Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar

(Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Choice Based Credit System (CBCS)

Bachelor of Science (B.Sc.)

Syllabus of

S. Y. B.Sc. Biotechnology

Implemented from

Academic Year 2022 - 23

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.	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)

Programme Structure and Course Titles

Sr. No.	Class	Semester	Course Code	Course Title	Credit
1.	F. Y. B.Sc.	I	BSC-BT 101T	Fundamentals ofChemistry-I	02
2.	F. Y. B.Sc.	I	BSC-BT 102T	Fundamentals of Physics-I	02
3.	F. Y. B. Sc.	I	BSC-BT 103T	Biochemistry I	02
4.	F. Y. B.Sc.	I	BSC-BT 104T	Biophysics and Bioinstrumentation	02
5.	F. Y. B.Sc.	I	BSC-BT 105T	Plant Biology	02
6.	F. Y. B.Sc.	I	BSC-BT 106T	Animal Biology	02
7.	F. Y. B. Sc.	I	BSC-BT 107T	Basic Microbiology	02
8.	F. Y. B.Sc.	I	BSC-BT 108T	Biomathematics andBiostatistics-I	02
9.	F. Y. B.Sc.	I	BSC-BT 109P	Practical in Chemistry and Biochemistry	1.5
10.	F. Y. B.Sc.	I	BSC-BT 110P	Practical in Botany and Zoology	1.5
11.	F. Y. B.Sc.	I	BSC-BT 111P	Practical in Microbiology &Biostatistics	1.5
12.	F. Y. B.Sc.	I	BSC-BT 112P	Practical in Physics and Biophysics	1.5
13.	F. Y. B.Sc.	II	BSC-BT 201T	Fundamentals of ChemistryII	02
14.	F. Y. B.Sc.	II	BSC-BT 202T	Biochemistry II	02
15.	F. Y. B.Sc.	II	BSC-BT 203T	Bioinstrumentation	02
16.	F. Y. B.Sc.	II	BSC-BT 204T	Applied Plant Biology	02
17.	F. Y. B.Sc.	II	BSC-BT 205T	Applied Animal Biology	02
18.	F. Y. B.Sc.	II	BSC-BT 206T	Applied Microbiology	02
19.	F. Y. B.Sc.	II	BSC-BT 207T	Biomathematics andBiostatics-II	02
20.	F. Y. B.Sc.	II	BSC-BT 208T	Information Technology	02
21.	F. Y. B.Sc.	II	BSC-BT 209P	Practical In Chemistry and Biochemistry II	1.5
22.	F. Y. B.Sc.	II	BSC-BT 210P	Practical In Applied Botany and Zoology	1.5

23.	F. Y. B.Sc.	II	BSC-BT 211P	Practical In Microbiology and Bioinstrumentation	1.5
24.	F. Y. B.Sc.	II	BSC-BT 212P	Practical In Information Technology andBiostatistics	1.5
25.	S. Y. B.Sc.	III	BSC-BT 301T	Cell Biology I	02
26.	S. Y. B.Sc.	III	BSC-BT 302T	Cell Biology II	02
27.	S. Y. B.Sc.	III	BSC-BT 303T	Metabolic Pathways	02
28.	S. Y. B.Sc.	III	BSC-BT 304T	Genetics	02
29.	S. Y. B.Sc.	III	BSC-BT 305T	Immunology	02
30.	S. Y. B.Sc.	III	BSC-BT 306T	Ecology and Environmental Biotechnology	02
31.	S. Y. B.Sc.	III	BSC-BT 307P	Practical in Cell Biology	02
32.	S. Y. B.Sc.	III	BSC-BT 308P	Practical in Genetics and Immunology	02
33.	S. Y. B.Sc.	III	BSC-BT 309P	Practical in Metabolic and Ecology and EnvironmentalBiotechnology	02
34.	S. Y. B.Sc.	III	BSC-BT 310	Critical thinking and scientific temper	02
35.	S. Y. B.Sc.	III	BSC-BT 311	English/ Hindi Communication	02
36.	S. Y. B.Sc.	III	BSC-BT 312T	Laboratory Management (Biosafety and instrumentation)	02
37.	S. Y. B.Sc	III	BSC-BT 313P	Practicals in Laboratory Management	02
38.	S. Y. B.Sc.	IV	BSC-BT 401T	Biodiversity and Evolution	02
39.	S. Y. B.Sc.	IV	BSC-BT 402T	Molecular Biology I	02
40.	S. Y. B.Sc.	IV	BSC-BT 403T	Molecular Biology II	02
41.	S. Y. B.Sc.	IV	BSC-BT 404T	Plant Development	02
42.	S. Y. B.Sc.	IV	BSC-BT 405T	Animal Development	02
43.	S. Y. B.Sc.	IV	BSC-BT 406T	Bioanalytical Techniques	02
44.	S. Y. B.Sc.	IV	BSC-BT 407P	Practical in Molecular Biology	02

45.	S. Y. B.Sc.	IV	BSC-BT 408P	Practical in Animal and Plant Development	02
46.	S. Y. B.Sc.	IV	BSC-BT 409P	Practical in Biodiversity and Evolution and Bioanalytical Techniques	02
47.	S. Y. B.Sc.	IV	BSC-BT 410	Environmental awareness	02
48.	S. Y. B.Sc.	IV	BSC-BT 411	LanguageCommunication	02
49.	S. Y. B.Sc.	IV	BSC-BT 412T	Oenology	02
50.	S. Y. B.Sc.	IV	BSC-BT 413P	Practical in Oenology	02
51.	T. Y. B.Sc.	V	BSC-BT 501T	Food and Dairy Biotechnology	02
52.	T. Y. B.Sc.	V	BSC-BT 502T	Recombinant DNA Technology	02
53.	T. Y. B.Sc.	V	BSC-BT 503T	Genetic Engineering	02
54.	T. Y. B.Sc.	V	BSC-BT 504T	Plant Tissue Culture	02
55.	T. Y. B.Sc.	V	BSC-BT 505T	Animal Tissue Culture	02
56.	T. Y. B.Sc.	V	BSC-BT 506T	Medical Biotechnology	02
57.	T. Y. B.Sc.	V	BSC-BT 507P	Practical in Food, Dairy and Medical Biotechnology	02
58.	T. Y. B.Sc.	V	BSC-BT 508P	Practical in Plant Tissue Culture and Animal Tissue Culture	02
59.	T. Y. B.Sc.	V	BSC-BT 509P	Practical in Genetic Engineering	02
60.	T. Y. B.Sc.	V	BSC-BT 510T	Seminar and Term Paper Writing	02
61.	T. Y. B.Sc.	V	BSC-BT 511P	Preparation and Presentation on Term Paper	02
62.	T. Y. B.Sc.	VI	BSC-BT 601T	Industrial Biotechnology	02
63.	T. Y. B.Sc.	VI	BSC-BT 602T	Enzyme Technology	02
64.	T. Y. B.Sc.	VI	BSC-BT 603T	Pharmaceutical Biotechnology	02
65.	T. Y. B.Sc.	VI	BSC-BT 604T	Bioinformatics	02
66.	T. Y. B.Sc.	VI	BSC-BT 605T	Bio safety and Bioethics and IPR	02
67.	T. Y. B.Sc.	VI	BSC-BT 606T	Applied Biotechnology	02
68.	T. Y. B.Sc.	VI	BSC-BT 607P	Practical in Industrial and Applied Biotechnology	02

69.	T. Y. B.Sc.	VI	BSC-BT 608P	Practical in Enzyme Technology	02
70.	T. Y. B.Sc.	VI	BSC-BT 609P	Practical in Bioinformatics and Pharmaceutical Biotechnology	02
71.	T. Y. B.Sc.	VI	BSC-BT 610T	Any Skill enhanced theory course	02
72.	T. Y. B.Sc.	VI	BSC-BT 611Pr	SEC – IV Project	02

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

Syllabus of S. Y. B.Sc. Biotechnology

Under

Faculty of Science

Semester – III	**Paper – I**
Course Code: BSC- BT- 301T	**Title of the Course: Cell Biology I**
Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

1. Learn the scope and importance of cell biology.
2. Learn different types of cells, especially eukaryotic cells, functional and structural similarities and dissimilarities between them.
3. Understand structure and function of important organelles.
4. Learn membrane and its transport system
5. Understand cell communication and other cellular components.

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Introduction to Cell** Discovery of cell and cell theory Types of cell: • Prokaryote &eukaryotic cell • Plant & animal cell and their features based on difference • Cellular diversity: cell structure & related functions	5
II	**Cell membrane** • Chemical components of biological membranes • Fluid mosaic model, membrane as a dynamic entity • Functions of cell membrane • Transport – active and passive transport with one example	6

(Bulk transport: exocytosis, endocytosis)

III **Structure, components and functions of cell organelle** : 12

- Nucleus
- Mitochondria
- Chloroplast
- Lysosome and Vacuole
- Rough endoplasmic reticulum andsmooth endoplasmic reticulum
- Golgi Bodies
- Ribosome
- Glyoxysome and peroxisome

IV **Cell communication** 7

- Cell junctions
- Extracellular matrix
- Cytoskeleton &basal bodies

Suggested Readings:

1. Molecular Cell Biology. 7th Edition, (2012) 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.
2. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
3. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. Sixth Edition. John Wiley & Sons. Inc.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. Fifth edition. ASM Press& Sunderland, Washington, D.C.; Sinauer Associates, MA.

Semester – III	Paper – II
Course Code: BSC- BT- 302T	Title of the Course: Cell Biology II
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs):

1. Learn the cell cycle phase and their control
2. Understand the process of cell signaling
3. Understand fundamental facts about division in plants and animals
4. Learn the process of cell death.

Detailed Syllabus:

Unit	Topics	No. ofHours
I	**Cell cycle** • Introduction to cell cycle • Phases and check points of cell cycle	4
II	**Cell division in plant &animal** • Mitosis • Meiosis	7
III	**Cell signalling** • Signalling molecules • Signalling receptors: Cell surface receptors • Autocrine, syncrine, paracrine signalling and juxtacrine signalling • G-protein signalling • Calcium signalling	12
IV	**Cell death** • Aging, necrosis, senescence and apoptosis • Neoplasia • Autophagy • Ferroptosis • Pyroptosis	7

Suggested Readings:

1. Molecular Cell Biology. 7th Edition, (2012) 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.
2. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
3. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. Sixth Edition. John Wiley & Sons. Inc.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. Fifth edition. ASM Press& Sunderland, Washington, D.C.; Sinauer Associates, MA.

Semester – III	**Paper –III**
Course Code: BSC-BT 303T	**Title of the Course: Metabolic pathways**

Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

1. Correlate between synthesis and degradation of biomolecules.
2. Learn biomolecules and their metabolism
3. Understand regulation of various metabolic pathways

Detailed Syllabus:

Unit	Topics	No. ofHours
I	**Introduction to Metabolism** • ATP energy cycle • Concept of bioenergetics, ATP & Phosphoanhydride bond.	2
II	**Lipid Metabolism:** • Digestion, mobilization and transport of fats • Fatty acid synthesis • Catabolism of Fatty acid: beta oxidation, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, ketone bodies.	8
III	**Carbohydrate Metabolism:** • Glycolysis, regulation in glycolysis, feeder pathways for glycolysis ,gluconeogenesis • Pyruvate metabolism, glyoxylate cycle and citric acid cycle with regulation • Cori cycle • Glycogenesis and glycogenolysis (sequence of reactions & regulation), Pentose-phosphate pathway (sequence of reactions & regulation)	10
IV	**Amino acid Metabolism:** • Overview of nitrogen metabolism- The nitrogen cycle and nitrogen fixation • Essential &non-essential amino acids, Biosynthetic families of amino acids • Transamination, transdeamination and oxidative deamination • Metabolic breakdown of amino acids – glucogenic & ketogenic amino acids • Urea Cycle	7

V Nucleotide Metabolism – 3

- Overview of purine & pyrimidine biosynthesis (de novo & salvage pathway) and its degradation

Suggested Readings:

1. Conn EE and Stump PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.
2. Voet D and Voet JG. 2011. Biochemistry. 4th Ed. John Wiley and Sons, Inc. NY, USA.
3. Nelson DL and Cox MM. 2012. Lehninger‟s Principles of Biochemisry, 6th Ed . Macmillan Learning, NY, USA.
4. Berg JM, Tymoczko JL, Stryer L and Gatto GJ. 2002. Biochemistry, 7th Ed. W.H. Freeman and Company, NY, USA
5. Stryer, L., “Biochemsitry”, 4th Edition, W.H. Freeman & Co., 2000. Murray, R.K., etal “Harper’s Biochemistry”, 23rd Edition, Prentice Hall International, 1993

Semester – III	**Paper –IV**
Course Code: BSC-BT 304T	**Title of the Course: Genetics**

Credits: 02	Total Lectures: 30 Hrs.

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 able to understand the chromosomal aberrations and mutation.
4. Students will learn the concept of sex determination and sex-linked inheritance.
5. Students will study the mechanisms Linkage, recombination and genetic disorders.

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Genetic basis of inheritance**: Variations, heredity, Pre- Mendelian Concept, importance of genetics	2
II	**Mendalism and Mendalian Genetics:** Mendel experiments, Mendel's Law: Law of dominance, segregation, Monohybrid. Law of independent assortment- Dihybrid. Deviation from Mendel's law- Partial or incomplete dominance, codominance, penetrance and expressivity- Pleiotropism, Gene interaction- Epistasis, Multiple allele	6
III	**Chromosomal aberrations -** Euploidy, aneuploidy, polyploidy, mosaics, trisomy and monosomy. Changes in chromosomal structure: translocation, inversion, duplication, deletion.	5
IV	**Mutations**- Classification and types, molecular basis of mutations, mutagens and their action, hot spot mutations.	4
V	**Linkage and Recombination**- Discovery of linkage, complete and incomplete linkage, crossing over, two-point cross, recombination frequency and map distance	5
VI	**Mechanism of Sex Determination and Inheritance-** Homo and heterogametic theory, X-Linked inheritance, Non-Mendelian inheritance, pedigree analysis	4
VII	**Genetic Disorders -** Sickle cell anemia, hemophilia, colour blindness, albinism, Down's and kleinfelter's Syndrome, genetic counseling	4

Suggested Readings:

1. Genetics, by Strickberger M W (2006) (Prentice Hall, India)
2. Fundamentals of Genetics. B.D Singh
3. Genetics: analysis of genes and genomes by Hartl DL, Jones EW (2001) –(Jones and Bartlett, Massachusetts)
4. Introduction to genetic analysis by Griffiths AJ, Wessler SR, Carroll SB, Doebley J (2012) (Freeman & Co, New York) tenth edition.
5. Molecular genetics of bacteria (ASM Press, Washington) Snyder L, Champness W (2007)
6. Textbook of Cell Biology, Genetics, molecular biology , Ecology and Evolution.: P.S. Verma and V.KAgarwal (2001)
7. Principals of Genetics: Robert H. Tamarin, 7th Edition.
8. GENES IX (2006): Benjamin Lewin.
9. Concepts of genetics (2011) : Robert Brooker.
10. Genetics: A Mendelian Approach (2006) :Peter J. Russell

Semester – III	**Paper – IV**
Course Code: BSC- BT- 305T	**Title of the Course: Immunology**
Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

1. Gain knowledge about Immunology.
2. Learn the scope and importance of immune system and immunology.
3. Learn different types of immunity, immune cells, vaccines and its types, antigen, antibody and its interactions.
4. Understand structure and function of lymphatic organs and lymphatic system.

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Immunology** • Basic definitions and fundamentals of the immune system • Definitions - Infection, Inflammation, Invasion, Pathogen, Immunity, Antigen, Antibody • Concept of host pathogen interaction • Organization of Immune system: a) Structure and function of the cells and tissues of immune system b) Structure and function of Primary (Thymus, Bone marrow and bursa) and Secondary lymphoid organs (Lymph, Lymph node, Spleen) • Types of immunity: Innate and acquired immunity • Cell mediated and humoral immune response	7
II	**Components of the immune system** • Antigens: Types and properties of an antigen. • Factors affecting immunogenicity. • Immunoglobulin: Structure and their types. • Properties and function of different Immunoglobulin classes. • Complement system: Components, function and pathways. • Major Histocompatibility Complex: Types (MHC class I and II) structure and function • Cytokines: Types, properties and their function	8
III	**Antigen – Antibody Interactions** • General characteristics of Antigen-Antibody reaction • Principle and example of different diagnostic tests:	7

i. Precipitation, Agglutination, Immunodiffusion and Complement fixation test
ii. Radioimmunoassay, Immunofluorescence, ELISA
iii. Western blotting

IV Clinical immunology 8

- Hypersensitivity reactions: Types of hypersensitivity and clinical manifestation.
- Autoimmunity: Mechanisms, Types of autoimmune diseases (Myasthenia gravis, Rheumatoid arthritis)
- Vaccine Technology
- Adjuvant- Properties and role with suitable example
- Concept with suitable example of Killed and Live attenuated vaccines, combined vaccines
- Modern Techniques: Concept of subunit vaccines, Recombinant, DNA Vaccines, conjugate vaccines, polyvalent vaccines, Monoclonal antibodies with suitable example

Suggested Readings:

1. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. University Press Publication.
2. Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
3. Kuby. Immunology. 4th edition. W. H. Freeman & company.
4. SudhaGangal and ShubhangiSontakke, Textbook of basic and clinical immunology, 1st edition (2013), University Press, India.

Semester – III	**Paper – VI**
Course Code: BSC-BT 306T	**Title of the Course: Ecology and Environmental Biotechnology**
Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

1. The student will be able to evaluate the potential of biodegradation of organic pollutants, taking microbial and physical/chemical environments.
2. Students will understand the phenomenon of phytoremediation for the decontamination of soil and water, wetlands as treatment processes.
3. Students will learn about the environmental quality evaluation, monitoring, and remediation of contaminated environments.
4. Students will learn about the use of biosensors in environmental analysis.

Detailed Syllabus:

Unit	Topics	No. ofHours
I	**Understanding Environment and Ecology** • Ecology and Environment: Concepts of ecology and relevance of studying ecology, History of ecology, major divisions of ecology • Earth and its environment: (Atmosphere, Hydrosphere, Lithosphere, Biosphere) and its inter-relationships (effect of light, temperature, precipitation and topography on growth and development of organism)	4
II	**Ecosystem and its structure** • Ecosystem: Concept, Types-Natural (aquatic and terrestrial) and Artificial (aquatic and terrestrial) • Ecosystem: Structure/components (biotic and abiotic components, trophic structure-ecological pyramids, food chain, its types, food web), productivity of ecosystem • Ecological energetics: Energy efficiency and linear and Y-shaped energy flow model, biogeochemical (nutrient) and atmospheric cycles • Concept of Community (biotic): Types, Characteristics, Structure • Ecological succession: Types, General process of succession, concept of climax community	10

III	**Threats to Environment and Role of Biotechnology in Environmental Protection** • Environmental pollution: Types of waste/pollutants (biodegradable, non-bio-degradable, Toxic/non-toxic, bio-medical etc.) • Types, sources and consequences of: Air, Water, Soil and Radiation pollution • Bio-indicators and detection of pollution • Significance of physical/Chemical Vs biotechnological methods/approaches used to reduce environmental pollution • Concept of bioremediation: Use of microorganisms (bacteria and fungi), plants, and algae for removal/degradation of organic/inorganic pollutants, plastic, hydrocarbons, and pesticides etc. and inorganic pollutants. • Role of biotechnology in biodiversity conservation	12
IV	**Environmental challenges and sustainable development** • Causes and consequences of global environmental change • Global/International efforts on sustainable Development- United Nations Conference on Environment and Development (UNCED 1992) • National efforts on sustainable development- Role of Environmental Impact assessment (EIA) in environmental protection	4

Suggested Readings:

1. Ecology and environment (2005) Sharma PD Rastogi Publication, New Delhi
2. Environmental Biology (2000) Varma & Agarwal S. Chand Limited, New Delhi
3. Environmental biotechnology (2010) Rana Rastogi Publications, New Delhi
4. Fundamentals of Ecology (2009) Dash 3rd edition, Tata McGraw-Hill Education, New Delhi.

Semester – III	**Paper – VII**
Course Code: BSC-BT-307 P	**Title of the Course: Practical in Cell Biology**
Credits: 02	**Total Practical: 15 (15x3Hrs) =45 Hrs.**

Course Outcomes (COs):

1. Learn to isolate and characterize subcellular organelles.

2. Study how to isolate Nucleic acid and agarose gel electrophoresis.
3. Analyze the methods cell lysis.

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of practical
1	Micrometry- Measurement of cell size of different types of cells.	1
2	Staining and Observation of human cheek epithelial cells.	1
3	Study of Prokaryotic and eukaryotic cell structure using Electron micrographs of all-important cell organelles.	1
4	Isolation and characterization (Qualitative) of the following subcellular components, using appropriate samples, by differential centrifugation. a. Nuclei b. Mitochondria c. Chloroplast d. Lysosome	4
5	Methods of cell lysis and confirmation	1
6	Study of different stages of mitosis using appropriate plant sample.	2
7	Effect of colchicine on mitosis.	1
8	Study of different stages of meiosis.	2
9	Study of polytene chromosomes (Drosophila/Chironomus larva).	2

Suggested Readings:

1. Cell biology and genetics lab manual Boğaziçi University Department of Molecular Biology and Genetics 2007-2008
2. Cell Biology Laboratory The University of Toledo Department of Biological Sciences/Natural Sciences and Mathematics
3. Celis JE (ed) (1998) Cell Biology: A Laboratory Handbook, 2nd edn. San Diego: Academic Press.

Semester – III	**Paper – VIII**
Course Code: BSC-BT 308P	**Title of the Course: Practicals in Immunology and Genetics**
Credits: 02	**Total Lectures: 15 (15×3Hrs.)= 45 Hrs.**

Course Outcomes (COs):

1. Gain knowledge about immunological techniques
2. Understand structure of different immunological cells.
3. To determine blood grouping with Rh factor.
4. Students will able to understand concept of epistasis, gene interaction and solve problems based on it
5. Students will learn the problems based on Mendelian and non-Mendelian inheritance, sex linkage, mapping and karyotype analysis.

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of practical
	Immunology	
1	Determination of blood group using slide agglutination Reaction.	1
2	To determine total leukocyte of given blood sample	1
3	Determine differential count of given blood sample	1
4	Immunodiffusuion: a) Single Radial immunodiffusion b) Ouchterlony double diffusion technique (pattern of identity)	2
5	Determination of antibody titer by slide agglutination test (Widal Test)	1
6	Detection of presence of antigen by qualitative ELISA (Dot ELISA)	1
	Genetics	
1	Problems based on Mendelian Inheritance- Monohybrid &dihybrid cross.	1
2	Problems based on Non- Mendelian Inheritance- Co-dominance, Incomplete dominance.	2
3	Problems based on epistasis, gene interaction and multiple alleles.	2
4	Problems based on sex linked inheritance.	1
5	Problems based on linkage and mapping.	1
6	Problems based on karyotype analysis	1

Suggested Readings:

1. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. University Press Publication.
2. Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
3. Kuby. Immunology. 4th edition. W. H. Freeman & company
4. Genetics, by Strickberger M W (2006) (Prentice Hall, India)

5. Fundamentals of Genetics. B.D Singh
6. Genetics: analysis of genes and genomes by Hartl DL, Jones EW (2001) –(Jones and Bartlett, Massachusetts)
7. Introduction to genetic analysis by Griffiths AJ, Wessler SR, Carroll SB, Doebley J (2012) (Freeman & Co, New York) tenth edition.
8. Molecular genetics of bacteria (ASM Press, Washington) Snyder L, Champness W (2007)
9. Textbook of Cell Biology, Genetics, molecular biology , Ecology and Evolution.: P.S. Verma and V.K. Agarwal (2001)
10. Principals of Genetics: Robert H. Tamarin, 7th Edition.
11. GENES IX (2006): Benjamin Lewin.
12. Concepts of genetics (2011) : Robert Brooker.
13. Genetics: A Mendelian Approach (2006) :Peter J. Russell

Semester – III	**Paper – IX**
Course Code: BSC-BT 309P	**Title of the Course: Practicals in Metabolic and Ecology and Environmental Biotechnology**
Credits: 02	**Total Practical: 15 (15×3Hrs.)= 45 Hrs.**

Course Outcomes (COs):

1. Learn quantitative methods of estimation.
2. Study to characterize biomolecules.

3. Understand how to isolate and identify enzyme activity.
4. Students can study the toxic effect of pollutants at gene level.
5. Gain the knowledge of sampling techniques

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of practical
	Metabolic Pathways	
1	Estimation of reducing sugar by Benedict's method.	1
2	Quantitative determination of amino acid by ninhydrin method.	1
3	Total carbohydrate content estimation by anthrone/phenol sulfuric acid method.	2
4	Estimation of alkaline phosphates activity from given sample.	1
5	Estimation of creatinine in urine or Preparation of lactalbumin from milk or plant pigment from plant source.	1
6	Estimation of cholesterol by ZAK's method.	1
	Ecology and Environmental Biotechnology	
1	Study of pollution indicator organisms (Air Pollution-Lichens; Water Pollution-algae).	1
2	Testing Geno toxicity of water sample: Polluted and Non-Polluted	1
3	Study of soil by: a. Physical properties: Colour, Texture, Water holding capacity b. Chemical properties: pH, Organic content, chlorides and alkalinity	3
4	Study of polluted and unpolluted soil by: Microbial (Bacterial/Fungal) community estimation.	1
5	Study of community by- Quadrate method for plants/point count method for animal and analysis of community for- Percentage of frequency, density, abundance. Frequency class diagram and comparison with Raunchier frequency chart.	2

Suggested Readings:

1. Jayaram T. 1981. Laboratory manual in Biochemistry, Wiley Estern Ltd. New Delhi.
2. Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
3. Nath RL. 1990. Practical Biochemistry in Clinical Medicine. Academic Pub.

4. Sadasivam S and Manickam A. 1996. Biochemical Methods. 2nd ed. New Age International (P) Ltd. Publisher, New Delhi.
5. A Practical Guide to Environmental Biotechnology (Learning Materials in Biosciences) by Jayant Kumar Patra.
6. Fundamentals of Ecology and Environment Book (Practical Manual) by B. L. Chaudhary & Jitendra Pandey.
7. Environmental Biotechnology Lawrence K. Wang, ,Volodymyr Ivanov Joo-Hwa Tay · 2010

Semester – III	**Paper – XII**
Course Code: BSC-BT 312T	**Title of the Course: Laboratory Management (Biosaftey and instrumentation)**
Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

1. Students will study the Laboratory design and management
2. Students will able to understand basic design consideration, control measures
3. Students will understand Framework of laboratory project
4. Students will learn the operation and maintenance of laboratory

Detailed Syllabus:

Unit	Topics	No. ofHou
I	Introduction to Laboratory Design and Management	2
II	Design Considerations - Facility space, Storage, Surfaces and finishes, Furniture, Facilities and systems, Laboratory equipment	6
III	Heightened Control Measures - Controlled access systems, Additional design features, Directional airflow and inward airflow, HEPA filters, Waste disposal, Laboratory emergency response	7
IV	Framework of a Laboratory Project– Planning team, Costs, Time Scale, Quality	5
V	Design- User requirement specification, Workflow diagrams, Typical project design stages, Budget, Procurement.	5
VI	Operation and Maintenance- Safety of maintenance personnel, Design for maintenance, Operating and maintenance manuals, Maintenance contracts, Planned maintenance, Breakdown maintenance, Maintenance records and inspections	4
VII	Decommissioning Laboratory facilities	1

Suggested Readings:

1. Laboratory biosafety manual, fourth edition. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
2. Risk assessment. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
3. Biological safety cabinets and other primary containment devices. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
4. Personal protective equipment. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
5. Decontamination and waste management. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).

Semester – IV	**Paper – XIII**
Course Code: BSC-BT 313P	**Title of the Course: Practicals in Laboratory Management**
Credits: 02	**Total Lectures: 15 (15×3Hrs.)= 45 Hrs.**

Course Outcomes (COs):

1. Students will study different types of laboratory and their components

2. Students will able to understand working principle of laboratory equipment, their handling and maintenance
3. Students will learn the laboratory safety, design layout and preparation of SOP's

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of practical
1	Study of different type of laboratories	1
2	Designing laboratory spaces, facilities, storage and furniture	2
3	To study the working principle of laboratory equipment	2
4	Handling of laboratory equipment's	2
5	To prepare the laboratory layout for establishing new laboratory	1
6	Hands on training of laboratory safety/biosafety management	2
7	Study of preparation of SOP's for laboratory instruments	**2**
8	Maintenance of some basic laboratory equipment	2

Suggested Readings:

1. Laboratory biosafety manual, fourth edition. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
2. Risk assessment. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
3. Biological safety cabinets and other primary containment devices. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
4. Personal protective equipment. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).
5. Decontamination and waste management. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).

Semester – IV	**Paper – I**
Course Code: BSC-BT 401T	**Title of the Course: Biodiversity and Evolution**
Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

Unit	Topics	Total Hours
I	**Origin and evolution of life** • History of life: Chemogeny (Chemical Evolution), Biogeny (Formation of Primitive Life), Cognogeny (Nature of Primitive Life and Its Evolution): • Natural selection as a guiding force-Its attributes and action Basic characteristics of natural selection. • Concept of species and variation, Speciation and its types	7
II	**Understanding Biodiversity** • Concept of Biodiversity, Value of biodiversity- consumptive use, productive use, social, ethical, aesthetic and option values • Types of Biodiversity-Ecosystem, Species and Genetic diversity • Change in Biodiversity over time and space • Biodiversity at Global, National and Local levels • Hotspots of biodiversity • India as a mega-diversity nation • Biogeographical classification of India • Domesticated animal diversity, agricultural diversity and Biodiversity utilization • Management, documentation and databases of biodiversity	8
III	**Population & Community Dynamics** • Population size&factors affecting population size, pattern of distribution, age class distribution, growth forms and carrying capacity, Life history strategies, r and k selection • Population structure: Isolation & territoriality • Habitat & niche, Types of Habitats- Terrestrial, aquatic, insular and extreme habitats • Community structure and attributes, ecotone and edge effect scales of diversity (alpha, beta, gamma), Measurement of Biodiversity (Jaccard similarity index, and Sørensen's similarity coefficient, Shanon Index and Simpsons Index)	8

IV. Conservation of Biodiversity **7**

- Threats to biodiversity
- Status of biodiversity and need for conservations
- *In-situ* and *Ex-situ* conservation of biodiversity
- Global Conservation efforts: Earth Summits, Convention on Biological Diversity, International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Role of NGOs in conservation: World Wild Life Fund (WWF), Farmers seed movement and contribution of Padmashri Rahibai Pophere

Suggested Readings:

1. Kenneth A Mason; Jonathan B Losos; Susan R Singer; Peter Hamilton Raven; George Brooks Johnson (2016) Biology 11th edition Published by McGraw-Hill Education
2. Krishnamurthy K V (2004) An Advanced Text Book On- Biodiversity- Principle And Practices, Oxford and IBH Publishing, Delhi
3. Ecology: Principles and Applications (1998) J. L. Chapman, M. J. Reiss Cambridge University Press, Cambridge Odum, E. and Barett, G. (2005).
4. Fundamentals of Ecology. Thomson Brooks/Cole.Jha, A. P. (1993). Genes and Evolution. Darbhanga: Macmillan India.
5. Rana Rastogi (2010) Environmental Biotechnology Publications, Meerut
6. Fundamentals of Ecology (2009) (2014) Dash 3rd edition, Tata McGraw-Hill Education, New Delhi
7. Dennett, D.C. (1995). Darwin's dangerous idea, Evolution and Meaning of Life. Simon & Schuster.
8. Simpson, G.G. (1949). The meaning of evolution, A Study of the History of Life and of Its Significance for Man. Oxford University Press.
9. Magguran, A.E. (1996). Ecological diversity and its measurements. Princeton University.
10. Gadgil, M. () A methodology mannual for scientific inventorying, monitoring andconservation of Biodiversity
11. Attenborough, D. The private life of plants. 1st Edn. BBC Worldwide Ltd.
12. Sutherland, W. (2006). Ecological census technique: A Handbook, 2nd Edn. CambridgeUniversity Press.

13. Global Biodiversity Strategies (1992) Courrier Kathleen (Editor) World Resource Institute, USA

Semester – IV	**Paper – II**
Course Code: BSC-BT 402T	**Title of the Course: Molecular Biology-I**
Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

1. Learn Structure and function of DNA & RNA.
2. Understand the comparative difference between prokaryotic and eukaryotic DNA replication.
3. To study the organization of genome and regulatory sequences.
4. Understand the types of DNA repair system.

Detailed Syllabus:

Unit	Topics	No. ofHours
I	**Historical and conceptual Background** • Discovery of DNA as genetic material: Griffith's experiment, Hershey and Chase warring blender experiment, Avery Experiment, Miescher to Watson and Crick- historic perspective • Nucleic acids- structure, components properties and function • Formsof DNA; A, B & Z, Chargaff's rule • Types of RNA: tRNA, rRNA, mRNA and noncoding RNA (miRNA, SiRNA) • Molecular basis of heredity,central dogma of molecular biology	9
II	**Concept and Organization of Genome** • Organization of DNA: Prokaryotes, Viruses • Hierarchical chromosomal organization in eukaryotes • Chromatin structure: euchromatin and heterochromatin • Organelle DNA – mitochondria and chloroplast DNA • Definition of gene – introns/exons, regulatory sequences, promoters, enhancers and suppressors	6
III	**Replication of DNA** • DNA synthesis: general principles, bidirectional replication, Conservative, Semiconservative and dispersive nature of DNA replication, rolling circle replication (D-loop)	10

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

IV DNA damage and repair 5

- Causes and types of DNA damage
- Mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, SOS repair, recombination repair, post transcriptional repair

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.

Semester – IV	**Paper – III**
Course Code: BSC-BT 403T	**Title of the Course: Molecular Biology-II**
Credits: 02	**Total Lectures: 30 Hrs.**

Course Outcomes (COs):

1. Learn the molecular processes like transcription and translation.
2. Students will understand RNA processing and protein modification.
3. Study about the Genetic Code.
4. Study about the Gene Regulation.

Detailed Syllabus:

Unit	Topics	No. ofHours
I	**Transcription** • Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, initiation, elongation and termination • Transcription in Eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation, termination. Processing of pre-mRNA: 5' cap formation, polyadenylationand RNA splicing	8
II	**Genetic Code** • Concept of codon, reading frame, frame shift mutation • Major scientific contributions to decipher genetic code • Properties of genetic code	6
III	**Translation** • Translation in Prokaryotes: properties of the prokaryotic initiator tRNA-fMet, charging of tRNA, amino acyl tRNA synthetases • Translationin Eukaryotes: Mechanism of initiation, elongation and termination of polypeptides • Fidelity of translation, Inhibitors of translation. • Posttranslational modifications of proteins	9
IV	**Regulation of activity of Genes and Gene products in Prokaryotes** • General aspects of gene Regulation: inducible and repressible system • The lactose operon: Catabolite repression • The Arabinose operon: Positive, negative regulation	7

- The Tryptophan operon: Regulation by attenuation

Suggested Readings:

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

Semester – IV	**Paper – IV**
Course Code: BSC-BT 404T	**Title of the Course: Plant Development**

Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs):

1. Understand plant developmental phases
2. Learn dicot and monocot embryogenesis
3. Study model plants like Arabidopsis
4. Understand plasticity and programmed cell death

Detailed Syllabus:

Detailed Syllabus:

Unit I: 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 II: Phases of Sexual Reproduction in plant **05**

Microsporogenesis - development of male gametophyte and male gamete, Megasprogenesis - development of female gametophyte and female gamete, Double fertilization and triple fusion, Development of endospermand its types

Unit III: Major phases of plant development **11**

Vegetative development: Zygote to seed embryo (monocot and dicot), embryo to seedling till vegetative maturity, Pattern formation in plants, Role of plant growth regulators

Reproductive development: Shift from vegetative to reproductive phase, Induction- perception of inductive stimuli and subsequent changes, Pattern formation in flowering (ABCDE model), Role of plant growth regulators

Developmental plasticity, Programmed Cell Death- ageing, senescence and necrosis

Unit IV: Plant development in Biotechnology **09**

Model systems to understand plant development - Arabidopsis, Molecular regulation of development in Arabidopsis

Parthenogenesis- Haploid and Diploid;Parthenocarpy – Natural , Induced; Importance of seed and seed dispersal;Applications of Plant development in Biotechnology

Suggested Readings:

1. Development Biology, 9th edition, (2010), Gilbert S. F. (Sinauer Associates, USA)
2. Principles of Development, 4th edition (2010), Wolpert L and Tickle C, Publisher: Oxford
3. University Press, USA.
4. Bhojwani S.S. and Bhatnagar S.P. (2009) – Embryology of Angiosperms (Vikas Publ House, New Delhi)
5. Burgess J. (1985) An Introduction to Plant Cell Development (Cambridge Univ Press, UK)
6. Taiz L, Zeiger E (2010) – Plant physiology (Sinauer Associates, USA).
7. Sharma HP (2009) – Plant embryology: Classical and experimental (alpha sci)
8. Steeves TA & Sussex IM (2004) – Patterns in plant development. (Cambridge Univ Press,
9. Cambridge, New York)
10. The molecular life of plants by Jones et al Wiley
11. Biochemistry and Molecular Biology of Plants, 2nd Edition - Bob Buchanan et al Wiley
12. Plant Physiology, Taiz and Zeiger Sixth edition Sinaeur

Semester – IV	Paper – V
Course Code: BSC-BT 405T	Title of the Course: Animal Development
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs):

1. Students will learn the concept of development in animals.
2. Students will study the model organisms such as frog, chick, mouse, Drosophila, Sea urchin, Zebra Fish, *C. elegans*
3. Students will able to understand the role of different genes in pattern formation.
4. Students will learn the concept of regeneration of various organs in animals.
5. Students will study the mechanisms of cell death by means of apoptosis and ageing processes.

Detailed Syllabus:

Unit	Topics	No. ofHours
I	**Introduction to Developmental Biology** History of developmental biology, Model organisms in study of developmental biology: frog, chick, mouse, *Drosophila*, Sea urchin, zebra fish, *C. elegans*	2
II	**Reproduction and Development:** Gametogenesis: Types – Oogenesis and spermatogenesis, Hormonal Regulation and Significance. Fertilization process in sea urchin and mammals and its significance Types of eggs, Types and patterns of cleavage, Blastulation.	9
III	**Gastrulation, Neurulation and Pattern Formation:** Morphogenetic movements**,** Gastrulation in *Amphioxus*, frog, chick, *Drosophila* up to formation of three germinal layers Basics of neurulation Concept of pattern formation: Maternal effect genes and their role in *Drosophila* pattern formation	11
IV	**Concepts of differentiation:** Concept of Stem cells, Progenitor cells, cell lineages, determination, commitment and differentiation, redifferentiation and trans-differentiation	2
V	**Regeneration:** Different types of regeneration with one example of each type	2
VI	**Ageing and apoptosis:** Theories of ageing,Apoptosis during embryonic development, intrinsic and extrinsic pathways	3
VII	Teratogenesis in animals	1

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 LearningIndia

Semester – IV	Paper – VI
Course Code: BSC- BT 406T	Title of the Course: Bio Analytical Technique
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs):

1. Learn the principle and working of different bioanalytical techniques.
2. Understand the applications of bioanalytical techniques for analysis of molecules.
3. Learn scientific notation and Units, errors and accuracy in experimentation

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Introduction:** Lab safety, Scientific notation & Units, errors & accuracy in experimentation, Biochemical calculations, Buffer solutions, Measurement of pH, Calibration of pipettes & balance	4
II	**Spectroscopy:** • The electromagnetic spectrum • Concept and measurement of transmittance and absorbance • Beers Lamberts law, molar extinction coefficient, limitations of Beers Lamberts law • Types of spectrometers- UV and visible; Principles, Instrumentation and applications	6
III	**Centrifuge:** • General principle- sedimentation velocity, sedimentation equilibrium, types of rotor • Types of centrifuges – differential, density gradient, ultracentrifuge • Applications	6
IV	**Chromatographic techniques:** • Introduction to chromatography, general principles • Partition chromatography- thin layer chromatography, paper chromatography	8

- Column chromatography- columns, stationary phases, packing of columns, application of samples, column development, fraction collection and analysis
- Types of column chromatography- Adsorption chromatography, ion exchange chromatography, size exclusion chromatography

V

Electrophoresis: 6

- General principle, factors affecting electrophoresis, voltage, current, resistance, buffer composition, concentration, pH
- Horizontal electrophoresis and staining techniques
- Vertical electrophoresis –SDS- PAGE and Native PAGEand staining techniques
- Applications

Suggested Readings:

1. Wilson K and Goulding K.H., A biologist's guide to Principles and Techniques of Practical Biochemistry.
2. Willard and Merrit, Instrumental Methods and Analysis
3. Ewing GW, Instrumental Methods of Chemical analysis.
4. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.
5. Raymond P. W. Scott, Techniques and Practice of Chromatography –Vol. 70.
6. Sethi P.D, DilipCharegaonkar, Chromatography –2nd Edition. Hanes, Gel Electrophoresis of Proteins- A Practical Approach,
7. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house.

Semester – IV	Paper – VII
Course Code: BSC-BT 407 P	Title of the Course:Practical's in Molecular Biology
Credits: 02	Total Lectures: 15 (15×3Hrs.)= 45 Hrs.

Course Outcomes (COs):

1. Learn to prepare buffers and reagents
2. Study how to isolate nucleic acid from plant and animal source.
3. Understand the working of agarose gel electrophoresis.
4. Study the estimation of nucleic acid.

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of practical
1.	Reagent and buffer preparation	1
2.	Determination of λ_{max} of nucleic acid by UV-Vis spectrophotometry	2
3.	Isolation of bacterial DNA, purity checkand analysis by Agarose gel electrophoresis	2
4.	Isolation of Eukaryotic(Plant) DNA, purity check and analysis by Agarose gel electrophoresis	2
5.	Isolation of Eukaryotic (Animal) DNA, purity check and analysis by Agarose gel electrophoresis	2
6.	Isolation of RNA from given source using appropriate method	2
7.	Estimation of RNA by Orcinol method	1
8.	Estimation of DNA by diphenylamine method	1
9.	Estimation of proteins by Lowry and Bradford method	2

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.

Semester – IV	**Paper – VIII**
Course Code: BSC-BT 408P	**Title of the Course: Practicals in Animal & Plantdevelopment**
Credits: 02	**Total Lectures: 15 (15×3Hrs.)= 45 Hrs.**

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 & 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. Study methods of plant development
6. Observation of dicot and monocot embryo

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)	1
2.	Culturing of *Drosophila* to study its lifecycle	1
3.	Study of staging & staining of chick embryos (24 h, 48h, 72 h)	3
4.	Effect of teratogen on development of chick embryo by window technique	2
5.	Demonstration of any one technique of chick embryo culturing	1
	Plant development	
6.	Methods of studying plant development (any suitable plant material) a)Dissection b) Sectioning c) Staining d) Mounting	1
7.	Study of apices and meristem –Root apical meristem (RAM), shoot apical meristem (SAM), florally induced meristem	2

8.	Microsporogenesis- anther squash technique	1
9.	Development of male and female gametophytes	1
10.	Study of developmental stages during plant embryogenesis in dicot and monocot.	2

Suggested Readings:

1. Development Biology, 9thedition, (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 LearningIndia
4. Burgess J. (1985) An Introduction to Plant Cell Development (Cambridge Univ Press, UK)
5. Taiz L, Zeiger E (2010) – Plant physiology (Sinauer Associates, USA).
6. Sharma HP (2009) – Plant embryology: Classical and experimental (alpha sci)
7. Development Biology, 9thedition, (2010), Gilbert S.F.(Sinauer Associates, USA)
5. Principles of Development, 5thedition (2018), Wolpert L and Tickle C, Publisher: Oxford University Press, USA.

Semester – IV	Paper – IX
Course Code: BSC-BT 409P	Title of the Course: Practicals in Biodiversity and Evolution and Bioanalytical techniques
Credits: 02	Total Practical: 15 (15×3Hrs.)= 45 Hrs.

Course Outcomes (COs):

1. Understand use and handling of different laboratory instruments and equipments.
2. Learn different separation techniques.
3. Learn

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of practical
	Bioanalytical techniques	
1.	Scientific notation &units, errors & accuracy in experimentation, Calibration of pipettes, pH meter & balance	1
2.	The separation of amino acids by paper chromatography	1
3.	The separation of amino acids by ion exchange chromatography	2
4.	SDS-polyacrylamide gel electrophoresis of proteins	2
5.	Native gel electrophoresis of proteins	1
6.	To obtain pH titration curve for amino acid and to determine its pKa value.	1
	Biodiversity and Evolution	
7.	To study the map of India/Maharashtra to locate: a) major sanctuaries, national parks. Botanical Gardens of India b) Reserve forest/protected areas of S.P. Pune University jurisdiction (Ahmednagar, Nashikand Pune district)	1

8.	To study Quadrate and transact methods for plant diversity analysis and calculation of species diversity, density and abundance from the data	2
9.	To study point count method for bird/butterfly/insect diversity analysis	1
10.	Field visit and report writing with photo documentation	1
11.	Analysis of species diversity,richness, abundance, diversity indices (Simson and Shanon), Similarty index using the field visit data	3

Suggested Readings:

1. Jayaram T. 1981. Laboratory manual in Biochemistry, Wiley Estern Ltd. New Delhi.
2. Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
3. Nath RL. 1990. Practical Biochemistry in Clinical Medicine. Academic Pub.
4. Sadasivam S and Manickam A. 1996. Biochemical Methods. 2nd ed. New Age International (P) Ltd. Publisher, New Delhi.

Semester–IV	Paper- XII
Course Code: BSC-BT 412T	Title of the Course: Oenology
Credits:02	Total Hours:30

Course Outcomes (COs)

1. Learn the concept of oenology
2. Understand the classification of wines
3. Learn the procedure of wine making and its storage
4. Understand health benefits of wine

Detailed Syllabus:

Unit	Topics	No. ofHours
I	**Introduction to Oenology** • Introduction to winemaking • History of wine • Important terminologies of wine: (Fermentation, Racking, Tears, Chaptalization, Vinification, Yeast strains, etc). • Thebasictastesofwine:bitterness,acidity,salt,sweetnessandalcoholonthetongue. • Concept of Terrior and importance of Terrior. • Health benefits of wine • Study of yeast strains used in wine making style	8
II	**Grapevines** • Overview of viticulture • Common wine grape varieties –red and white grape varieties • Anatomy and chemical constituents of grapes	5
III	**Classification, production and spoilage of wines** • Types and styles of wines • Red wine	12

- White wine

IV Aging and Storage of wine 5

- Aging of wine- Introduction to barrel: Distribution, species and advantages of oak barrels.
- Barrel ageing and maturation in bottle.
- Bottling, corking and storage of wine.

Suggested Readings:

1. Ron s. Jockson (2000) Wine science principles practices & perception
2. Vine, Richard p (1997) WineAppreciation
3. Emile Peynavd (1997) The taste ofwine
4. Brue W. Zoecklein, Kenneth Fugelsang, Barry H. Gump Fred S. Nury (1999) Wine analysis and production.
5. C. S. Ough (1992) Wine making Basics.

Semester–IV	Paper-XIII
Course Code: BSC-BT 413P	Title of the Course: Practicals in Oenology
Credits:02	Total Lectures:15 (15×3Hrs.)= 45 Hrs.

Course Outcomes (Cos)

1. Students will learn the sensory evaluation of wine
2. Students will understand the concept of commercial aspects of wine production.
3. Students will acquire the knowledge of wine appellations and regulations
4. Students will learn the methods of wine marketing.
5. Students will understand the new concept in wine production which includes organic wines and biodynamic wines.

Detailed Syllabus:

Sr. No.	Title of Experiment	No.of Practicals
1	Introduction to winetechnology laboratory and instruments	1
2	Study of grape berry	1
3	Determination of sugar and pH of grapes/fruits juice and wine	1
4	To study threshold detection of acid, sweet, bitter and salt taste.	4
5	Types of wineglasses and bottles	1
6	Detection of different aromas in wine using aroma wheel.	1
7	Wine making from grapes (Red and White)	4
8	Visit to winery and report writing	2

Suggested Readings:

1. Ronald S. Jackson (2002) Wine Testing a professional handbook
2. Ron s. Jockson (2000) Wine science principles practices & perception
3. Vine, Richard p (1997) Wine Appreciation

4. Emile Peynavd (1997) The taste of wine
5. Brue W. Zoecklein, Kenneth Fugelsang, Barry H. Gump Fred S. Nury (1999) Wine Analysis and Production