Level:- 5.0 (Second Year) Sem:III

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2or4), (T/P)(2)	24ScBioU3101	Cell Biology	4		4		20	30	50
	24ScBioU3102	Lab Course on Cell Biology	2		2		20	30	50
VSCP(2)	24ScBioU3501	Immunology		2		4	20	30	50
IKS(T/P)(2)	24ScBioU3901	Application of IKS in Biotechnology	2		2		20	30	50
FPP(2)	24ScBioU3002	Field Project I		2		4	20	30	50
Minor (T/P)(2+2or 4)	24ScBioU3301	Animal Development and Physiology	2		2		20	30	50
	24ScBioU3302	Lab Course on Animal Development and Physiology		2		4	20	30	50
GE/OE(T/P) (2)	24ScBioU3401	Biotechnology and Human Welfare III		2		4	20	30	50
AECT(2)	24CpCopU3703	English Communication Skills II	2		2		20	30	50
CCT(2)	24CpCopU3001	Online Course on Yoga	2		2		20	30	50
Total			12	10	12	20			550

Level:- 5.0 (Second Year) Sem: IV

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2or4), (T/P)(2)	24ScBioU4101	Molecular Biology	4		4		20	30	50
	24ScBioU4102	Lab Course on Molecular Biology		2		4	20	30	50
VSCP(2)	24ScBioU4501	Genetics		2		4	20	30	50
CEPP(2)	24ScCopU4003	Community Engagement Project		2		4	20	30	50
Minor (T/P)(2+2or 4)	24ScBioU4301	Plant Development and Physiology	2		2		20	30	50
	24ScBioU4302	Lab Course on Plant Development and Physiology		2		4	20	30	50

GE/OE(T/P) (2)	24ScBioU4401	Biotechnology and Human Welfare IV	2		2		20	30	50
SECT(2)	24ScBioU4601	Metabolism		2		4	20	30	50
AECT(2)	24CpCopU4701 / 24CpCopU4702	MIL-II(Hindi)/MIL-II(Marathi)	2		2		20	30	50
CCT(2)	24CpCopU4001	Health and Wellness	2		2		20	30	50
Total			12	10	12	20			550

Semester III

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous) Shivajinagar, Pune - 5

Second Year of B.Sc. Biotechnology

(2024 pattern under NEP 2020) Semester III

Course Code: 24ScBIOU3101 **Course Name: Cell Biology**

Teaching Scheme: TH: 4 Hours/Week **Credit: 4C (4T)**

Examination Scheme: CIA: 40 Marks **End-Sem: 60 Marks**

Prerequisite Courses:

- Basics of Biology
- Basics of Cell Biology

Course Objectives:

- To Study advanced techniques in cell Biology.
- To learn the progress in the field of cell Biology and Basic Techniques.

Course Outcomes:

After completion of the course, student will be able to–

CO No	Course Outcomes (COs)	Blooms Cognitive Level
CO 1	Find the structure of a cell and cell organelles	**1**
CO 2	Illustrate functions of cell organelles	**2**
CO 3	Identify various cellular events	**3**
CO 4	Distinguish between various cell structures and functions	**4**
CO 5	Evaluate several cellular mechanisms	**5**
CO 6	Discuss biology of cell from various aspects of structure and function	**6**

Course Contents

Unit	Topic	60 Lectures
Unit 1	**Introduction to Cell Biology**	**2 Lectures**
	• History and Development of Cell Biology	

	• Cell theories • Basic Properties of Cells	
Unit 2	**Basics of Cell Structure**	**4 Lectures**
	• Cellular diversity of prokaryotic and eukaryotic cells • Sizes of Cells and cell components • Overview of plant and animal cell structure	
Unit 3	**Cell Membrane: Structure - Function**	**20 Lectures**
	• Plasma Membrane: Structure and chemical composition of membrane, membrane carbohydrates and proteins, lipids and membrane properties – fluidity and permeability • membrane potential and propagation of nerve impulse • Cell wall: composition and synthesis, structure and function • Cytoplasm and Cytoskeleton • Cell Signalling	
Unit 4	**Structure and function of cell organelles**	**4 Lectures**
	Structure and function of cell organelles: • Nucleus • Chloroplast and Photosynthesis • Mitochondria and aerobic respiration	
Unit 5	**Cellular Transport and Cell Organelles**	**10 Lectures**
	• Transport- Passive transport (simple diffusion, facilitated diffusion), active transport, vesicles and vesicular transport, exocytosis and endocytosis, pinocytosis and phagocytosis • Endoplasmic reticulum and Ribosome • Golgi body, Lysosomes and Vacuoles • Peroxysomes and Glyoxysomes	
Unit 6	**Cell Division**	**8 Lectures**
	• Cell cycle and phases of the cell cycle • Mitosis and cytokinesis • Meiosis and stages of meiosis • Genetic recombination during meiosis	
Unit 7	**Cell junctions and Cell matrix interactions**	**8 Lectures**
	• Overview of cell-cell and cell- matrix interactions • Extracellular matrix and components of extracellular matrix • Properties of ECM and interaction with cells • Interaction of cells with other cells • Cell Junctions: Types of junctions - Adherence junctions and Desmosomes, Tight junctions, Gap Junctions and Plasmodesmata	
Unit 8	**Apoptosis , Necrosis and Cell Death**	**4 Lectures**

	• Cell death and cell death types • Apoptosis and overview of apoptosis • Pathways of apoptosis • Apoptosis and necrosis • Apoptosis in Cancer and Immune system	

References:

1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA

2. Molecular Biology of the Cell, 5th Edition & latest edition Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA

3. Cell Biology, 6th edition, (2010)&latest edition Gerald Karp. John Wiley & Sons., USA

4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA

5.Cell Biology,Genetics,Molecular Biology: Evolution and Ecology by P.S.Verma.1st Edition

6.Becker's World of the cell 9th Edition by Jeff Hardin, Gregory Paul Bertoni

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous) Shivajinagar, Pune- 5

Second Year of B.Sc. Biotechnology

(2024 pattern under NEP 2020) Semester III

Course Code: 24ScBIOU3102 **Course Name: Lab Course on 24ScBIOU3101**

Teaching Scheme: P: 4 Hours/Week **Credit: 2C (15P)**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Basics of Biology
- Basics of Cell Biology

Course Objectives:

- To Study advanced techniques in Cell Biology.
- To learn the progress in the field of Cell Biology and Basic Techniques.

Course Contents

Practical	Topic	Total practicals 15
Practical 1	**Microscopy & Micrometry**	**1Practical**
	• measurement of cell size and nucleus	
Practical2	**Isolation of Cell Organelle: Mitochondria**	**2 Practical**
	• Isolation of mitochondria from cauliflower by density gradient centrifugation • DCPIP assay	
Practical 3	**Isolation of Cell Organelle: Nucleus**	**2 Practical**
	• Isolation of nuclei using density gradient centrifugation • Counting of nuclei by haemocytometer	
Practical 4	**Cell harvesting and cell lysis- methodology**	**1 Practical**
	• Physical method • Chemical method • Enzymatic method	
Practical 5	**Study of subcellular organelles**	**1 Practical**
Practical 6	**Cell Division**	**3 Practical**
	• Study of mitosis (onion root tip) - preparation of slides and identification of different stages • Effect of colchicine on mitosis • Study of meiosis (onion inflorescence) – preparation of slides and identification of different stages	
Practical 7	**Cell Viability**	**1 Practical**
	• TTC method for seed viability testing	
Practical 8	**Chloroplast and Photosynthesis**	**2 Practical**
	• Chloroplast Isolation • Chlorophyll estimation	
Practical 9	Demonstration of Enzyme Activity	**2 Practical**
	• Peroxidase activity • Nitrate reductase activity	

References:

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

2. Molecular Biology of the Cell, 5th Edition (2007)BruceAlberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA

3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA

4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E.Hausman, Sinauer Associates, Inc. USA

5.Cell Biology, Genetics, Molecular Biology: Evolution and Ecology by P.S.Verma.1st Edition

6. Becker's World of the cell 9th Edition by Jeff Hardin, Gregory Paul Bertoni

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous)

Shivajinagar, Pune - 5

Second Year of B.Sc. Biotechnology

(2024 Course Under NEP 2020 pattern) Semester III

Course Code: 24ScBIOU3501 **Course Name: Immunology**

Teaching Scheme: PR: (4 hrs/ week) **Credit: 2C (15 P)**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite:

- Basics of Biology
- Basics of FYBSc Biotechnology

Course Objectives:

- To Study Basics of immunology and its processes which will help in understanding immune system
- To understand structure of function of various molecules related to immunology.

Course Contents

Practical	**Topic**	**15**

		Practicals
Practical- 1	• Widal Agglutination test	1
Practical -2	• Blood Grouping	1
Practical -3	• Haemocytometer (Total cell count + Dead : Live cell counting)	2
Practical -4	• Leishmania Staining (Differential Blood staining)	1
Practical -5	**Immunodiffusion Techniques**	3
	• Serial Radial immune Diffusion • Ouchterlony method (Double immune diffusion)	
Practical -6	• ELISA (Different types of ELISA)	4
Practical -7	• Biosensors (Demonstration)	1
Practical- 8	• Rapid Plasma Reagin test for syphilis (Demo/ Practical)	2

References-

1. Immunology, Kuby Seventh Edition (2013). Judith Owen, Jenni Punt and Sharon Strandford.
2. Textbook of Microbiology, Seventh Edition (2008). R. Ananthanarayan and C. J.K. Panikar.
3. The Elements of Immunology (2009). F. H. Khan, Person Education Publishing.
4. i Genetics: A Molecular Approach (2007). Peter Russell.Pearson Education, Limited.
5. Immunology: Essential and Fundamental, Second Edition (2005). SulabhaPathak and UrmiPalan. Science Publishers Inc.
6. Elements of Immunology (2006). Rastogi S.C.
7. Roitt I. Essential Immunology. 10th Ed. Blackwell Science.
8. Kuby. Immunology. 4th edition. W. H. Freeman & company.
9. SudhaGangal and ShubhangiSontakke, Textbook of basic and clinical immunology, 1st edition (2013), University Press, India

Progressive Education Society's
Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune - 5
Second Year of B.Sc. Biotechnology
(2024 Course Under NEP 2020 pattern) Semester III

Course Code: 24ScBioU3901 | **Course Name: Applications of IKS in Biotechnology**

Teaching Scheme: TH: 2 Hours/ Week | **Credit: 2C (30L)**

Examination Scheme: CIA: 20 Marks | **End-Sem: 30 Marks**

Prerequisite Courses:

- Basic idea of ancient Indian knowledge and Biotechnology.

Course Objectives:

- To study ancient Indian Knowledge System with respect to medicine, nutrition, agriculture, environmental and biodiversity conservation etc.
- To learn applications of ancient Indian knowledge in current times.

Course Outcomes:

On completion of the course, student will be able to–

CO No	Course Outcomes (COs)	Blooms Cognitive level
CO 1	Recall need and basic concepts of IKS.	**1**
CO 2	Compare modern medical science with traditional medical practices and Ayurveda.	**2**
CO 3	Identify relation of humans with food and nourishment since ancient times.	**3**
CO 4	Analyze relevance of traditional agriculture practices to face modern age challenges.	**4**
CO 5	Value significance of environment and	**5**

	biodiversity through understanding of ancient concepts like Devrai	
CO 6	Build deeper sense of belonging to the Bharat and gratitude for our continuous parampara of knowledge.	**6**

Course Contents

Unit	Topic	30 Lectures
Unit 1	Introduction to Indian Knowledge System	3lectures
	• Concept of IKS. • Need and scope.	
Unit 2	Medical knowledge	8lectures
	• Origin of Indian medicines. • Chronology of Indian medical knowledge and archeological records of medical practices. • Contribution to surgery and cardiology. • Relevance of Ayurveda today: potential of Ayurveda in development of regenerative medicine, stem cell research, Ayurgenomics, Prakriti based drug discovery and development of personalized medicine, etc.	
Unit 3	Food, Dietetics and Nutrition	8 lectures
	• Concept of nutrition and balanced diet in ancient India. • Groups of food and their significance. • Concept of appetite and food etiquette. • Metabolic effects of food and nutritional disorders. • Food as medicine: spices, millets,	

	fermented food. • Significance of fasting rituals. • Relevance of traditional food habits, Ayurvedain nutrition and dietetics today.	
Unit 4	Agriculture	6 lectures
	• Sustainable agriculture in ancient India. • Use of natural fertilizers. • Relevance of traditional agricultural knowledge today:combination of Vedic agriculture, permaculture and science.	
Unit 5	Environment, Ecology and Biodiversity	5 lectures
	• Forest and biodiversity conservation in ancient Indian texts. • Religion as tool to protect nature and natural resources: tree and river worshiping, devoted reserved forests "Devrai". • Relevance of traditional forest and biodiversity conservation practices today: use of technology in *Ex-situ*and *In-situ* conservation.	

References:

1. Food, dietetics and nutrition in ancient India*;* (1995) Bala V. Manyam*;* *Bulletin of the Indian Institute of History of Medicine (BIIHM*), Hyderabad; (Central Council for Research in Ayurvedic Sciences Ministry of AYUSH, Govt. of India.); Volume XXV pp. 79 to 99.
2. From ancient medical knowledge to the modern drug development in India;(2017), BeenaNegi; *Indian and western knowledge traditions* (pp.40-47).
3. Forestry in Ancient India: Some Literary Evidences on Productive and Protective Aspects;(2008), B.M. Kuma, *Asian Agri-History*,r Volume 12, No.4; 299-306.
4. The Story of Millets, (2018), B VenkateshBhat, BDayakarRao and Vilas A Tonapi.; Karnataka State Department of Agriculture, Bengaluru, India with

ICAR-Indian Institute of Millets Research, Hyderabad, India,
5. Concept of Dietetics and its Importance in Ayurveda;(2014); Das Banamali;*Homeopathy &Ayurvedic Medicine*; ISSN: 2167-1206; Vol 3, 149;doi:10.4172/2167-1206.1000149.
6. Insights from Ayurveda for translational stem cell research;(2014); Kalpana S. Joshi, Ramesh Bhonde*Journal of Ayurveda & Integrative Medicine* Vol. 5; Issue 1; 10.4103/0975-9476.128846.
7. *History of Medicine in India*,(2021); R.D. LeleNational Centre of Indian Medical Heritage, Central Council for Research in Ayurvedic Sciences Ministry of AYUSH, Govt. of India, New Delhi; 978-81-948978-5-9.
8. Ayurgenomics and Modern Medicine; (2020); Robert Keith Wallace *Medicina*, 56, 661; doi:10.3390/medicina56120661.
9. Contributions of ancient Indian knowledge to modern medicine and cardiology;(2021); R. Vedam, T.A. Pansare and J. Narula*Indian Heart Journal* 73 (2021) 531e534.
10. Traditional agricultural practices in India: an approach for environmental sustainability and food security; (2020); SanojPatel, Anil Sharma, Gopal Singh; *Energy Ecology and Environment*; 5(4):253–271; DOI: 10.1007/s40974-020-00158-2.
11. Forest and biodiversity conservation in ancient Indian culture: A review based on old texts and archaeological evidences; (2014); Sayan Bhattacharya; *International Letters of Social and Humanistic Sciences* Online: 2014-06-16 ISSN: 2300-2697, Vol. 30, pp 35-46 doi: 10.18052/www.scipress.com/ILSHS.30.35.
12. *Indian Contributions to Science* (Third Edition) (2018)VijnanaBharti.

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune - 5

Second Year of B.Sc. (Biotechnology)

(2024 pattern under NEP 2020) Semester III

Course Code: 24ScBioU3002	**Course Name: Field Project**
Teaching Scheme: P: 4 Hours/Week	**Credit: 2C (P)**
Examination Scheme: CIA: 20 Marks	**End-Sem: 30 Marks**

Field Project work, Report Submission & presentation

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),
Shivajinagar, Pune - 5
Second Year of B.Sc. (Biotechnology)
(2024 pattern under NEP 2020) Semester III

Course Code: 24ScBioU3301 **Course Name: Animal Development and Physiology**

Teaching Scheme: T: 2Hours/Week **Credit: 2C (2T)**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Course Contents

Unit	Topic	30 Lectures
Unit 1	**History and basic concepts**	**1 lecture**
	• History of developmental biology • Model organisms in developmental biology: Sea urchin, Drosophila, Frog, Chick, Mouse.	
Unit 2	**Gametogenesis and fertilization**	**5 lectures**
	• Gametogenesis: oogenesis, spermatogenesis and spermiogenesis, Hormonal control. • Detailed structure of gametes, types of eggs. • Fertilization process in Sea urchin and mammals. • Patterns of cleavages and blastulation types. • Fate map.	
Unit 3	**Gastrulation:**	**3 lectures**
	• Types of Morphogenetic movements. • Gastrulation in Amphioxus, Frog, Chick, Mouse. • Axes formation in Frog and Chick embryo	
Unit 4	**Neurulation**	**2 lectures**
	• Induction, Competence. • Primary and secondary neurulation. • Neurulation in Amphioxus and Frog.	
Unit 5	**Axes and Pattern formation**	**4 lectures**
	• Pattern formationin*Drosophila*: Maternal effect genes, Gap genes, Pair rule genes and Segment polarity genes, Homeotic genes and their role in *Drosophila* pattern formation.	

	• Hox genes in mammals. • Variation in Hox gene expression patterns and evolutionary change.	
Unit 6	**Molecular mechanism of development**	**2 lectures**
	• Molecular mechanisms of animal development (homeotic genes, DNAmethylation and epigenetic gene regulation).	
Unit 7	**Stem cells and cell differentiation**	**2 lectures**
	• Stem cells: Properties, types. • Progenitor cells • Difference between Stem cell and Progenitor cell • Cell lineages. • Specification, Determination, Commitment and Differentiation • Re-differentiation and Trans-differentiation.	
Unit 8	**Regeneration**	**2 lectures**
	• Epimorphosis, Morphallaxis and Compensatory type of regeneration with one example of each type.	
Unit 9	**Aging and apoptosis**	**2 lectures**
	• Aging : Theories of aging • Apoptosis: concept, intrinsic an extrinsic pathways. • Apoptosis during embryonic development.	
Unit 10	**Teratogenesis**	**1lecture**
	• Teratogenesis: Concept of abnormal development in animals with suitable example.	
Unit 11	**Nutrition and Digestion**	**6 lectures**
	• Nutritional requirement & balanced diet. • Digestion and absorption of carbohydrates, proteins and lipids. Vitamins - outline of fat soluble and water-soluble vitamins; Sources, deficiency and diseases. 2. Respiration: • Mechanism of respiration: Regulation of ventilation in lungs, exchange of gases at respiratory surface. • Respiratory pigments in animals: Haemoglobin, Hemocyanin, Hemerythrin, Chlorocruorin. • Transport of gases: O2 and CO2 transport. 3. Circulation: Blood: Definition and its constituents, functions of blood. Heart: Structure of human heart, Pace maker, Cardiac Cycle. Origin and conduction of heart beat. 4. Excretion:	

	• Structure of Uriniferous tubule. • Mechanism of urine formation. • Normal and abnormal constituents of urine, Elementary idea of dialysis 5. Muscles: • Structure of smooth, skeletal and cardiac muscles. • Mechanism of muscle contraction by Sliding filament theory.	

References:

1. Development Biology, 9th edition, (2010), Gilbert S.F.(Sinauer Associates, USA)
2. Principles of Development, 5th edition (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

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),
Shivajinagar, Pune - 5
Second Year of B.Sc. (Biotechnology)
(2024 pattern under NEP 2020) Semester III

Course Code: 24ScBioU3302 **Course Name: Lab Course on 24ScBioU3301**
Teaching Scheme: T: 2Hours/Week **Credit: 2C (15P)**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Practical	Topic	15 Practicals
Practical 1	**Different types of eggs**	**3 Practical**
	• Types on the basis of amount of yolk. • Types on the basis of distribution of yolk. • Types on the basis of development. • Types on the basis of presence or absence of shell.	
Practical 2	**Frog development**	**2 Practical**
	• Study of frog gametes, fertilization. • Developmental stages (2celled 4 celled,morulla, blastula, and gastrula). • Life cycle of frog.	
Practical 3	**Chick embryo development**	**2 Practical**
	• Hamburger & Hamilton Chart. • Staging and staining of Chick embryos (33hrs, 48hrs, 72 hrs).	
Practical 4	**Effect of temperature on the development of Drosophila**	**2 Practical**
	• Study the effect of temperature on the development of Drosophila.	
Practical 5	**Teratogenesis**	**3 Practical**
	• Effect of teratogen on development of chick embryo.	
Practical 6	**Regeneration of Hydra**	**3 Practical**
	• Study the regeneration in Hydra.	

References:

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 Learning India

Progressive Education Society's

Modern College of Arts, Science and Commerce *(Autonomous),*

Shivajinagar, Pune - 5

Second Year of B.Sc. Biotechnology

(2024 pattern under NEP 2020) Semester III

Course Code: 24ScBIOU3401 Course Name: Biotechnology and Human welfare III

Teaching Scheme: TH: 2 Hours/Week **Credit: 2C (30 L)**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite:

- Basics of Science till 10th Standard.

Course Objectives:

- To popularize Biotechnology among non- science students.

Course Outcomes:

Sr. No.	Course Outcome	Blooms Cognitive Level
1.	Define Biotechnology and understand its applications in Human Welfare.	1
2.	Illustrate applications of Biotechnology in stem cell banking and Healthcare.	2
3.	Diagnosis of diseases from a given DNA profile.	3
4.	Compare biotechnological tools used for diagnosis of human diseases.	4
5.	Explain the role of biomarkers in diagnosis with aspects in Biotechnology.	5
6.	Discuss the molecular diagnosis impacts of Biotechnology.	6

Course Contents

Unit	Topic	30 Lectures
Unit 1	**Biotechnology: Stem cell Banking and therapy**	**12 lectures**
	Introduction to stem cells • Clinical and experimental applications of stem cells • Current therapeutic use of stem cells in disease: neural disorders, hematopoietic disorders and cardio vascular diseases • use of embryonic stem cells and stem cell banking	
Unit 2	**Biotechnology: Molecular Diagnostics**	**18 lectures**
	• Introduction to Molecular Diagnostics • Significance, Scope, Rise of diagnostic industry • Biomarkers in disease diagnostics: Role of markers in Disease diagnosis. Example • Immunodiagnostic techniques: Immunoassays – precipitation agglutination RIA,ELISA,(overview) • PCR in molecular diagnostics • Cellular and functional genomics in diagnostics.	

References:

1. Molecular biotechnology: principles and applications of recombinant DNA (2010). Glick, B. R., Pasternak, J. J., & Patten, C. L. Washington, DC: ASM Press.
2. Protein structure prediction: concepts and applications (2006) Tramontano, A
3. Principles of gene manipulation and genomics, (2013) Primrose, S. B., &Twyman, R. John Wiley & Sons.
4. Industrial Biotechnology (2009), Mathuriya A. S, Ane Books Pvt. Ltd.
5. New Products and New Areas of Bioprocess Engineering (Advances in Biochemical Engineering/Biotechnology, 68) by T. Scheper. Publisher : Springer Verlag
6. Prescott's Microbiology (2010), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton 8th Edition McGraw-Hill Publishers Eight edition.
7. Stem cell books

Semester IV

Progressive Education Society's
Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune - 5
Second Year of B.Sc. Biotechnology
(2024 pattern under NEP 2020) Semester IV

Course Code: 24ScBioU4101 **Course Name: Molecular Biology**
Teaching Scheme: TH: 4 Hours/ Week **Credit: 4 C (4T)**
Examination Scheme: CIA: 40 Marks **End-Sem: 60 Marks**

Prerequisite Courses:

- Basics of Cell Biology and Biochemistry

Course Objectives:

- To learn the progress in the field of Molecular Biology
- To Study basic techniques in Molecular Biology.

Course Outcomes:

On completion of the course, student will be able to–

- Obtain the latest developments in the field of Molecular Biology

CO No	Course Outcomes (COs)	Blooms Cognitive Level
CO1	Finding relevant information about transcription,	1
CO2	Translation process from reference books	1
CO3	Understanding the molecular mechanisms in the cells	2
CO4	Compare transcription and translation processes in eukaryotic and prokaryotic organisms	3
CO5	Examine posttranscriptional modifications.	4
CO6	Correlating the molecular mechanisms to a cellular level	1
	Explain major contributions towards the development of branch of molecular biology	5

Course Contents

Unit	Title	60 Lectures
Unit 1	**Overview of Molecular biology**	**10 Lectures**
	• Definition and Scope of Molecular Biology • Structure of DNA - Watson & Crick model • DNA forms; A, B & Z • RNA: tRNA, rRNA, mRNA and non-coding RNA (Mi-, SiRNA) • DNA content of cell and C- value Paradox • Chromosomal organization and structure. • Euchromatin, heterochromatin, centromere, telomere.	

	• Chromatin structure (nucleosomes)- histone, non-histone proteins • Central Dogma of Molecular Biology and exception to central dogma	
Unit 2	**Overview of DNA replication in prokaryotes and eukaryotes**	**10 Lectures**
	• Replication in Prokaryotes i.Initiation ii.Elongation iii. Termination • Replication in eukaryotes i. Initiation ii.Elongation iii. Termination	
Unit 2	**Transcription in Prokaryotes**	**14 Lectures**
	Transcription Machinery in Prokaryotes • Initiation and elongation of transcription • Termination of transcription • Regulation of transcription	
Unit 3	**Transcription in Eukaryotes**	**14 Lectures**
	• Eukaryotic promoters • Initiation, Elongation and termination of transcription with details of transcription factors • Post transcriptional modifications • Regulation of transcription	
Unit 4	**Translation**	**12 Lectures**
	• Components of Protein Synthesis Machinery– mRNA,tRNA,Ribosomes • Mechanism of protein synthesis- Initiation, elongation and termination • Post translational Modifications • Regulation of protein synthesis	

References:

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, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA

3. Molecular Biology, 5th Edition (2011), Weaver R., Publisher-McGrew Hill Science. USA

4. Fundamentals of Molecular Biology, (2009), Pal J.K. and SarojGhaskadbi, Oxford University Press. India

Progressive Education Society's
Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune - 5
Second Year of B.Sc. Biotechnology
(2024 pattern under NEP 2020) Semester IV

Course Code: 24ScBioU4102 **Course Name: Lab Course on 24ScBioU4101**
Teaching Scheme: TH: 4 Hours/ Week **Credit: 2 C (15P)**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Basics of Cell Biology and Biochemistry

Course Objectives:

- To learn the progress in the field of Molecular Biology
- To Study basic techniques in Molecular Biology.

Course Contents

Practical	Title	15 Practicals
Practical1	**Importance of clean handling, sterility, cleanliness, reagent preparation**	**2 Practical**
	Preparation of Molar and Normal Solution Preparation of stock solutions Preparation of buffers for molecular biology	
Practical2	**Estimation of DNA and RNA by colorimetric method**	**2 Practical**
	DNA estimation by Diphenyl amine method RNA estimation by Orcinol methods	
Practical 3	**Study of Absorption spectra and quantitation**	**1 Practical**
	Absorption spectra and quantitation of DNA, RNA and proteins	
Practical4	**Agarose gel electrophoresis**	**2 Practical**
	Study of std DNA by using Agarose gel electrophoresis	
Practical 5	**Restriction Digestion**	**2 Practical**
	Restriction enzyme digestion and analysis of DNA by gel electrophoresis	
Practical 6	**Isolation of Plant DNA**	**3 Practical**
	Isolation of Eukaryotic(Plant) DNA and analysis of it by Agarose gel electrophoresis	
Practical7	**Isolation of Animal DNA**	**3 Practical**
	Isolation of Eukaryotic(Animal) DNA and	

	analysis of it by Agarose gel electrophoresis	

References:

1. Lewin's Genes, 12th edition, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, Jones& Bartlett Learning, Burlington, MA, 2018.
2. Molecular Biology of the Gene, 7th Edition (2013), James D. Watson, Tania Baker,Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
3. Molecular Biology, 5th Edition (2012), Weaver R., Publisher-McGrew Hill Science.USA
4. Molecular biology of the cell 6th edition, Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter, Garland Science, Taylor & Francis Group, 711 Third Avenue, New York, NY 10017, US
5. Molecular Cell Biology,9th edition, 2021,Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Kelsey C. Martin; Michael Yaffe; Angelika Amon, W.H. Freeman Publishing.
6. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India

Progressive Education Society's
Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune - 5
Second Year of B.Sc. Biotechnology
(2024 pattern under NEP 2020) Semester IV

Course Code: 24ScBioU4501 **Course Name: Genetics**
Teaching Scheme: TH: 4 Hours/Week **Credit: 2C (15P)**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite:

- Knowledge of genetics from XI, XII science.

Course Objectives:

- To Study: Mendelian and Non-Mendelian genetics.
- To learn concepts related to Linkage,Pleiotropy, Penetrance, Expressivity, Pedigree analysis, and Clinical genetics.

Course Content

Unit	Topic	15 Practicals
Unit 1	**Mendelian Genetics (Problems based on following topics)**	**5 Practicals**
	• Problem sets in Mendalian inheritance, single point & two point crosses and gene mapping in bacteria.	
Unit 2	**Observation of Drosophila**	**3 Practicals**
	• Observation of Drosophila – wild type and mutant. • Patterns of inheritance and genetic models (computer-based practicals)	
Unit 3	**Linkage and linkage maps**	**3 Practicals**
	• Problem sets based on Complete and incomplete linkage, crossing over, three point cross, genetic mapping.	
Unit 4	**Pedigree analysis**	**2 Practicals**
	• Standard symbols used. Problems based on • Recessive and dominant inheritance • Sex linked inheritance. • Probability.	
Unit 5	**Demonstration of Chromosomal aberrations**	**2 Practicals**
	• Demonstration of Chromosomal aberrations in Down's syndrome, Patau's syndrome, Edward's syndrome, Turner's syndrome, Klinefelter's syndrome. • Variation in chromosome structure – types, generation of variation, consequences. • Genetic counseling.	

References:

1. Genetics, (2006) Strickberger MW - (Prentice Hall, India.)
2. Fundamentals of Genetics: B.D Singh.
3. Hartl DL, Jones EW (2001) – Genetics: analysis of genes and genomes (Jones and Bartlett, Massachusetts).
4. Principles of Genetics: Robert H. Tamarin, 7th Edition.
5. GENES IX (2006): Benjamin Lewin.
6. Concepts of genetics (2011): Robert Brooker.
7. IGenetics: A Mendelian Approach (2006) :Peter J. Russell
8. Plant Breeding: Mendelian to molecular approaches: (2004) H.K. Jain and M.C. Kharkwal.
9. Introduction to Genetic Analysis 9th Edition: Griffiths A, Wessler S., Lewontin R., Carroll S.

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),
Shivajinagar, Pune - 5
Second Year of B.Sc. (Biotechnology)
(2024 pattern under NEP 2020) Semester IV

Course Code: 24ScCopU4003 Course Name: Community Engagement Project
Teaching Scheme: P: 4 Hours/Week Credit: 2C (2P)
Examination Scheme: CIA: 20 Marks End-Sem: 30 Marks

Field Project work, Report Submission & presentation

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune - 5
Second Year of B.Sc. Biotechnology
(2024 pattern under NEP 2020) Semester IV

Course Code: 24ScBioU4301 Course Name: Plant Development & Physiology
Teaching Scheme: TH: 2 Hours/Week Credit 2 C (30 L)
Examination Scheme: CIA: 20 Marks End-Sem : 30 Marks

Prerequisite Courses:

- Knowledge of Plant Science from XII standard and FYBSc Biotechnology.

Course Objectives:

- To Study Plant Development and Embryo Development.
- To learn Coordination manner how Developmental Stages in Plant.

Course Outcomes:

On completion of the course, student will be able to –

CO No	Course Outcomes (Cos)	Blooms Cognitive Level
CO 1	Find history and development of plant	1
CO 2	Explain and sketching diagrams of internal structure of Stem and Root	2

CO3	Identify various major phases of plant development	3
CO4	Examine outline structures of ovules	4
CO5	Importance of plant development and their application	5
CO6	Discuss the concepts with protocol and biotechnical approaches	6

Course Contents

Units	Title	30 lectures
Unit 1	**Principles of Plant Development**	**4 lectures**
	• Principles of plant development • Cellular, organ and whole-plant levels • Plant as an interacting dynamic system • Plant as a living system	
Unit 2	**Floral biology**	**4 lectures**
	• Unique features of plant development • Function of flower • Structure of flower	
Unit 3	**Major phases of plant development**	**5 lectures**
	• Vegetative development: • Fertilization –vegetative propagation, importance of vegetative propagation.	
Unit 4	**Reproductive development:**	**4 lectures**
	• Pollination and types of pollination • Growth of the pollen tube	
Unit 5	**Embryogenesis in plants**	**6 lectures**
	• Microsporogenesis, development of male gametophyte and male gamete • Megasprogenesis, development of female gametophyte and female gamete • Double fertilization and triple fusion	
Unit 6	**Concept of competence, Determination**	**2 lectures**
	• Concept of competence, determination, commitment, differentiation, de-differentiation and re-differentiation	
Unit 7	**Arabidopsis- as a plant development model system.**	**3 lectures**
	• Model systems to understand plant development, and *Arabidopsis*	
Unit 8	**Growth and Growth hormones**	**2 lectures**

	• Definition • Phases of growth • Phytohormones • Factors affecting growth	

References:

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 University Press, USA.
3. Bhojwani S.S. and Bhatnagar S.P.(2009) – Embryology of Angiosperms (VikasPubl House,
New Delhi)
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. Steeves TA & Sussex IM (2004) – Patterns in plant development. (Cambridge Univ Press, Cambridge, New York)

Progressive Education Society's
Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune - 5
Second Year of B.Sc. Biotechnology
(2024 pattern under NEP 2020) Semester IV

Course Code: 24ScBioU4302 **Course Name: Lab Course on 24ScBioU4301**
Teaching Scheme: TH: 4 Hours/Week **Credit 2 C (15P)**

Examination Scheme: CIA: 20 Marks **End-Sem : 30 Marks**

Course Contents

Practical	Title	15 Practicals
Practical 1	**Plant Development**	**3 Practical**
	• Methods of studying plant development • Dissection • Sectioning • Staining • Mounting.	
Practical 2	**Floral biology**	**4 Practical**
	• Study of apices and meristem- • RAM, SAM, florally induced meristem,	
Practical 3	**Major phases of plant development**	**3Practical**
	• Development of male and female gametophytes • Developmental stages during plant embryo genesis in dicots and monocots).	
Practical 4	**Reproductive development:**	**3Practical**
	• Dissection of seed and excision of young embryo and endosperm dicotyledon and one monocotyledon.	
Practical 5	**Embryogenesis in plants**	**2 Practical**
	• Microsporogenesis- anther squash technique	

References:

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 University Press, USA.
3. Bhojwani S.S. and Bhatnagar S.P.(2009) – Embryology of Angiosperms (VikasPubl House,
New Delhi)
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. Steeves TA & Sussex IM (2004) – Patterns in plant development. (Cambridge Univ Press, Cambridge, New York)
8. Dr. B.P. Pandey .S.Chand& Company, Delhi

Modern College of Arts, Science and Commerce (Autonomous),
Shivajinagar, Pune - 5
Second Year of B.Sc. Biotechnology
(2024 pattern under NEP 2020) Semester IV

Course Code: 23ScBioU4401 Course Name: Biotechnology and Human welfare IV
Teaching Scheme: TH: 2 Hours/Week Credit: 2C (30 L)
Examination Scheme: CIA: 20 Marks End-Sem: 30 Marks

Prerequisite:

- Basics of Science till 10th Standard.

Course Objectives:

- To popularize Biotechnology among non- science students.

Course Outcomes:

CO No	Course Outcome	Blooms Cognitive Level
CO 1	Define Biotechnology and understand its applications in Human Welfare.	1
CO 2	Illustrate applications of Biotechnology in bioinformatics	2
CO 3	Use of bioinformatics in plantgenome studies and crop improvement.	3
CO 4	Compare genomics tools used for drug delivery and design.	4
CO 5	Explain the Molecular phylogeny in with respect to evolutionary studies.	5
CO 6	Discuss the socio-economic impacts of Biotechnology and clinical trials.	6

Course Contents

Unit	Topic	Lectures
Unit 1	**Biotechnology: Bioinformatics and computational biology**	**15 lectures**
	• Introduction to bioinformatics and computational biology • Introduction to genome databases and tools in plant genome analysis and crop improvement • Introduction to genome databases and tools in applications in Medicine, drug delivery, drug design	
Unit 2	**Molecular Phylogeny**	**7 lectures**
	• Introduction to Molecular Phylogeny • Molecular Phylogeny and metgenomics • Phylogenetic tree construction using bioinformatics	

	tools	
Unit 3	**Biotechnology: clinical research**	**8 lectures**
	What is clinical research? • History of Clinical research • Different Phases of clinical research and significance of each phase • Clinical trial design in production of vaccines, therapeutics • Clinical Trial Documentation, Audits and Inspections • Institutional ethical committee • Data Management Standards	

References:

1. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers. 3. Baldi, P. and Brunak, S. 2001 5. Bioinformatics: The machine learning approach, The MIT Press.
2. Mount, D.W., Bioinformatics: 2001, Sequence and Genome Analysis. CSHL Press
3. Liebler, D. 2002 Introduction to Proteomics: Tools for New Biology. Human Press Totowa.
4. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997 Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
5. Molecular biotechnology: principles and applications of recombinant DNA (2010). Glick, B. R., Pasternak, J. J., & Patten, C. L. Washington, DC: ASM Press.
6. Protein structure prediction: concepts and applications (2006) Tramontano, A
7. Principles of gene manipulation and genomics, (2013) Primrose, S. B., &Twyman, R. John Wiley & Sons.
8. Industrial Biotechnology (2009), Mathuriya A. S, Ane Books Pvt. Ltd.
9. New Products and New Areas of Bioprocess Engineering (Advances in Biochemical Engineering/Biotechnology, 68) by T. Scheper. Publisher : Springer Verlag
10. Prescott's Microbiology (2010), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton 8th Edition McGraw-Hill Publishers Eight edition.
11. Biotechnology and Safety Assessment, (2002), Thomas J.A., Fuch R.L Academic Press 3rd Edition.
12. Biological safety Principles and practices (2000) Fleming D.A., Hunt D. ASM Press 3rd. ed.

(2024 pattern under NEP 2020) Semester IV

Course Code: 24ScBIOU4601 **Course Name: Metabolism**
Teaching Scheme: TH: 2 Hours/Week **Credit: 2C (2T)**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite: The course requires that the students have basic understanding of chemistry and biochemistry and structure, properties and characteristics of biomolecules.

Course Objectives:

- To study basics of metabolism to understand important processes in biological system.
- To comprehend different fates of biomolecules in biological system,
- To understand chemical kinetics of both chemical and biochemical reactions
- To understand the processes involved in anabolic and catabolic reactions
- To understand the steps necessary for carbohydrate, lipid, and nucleotide metabolism.

Course Outcomes:

CO No	Course Outcomes (COs)	Blooms Cognitive Level
CO 1	Find the basic concepts of bioenergetics	**1**
CO 2	Illustrate functions of enzymes in metabolism	**2**
CO 3	Identify various metabolism mechanisms in carbohydrates	**3**
CO 4	Distinguish between various pathways of nucleotide metabolism	**4**
CO 5	Evaluate several lipid metabolic pathways	**5**
CO 6	Discuss metabolism concepts like catabolism,anabolism and metabolic disorders	**6**

Course Contents

Unit	Topic	30 Lectures
Unit 1	**Bioenergetics**	**3 lectures**
	• Basic principles of thermodynamics • Concept of energy and energy change • Important types of reaction in metabolism: oxidation-	

	reduction reaction , group transfer etc; Types of electron transfer, redox potential, phosphoryl group transfer • Role of ATP as energy source.	
Unit 2	**Metabolism**	**1 lectures**
	• Basic concepts and design of metabolism • Introduction to anabolism, catabolism and interconversion of biomolecules • Metabolic disorders	
Unit 3	**Enzymes**	**4 lectures**
	• Introduction to enzymes • Kinetics and mechanism of action. • Enzyme activity, specific activity. • Introduction to regulation and inhibition of enzyme activity • Coenzyme forms of enzyme: NAD, FAD, FMN etc	
Unit 4	**Carbohydrate Metabolism**	**9 lectures**
	• Glycolysis, fates of pyruvate: • Pyruvate dehydrogenase as multienzyme complex • TCA cycle, Anapleurotic reactions, • Gluconeogenesis, glycogen breakdownand glycogen synthesis, • Glyoxylate Pathway, • Pentose phosphate pathway. • Regulation and energetics of pathways	
Unit 6	**Lipid metabolism**	**7 lectures**
	• Metabolism of Dietary Triacyl glycerol (TAG) • Catabolism of fatty acids: Beta oxidation of fatty acids, Oxidation of odd chain fatty acids • Biosynthesis of Saturated and unsaturated fatty acids • Lipoproteins	
Unit 7	**Nucleotide Metabolism**	**6 lectures**
	• Biosynthesis and regulation of purine and pyrimidines (de novo & salvage pathways) • Catabolism of purine and pyrimidines	

References-

1. Biochemistry; Rex Montgomery, Thomas W. C, Arthur AS, Barry H. G; 5th edition; St. Louis: Mosby; [1990].
2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Palmer Trevor, Bonner Philip; 2nd edition; Woodhead Publishing, Oxford; [2011].
3. Biochemistry: The Molecular Basis of Life; James RM, Trudy M; 7th Edition; Oxford Printing press; [2015].
4. Enzyme structure and mechanism; Alan Fersht, W. H. Freeman; Reading [Eng.]: [1977].
5. Outlines of Biochemistry; E. Conn, P. Stumpf; 4th edition; New York, Wiley; [1976].
6. Biochemistry; Jeremy MB, John LT, Lubert S; 5th edition; New York: W H Freeman: [2002].
7. Concepts in Biochemistry; Boyer RF; Pacific Grove, Calif., Brooks/Cole; [1999].
8. Principles of biochemistry; Donald Voet, Judith Voet, Charlotte Pratt; 5th edition; Hoboken, NJ: Wiley; [2008].