Readings/Material:

1. Genetics: Strickberger M W (2006) (Prentice Hall, India)
2. Genetics: analysis of genes and genomes by Hartl DL, Jones EW (2001) –(Jones and Bartlett, Massachusetts)
3. Introduction to genetic analysis by Griffiths AJ, Wessler SR, Carroll SB, Doebley J (2012) (Freeman & Co, New York) tenth edition.
4. Molecular genetics of bacteria (ASM Press, Washington) Snyder L, Champness W (2007)
5. Textbook of Cell Biology, Genetics, molecular biology , Ecology and Evolution.: P.S. Verma and V.KAgarwal (2001)

6. Principals of Genetics: Robert H. Tamarin, 7th Edition.
7. GENES IX (2006): Benjamin Lewin.
8. Concepts of genetics (2011) : Robert Brooker.
9. Genetics: A Mendelian Approach (2006) :Peter J. Russell
10. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. University Press Publication
11. Sudha Gangal and Shubhangi Sontakke, Textbook of basic and clinical immunology, 1st edition (2013), University Press, India.
12. Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
13. Kuby. Immunology. 4th edition. W. H. Freeman & company.

Title of the Course: Practical in Cell biology								
Year: II				**Semester: III**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-8	BS-BT233 P	00	02	02	60	15	35	50

Learning Objectives:

1. To learn about cell division in plant.
2. To study micrometry technique.
3. To study prokaryotic and eukaryotic cell structure using electron micrographs.
4. To gain knowledge of by differential centrifugation for organelle isolation.

Course Outcomes (Cos)

1. Students will learn to isolate and characterize subcellular organelles
2. Students can analyze the methods cell lysis.
3. Students will able to study different stages of mitosis and meiosis.
4. Students can measure size of cell using micrometry.

Detailed Syllabus:

Sr. No.	**Name of Practical**	**No. of Practical**
1.	Micrometry- Measurement of cell size of different types of cells	01
2.	Study of Prokaryotic and eukaryotic cell structure using Electron micrographs of all-important cell organelles.	01
3.	Isolation and characterization (Qualitative) of the following subcellular components, using appropriate samples, by differential centrifugation. a. Nuclei b. Mitochondria c. Chloroplast d. Lysosome	02
4.	Study of different types of cells (plant and animal)	02
5.	Study of different stages of mitosis using appropriate plant sample.	02

6.	Effect of colchicine on mitosis.	01
7.	Study of different stages of meiosis (plant/animal).	02
8.	Visit to National Institute of cell center.	01

Title of the Course: Practical in Genetics and Immunology								
Year: II				**Semester: III**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
SEC-3	BS-BT234P	00	02	02	60	15	35	50

Learning Objectives:

1. To acquire a comprehensive understanding of various immunological techniques for practical application.
2. To demonstrate comprehension of the structures of diverse immunological cells, emphasizing their roles in immune responses.
3. To apply the concepts of epistasis and gene interaction to solve problems, showcasing a practical understanding of genetic interactions.
4. To develop problem-solving proficiency in Mendelian and non-Mendelian inheritance, sex linkage, mapping, and karyotype analysis through practical applications.

Course Outcomes (Cos)

1. Students will gain knowledge about immunological techniques
2. Students will understand structure of different immunological cells.
3. Students will able to understand concept of epistasis, gene interaction and solve problems based on it
4. Students will learn the problems based on Mendelian and non-Mendelian inheritance, sex linkage, mapping and karyotype analysis.

Detailed Syllabus:

Sr. No.	**Title of Practical**	**Number of Practicals**
1.	Problems based on Mendelian Inheritance- Monohybrid and Dihybrid cross	1
2.	Problems based on Non- Mendelian Inheritance- Co-dominance, Incomplete dominance	1
3.	Problems based on epistasis, gene interaction and multiple alleles	1

4.	Problems based on sex linked inheritance	1
5.	Problems based on linkage, mapping and karyotype analysis	1
6.	Visit to diagnostics laboratory /Agricultural university/ Seed company	1
7.	Blood group detection by agglutination reaction.	1
8.	Total leukocyte of given blood sample	1
9.	Differential count of given blood sample	1
10.	Ouchterlony double diffusion	1
11.	Determination of antibody titer by slide agglutination test (Widal Test)	1
12.	Detection of presence of antigen by qualitative ELISA (Dot ELISA)	1

Title of the Course: Field Project								
Year: II				**Semester: IV**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
FP-01	BS-BT235P	00	02	02	30	15	35	50

Learning Objectives:

1. To understand concept of field project.
2. To learn role of different authorities in various biotechnological fields.
3. To understand working of instruments in industries.
4. To learn about biotechnological plant.

Course Outcomes (Cos)

1. Students will study the concept of field project.
2. Students will understand role of different authorities in various biotechnological fields
3. Students will understand working of instruments in industries.
4. Students will learn about biotechnological plant.

Syllabus:

1. All students have to do internship at any biotechnological field.
2. The duration should be 30 hours.
3. Students should bring certificate of internship from the concerned institute.
4. Students have to submit report on the training subject and purpose.
5. The marks will be given accordingly.

Title of the Course: Animal and Plant Development								
Year: II				**Semester: IV**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-9	BS-BT241T	03	00	03	45	30	70	100

Learning Objectives:

1. To understand concept of development in plant and animals.
2. To learn role of different genes in pattern formation.
3. To understand concept of regeneration of various organs in animals.
4. To learn plant reproductive process.

Course Outcomes (Cos)

1. Students will study the model organisms.
2. Students will understand the mechanisms of cell death
3. Students will understand structure and development of reproductive organs.
4. Students will learn embryo development.

Detailed Syllabus:

Section I: Animal Development:

Unit I: Introduction to Developmental Biology **02**

Model organisms in study of developmental biology: frog, chick, mouse, Drosophila, Sea urchin, Zebra Fish, *C. elegans*

Unit II: Reproduction and Development: **07**

Gametogenesis: Types – Oogenesis and spermatogenesis, Fertilization process in sea urchin and mammals, Types of eggs, Types and patterns of cleavage, Blastulation.

Unit III: Gastrulation, Neurulation and Pattern Formation: **07**

Morphogenetic movements**,** Gastrulation in *Amphioxus*, frog, chick, *Drosophila* up to formation of three germinal layers, Concept of neurulation, Concept of pattern formation: Maternal effect genes and their role in Drosophila pattern formation

Unit IV: Cellular fate **07**

Differentiation: Concept of Stem cells, Progenitor cells, cell lineages, determination,

commitment and differentiation, redifferentiation and trans-differentiation**,**

Regeneration: Different types of regeneration with one example of each type**,**

Ageing and apoptosis: Theories of ageing, Apoptosis during Embryonic development, intrinsic and extrinsic pathways

Teratogenesis in animals

Section II: Plant Development

Unit V: Plant as a living system **05**

Unique features of plant development, Plant development at Cellular, organ and whole-plant levels, Concept of competence, Determination, Commitment, Differentiation, De-differentiation and Re-differentiation (partial/ terminal) *in vivo*

Unit VI: Major phases of plant development **08**

Vegetative development: Seed germination, seedling till vegetative maturity, Pattern formation in plants.

Reproductive development: Shift from vegetative to reproductive phase, Induction-perception of inductive stimuli and subsequent changes, Developmental plasticity, Role of plant growth regulators in growth, development and Senescence.

Unit VII: Phases of Sexual Reproduction in plant **07**

Microsporogenesis - development of male gametophyte and male gamete, Megasprogenesis - development of female gametophyte and female gamete, Double fertilization and triple fusion, Development of embryo (monocot and dicot), endosperm and its types

Unit VIII: Model plant- *Arabidopsis thaliana* **03**

Model systems to understand plant development - Arabidopsis, Pattern formation in flowering (ABCDE model), Molecular regulation of development in Arabidopsis

Suggested Readings:

1. Development Biology, 9th edition, (2010), Gilbert S.F. (Sinauer Associates, USA)

2. Principles of Development, 5thedition (2018), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.

3. An introduction to embryology, 5th edition, B. I. Balinsky, B.C. Fabian (2012) Cengage Learning India.

Title of the Course: Molecular Biology								
Year: II				**Semester: IV**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-10	BS-BT242T	03	00	03	45	30	70	100

Learning Objectives:

1. To understand basics of molecular biology
2. To learn concept of central dogma.
3. To study different mechanisms of mRNA modification and protein maturation.
4. To understand different types of mutations and their repair systems.

Course Outcomes (Cos)

1. Students will acquire basic knowledge about structure and function of DNA, RNA and protein.
2. Students will able to distinguish between prokaryotic and eukaryotic DNA replication, transcription, translation and gene regulation
3. Students will study the organization of genome and regulatory sequences.
4. Students will understand RNA processing and protein modification.

Detailed Syllabus:

Unit I: DNA as the genetic material **02**

Introduction

Different classical experiments leading to evidence of DNA as geneticmaterial- Griffith's experiment, Avery experiment, Hershey and Chase experiment

Unit II: Nucleic acids **03**

Discovery of DNA structure, Watson and Crick model

DNA forms: A, B and Z

RNA: tRNA, rRNA , mRNA and non-coding RNA

Unit III: Concept and Organization of Genomes **07**

Genome organization: Viral, Bacterial, Organelles

Eukaryotic genome: Chromatin structure- nucleosomes, histone, non-histone proteins, 30nm fiber, chromosomal organization and structure, euchromatin,

heterochromatin,centromere, telomere.

Gene families, gene clusters and pseudogenes

Unit IV: Gene **04**

Definition of gene, introns, exons, regulatory sequences, promoters,enhancers and suppressors

Central dogma of Molecular Biology and exceptions to Central Dogma

Unit V: DNA replication **07**

DNA synthesis: general principles, bidirectional replication, Conservative, Semiconservative and dispersive nature of DNA replication, rolling circle replication (D-loop)

Replication complex: Enzymes involved in DNA replication, overview of unique aspects of eukaryotic and prokaryotic DNA replication, their differences and fidelity of replication

Unit VI: DNA damage and repair **05**

Mutagens: Physical and chemical mutagens

Mutation: Point mutations, Transition and transversion, Missence, Nonsence, neutral and silent mutation

DNA repair mechanisms: Photoreactivation, nucleotide excision repair, mismatch repair

Unit VII: Transcription **08**

Mechanism of transcription: Initiation, elongation and termination of transcription in prokaryotes

Regulation of transcription:

Inhibitors of transcription

Gene regulation in prokaryotes: concept of operons, Inducible and Repressible gene expression, Negative and positive regulation, lac operon, arabinose operon, tryptophan operon

Regulation of Translation,

Overview of eukaryotic transcription

Unit VIII: Translation **08**

Mechanism of translation: Initiation, elongation and termination of translation in prokaryotes

Inhibitors of translation

Genetic Code-Major scientific contributions to decipher genetic code

Concept of codon, reading frame, frame shift

Properties of codon

Overview of eukaryotic translation

Suggested Readings:

1. Genes X, 10th edition (2009), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc. USA
2. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker
3. Principles of Gene manipulation and Genomics. - S.B. Primrose and R.M. Twyman.Blackwell Publication
4. Recombinant DNA - Genes and Genomes. - James D. Watson, Any A candy, RichardM.M, Jan A Witkowski. W.H. Freeman and Company Publication.

Title of the Course: Practicals in Animal and Plant Development								
Year: II				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-11	BS-BT243P	00	02	02	60	15	35	50

Learning Objectives:

1. Students will study the development of frog and amphioxus by observing the stages of their life cycle.
2. Students will able to perform staging and staining of chick embryos at 24 h, 48h, 72 h.
3. Students will learn the concept of teratogenesis and regeneration in *Hydra*.
4. Understand structure and development of plant reproductive organs
5. Observation of dicot and monocot embryo

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Course Outcomes (COs):

1. Students will study the development of frog and amphioxus by observing the stages of their life cycle.
2. Students will able to perform staging and staining of Chick embryos at 24 h, 48h, 72 h.
3. Students will learn the concept of teratogenesis and regeneration in *Hydra*.

Detailed Syllabus:

Sr. No.	**Title of Experiment**	**No. of practical**
	Animal development	
1.	Study of frog and amphioxus development, observation of different development stages (Permanent slides or fixed embryos)	01
2.	Culturing of *Drosophila* to study its developmental stages.	01
3.	Study of staging and staining of chick embryos (24 h, 48h, 72 h)	03
4.	Effect of teratogen on development of chick embryo by window technique	01

Plant development

6	Methods of studying plant development (any suitable plant material) a) Dissection b) Sectioning c) Staining d) Mounting	01
7	Study of apices and meristem –Root apical meristem (RAM), shoot apical meristem (SAM), florally induced meristem	01
8.	Study of Microsporogenesis- anther squash technique	01
9.	Study of development of male and female gametophytes	01
10.	Study of developmental stages during plant embryogenesis in dicot and monocot.	01
11.	Visit to Agricultural university/ Research institute.	01

Title of the Course: Practical in Molecular Biology								
Year: II				**Semester: IV**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
VSC-10	BS-BT 244P	00	02	02	60	15	35	50

Learning Objectives:

1. To learn isolation of genomic DNA.
2. To gain knowledge of determination of concentration and purity of isolated DNA.
3. To understand qualitative analysis of isolated DNA by agarose gel electrophoresis.
4. To study protein separation by SDS-PAGE

Course Outcomes (Cos):

1. Students will learn to prepare buffers and reagents.
2. Students will study how to isolate nucleic acid from plant and animal source.
3. Students will understand the working of agarose gel electrophoresis.
4. Students will study the analysis of nucleic acid.

Detailed Syllabus:

Sr. No.	**Title of Experiment**	**No. of practical**
1.	Introduction to molecular biology laboratory, Determination of λmax	01
2.	Isolation of bacterial genomic DNA, purity check, size determination and quantitative analysis	02
3.	Isolation of Plant genomic DNA, purity check, qualitative and quantitative analysis	02
4.	Isolation of Animal genomic DNA, purity check, qualitative and quantitative analysis	02
5.	Estimation of proteins by Lowry and Bradford method	02
6.	SDS-PAGE separation of proteins, staining and destaining of protein gels	02

7. Visit to molecular biology laboratory/Research institute 01

Title of the Course: Community Engagement and Service								
Year: II				**Semester: IV**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
CEP-01	BS-BT245P	00	02	02	60	15	35	50