Deccan Education Society's
Fergusson College (Autonomous), Pune-4
Department of BIOTECHNOLOGY

Deccan Education Society's

Fergusson College (Autonomous)

Pune

Learning Outcomes-Based Curriculum

for 3/4 years B. Sc. / B. Sc. (Honours) Programme

as per guidelines of

NEP-2.0

for

S. Y. B. Sc. (BIOTECHNOLOGY)

With effect from Academic Year

2025-2026

Syllabi NEP 2.0 Implemented from Academic Year 2025-26
S.Y. B.Sc. Biotechnology Semester: III and IV

Program Specific Outcomes (PSOs)

PSO	Outcomes
PSO1	**Academic competence**: i. Gain strong foundation and knowledge in scientific fundamentals and acquire comprehensive understanding of the principles and practices of biotechnology including skill-based concepts, in an interdisciplinary course structure, provided by highly qualified and competent faculty. ii. Acquire training in techniques/skills utilized in biotechnology and understand the scope and applications of biotechnology in well- equipped and state of the art laboratories. iii. Achieve competence for higher studies, research and be employment ready in the domain of Biotechnology and allied field. **iv.** Demonstrate qualities of a responsible biotechnologists that can work within the interdisciplinary framework of biotechnology and related fields.
PSO2	**Personal and Professional Competence**: i. Analyze and interpret data and provide solutions to basic problems relevant to biotechnology and related fields. ii. Apply appropriate tools and techniques in biotechnology, combine experimental and computational approaches to design and perform experiments proficiently. iii. Demonstrate and apply knowledge and skill in the design and development of solutions for relevant problems to cater to the requirements of biotechnology industries iv. Acquire good oral and written communication skills v. Experience the opportunity to curate/ manage or participate in a variety of co and extracurricular activities like internships, research projects, field projects, that will cater to professional demands by the Industry, Research institutes and overall personality development
PSO3	**Research Competence:** i. Develop an interdisciplinary approach to **c**onduct original research in various field of Biotechnology and allied fields **ii.** Demonstrate appropriate skills in design of experiments with appropriate controls, critical thinking and result analysis **iii.** Apply statistical skills and computational tools to explore, analyze and authenticate biological data in experiments and research
PSO4	**Entrepreneurial and Social competence:** i. Implement skills and knowledge acquired in skill imparting and entrepreneurial courses in upcoming fields of Biotechnology ii. Develop a sense of social, ethical, environmental and professional responsibility iii. Practice professional ethics in the conduct of science iv. Recognize the importance of Bioethics, IPR, entrepreneurship, Communication, management skills and community engagement programmes to be ready to pursue future course of career.

S.Y. B.Sc. NEP 2.0						
Semester	Paper	Paper Code	Paper Title	Type	Credits	Exam Type
III	Major	BTH-2003	Foundations of Cell and Molecular Biology	Theory	2	CE+ESE
		BTH-2013	Classical Genetics and Plant Development	Theory	2	CE+ESE
		BTH-2023	Biotechnology Practical-3	Practical	2	CE+ESE
	Minor	BTH-2113	Analytical Techniques in Biology	Theory	2	CE+ESE
		BTH-2123	Biotechnology Practical-4	Practical	2	CE+ESE
	OE	-	Offered by other departments	Theory	2	
	VSC	BTH-2303	Metabolic Pathways	Theory	2	CE
	SEC	BTH-2403	Biomolecules and Bioinstrumentation	Theory	2	CE
	CEP	BTH-2453	Community Engagement Programme	Theory / Practical	2	CE
	AEC	AEC-2003	Conducted centrally	AEC	2	CE
	CC	CC-2013 NSS	Conducted centrally	CC	2	CE
		CC-2023 NCC	Conducted centrally	CC	2	CE
		CC-2033 Sports	Conducted centrally	CC	2	CE
		CC-2043 Cultural	Conducted centrally	CC	2	CE
		CC-2053 Yoga	Conducted centrally	CC	2	CE
IV	Major	BTH-2004	Biomolecular Interactions and Pathways	Theory	2	CE+ESE
		BTH-2014	Introduction to Animal Development	Theory	2	CE+ESE
		BTH-2024	Biotechnology Practical-5	Practical	2	CE+ESE
	Minor	BTH-2114	Tissue Culture Techniques	Theory	2	CE+ESE
		BTH-2124	Biotechnology Practical-6	Practical	2	CE+ESE
	OE	-	Offered by other departments-	Theory	2	CE
	VSC	BTH-2304	Immunology	Theory	2	CE
	SEC	BTH-2404	Introduction to Genetic Engineering	Theory	2	CE
	FP	BTH-2454	Field Project	Theory / Practical	2	CE
	AEC	AEC-2004	Conducted centrally	AEC	2	CE
	CC	CC-2014 NSS	Conducted centrally	CC	2	CE
		CC-2024 NCC	Conducted centrally	CC	2	CE

		CC-2034 Sports	Conducted centrally	CC	2	CE
		CC-2044 Cultural	Conducted centrally	CC	2	CE
		CC-2054 Yoga	Conducted centrally	CC	2	CE

	BTH-2003 - Foundations of Cell and Molecular Biology Major -Theory	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the structure and functions of cell organelles	1
CO2	Explain the architecture of cytoskeleton, membranes and extracellular matrix	2
CO3	Outline various modes of membrane transport and their significance	3
CO4	Connect the events of cell cycle to mechanisms of regulation	4
CO5	Compare the organization of bacterial, eukaryotic and viral genomes	5
CO6	Design models and experimental approaches to study DNA replication	6

BTH-2003 - Foundations of Cell and Molecular Biology
(Major –Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Structure and Function of Cell Organelles:** ● Endoplasmic reticulum, Golgi body, lysosomes, vacuoles ● Mitochondria, chloroplast ● Nucleus, ribosomes ● Peroxisomes and Glyoxysomes	6
2	**Plasma Membrane, Cytoskeleton and Extracellular Matrix:** ● Organization and properties of plasma membrane ● Structure and organization of cytoskeletal elements ● Structure and functions of cell junctions and Extracellular matrix	4
3	**Types and Modes of Membrane Transport:** ● Passive transport, active and secondary active transport ● Exocytosis, endocytosis, pinocytosis and phagocytosis ● Channels and carriers ● Regulation of membrane potential	4
4	**Regulation of Cell Division:** ● Checkpoints and regulation of eukaryotic cell cycle ● Binary Fission and its regulation ● Exceptions to cell cycle	3
5	**Genome Structure and Organization:** ● Organization of viral, prokaryotic and eukaryotic genomes: DNA compaction, Structure of chromatin, nucleosome, significance of chromatin remodeling, introduction to Cot curves and its correlation to complexity of genomes; C value paradox ● Higher order organization of chromatin; types and parts of chromosomes ● Repetitive DNA elements	6

6	**DNA Replication and Regulation:** ● Structure and properties of DNA polymerases in prokaryotes and eukaryotes ● Mechanisms of genomic DNA replication in prokaryotes and eukaryotes (Theta loop and linear model) ● Mechanisms of extrachromosomal DNA replication in prokaryotes and eukaryotes (Rolling circle and D-loop model) ● Introduction to concepts of regulation	7
	Discussion on relevant techniques to study cellular and molecular processes, disorders and dysfunction of pathways.	

Learning Resources- References

Sr. No.	References
1.	Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular biology of the cell* (6th ed.). Garland Science. ISBN: 978-0815344322.
2.	Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). *Molecular cell biology* (9th ed.). W.H. Freeman and Company. ISBN: 978-1319208520.
3.	Karp, G., Iwasa, J., & Marshall, W. (2019). *Karp's cell and molecular biology: Concepts and experiments* (9th ed.). Wiley. ISBN: 978-1119598244.
4.	Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular biology of the gene* (7th ed.). Benjamin Cummings. ISBN: 978-0321762436.
5.	Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's GENES XII* (12th ed.). Jones & Bartlett Learning.
6.	Cooper, G. M., & Adams, K. (2022). *The cell: A molecular approach* (9th ed.). Sinauer Associates, an imprint of Oxford University Press. ISBN: 978-0197583722
7.	Weaver, R. F. (2011). *Molecular biology* (5th ed.). McGraw Hill. ISBN: 978-0073525327.
8.	Pal, J. K., & Ghaskadbi, S. (2009). *Fundamentals of molecular biology*. Oxford University Press. ISBN: 978-0195697810.
9.	Tropp, B. E. (2012). *Molecular biology: Genes to proteins* (4th ed.). Jones & Bartlett Learning. ISBN: 978-1449647910.
	Web Resources
	1. https://www.youtube.com/watch?v=gbSIBhFwQ4s 2. https://www.youtube.com/watch?v=IjVLhoyfGAM 3. https://www.youtube.com/watch?v=dgPh1qigv7s

	BTH-2013 - Classical Genetics and Plant Development **Major-Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Associate the science of genetics with the expression of characters in living organisms.	1
CO2	Distinguish between Mendelian genetics and modern genetics.	2
CO3	Illustrate the need for understanding chromosomal aberrations and techniques used therein.	3
CO4	Explain the processes in early development and apply the concepts in technology	4
CO5	Determine different cellular organizations during development that leads to development of multicellular organism from a zygote	5
CO6	Specify the concept of pattern formation using various model systems.	6

BTH-2013 - Classical Genetics and Plant Development
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of hours (30)
	Classical Genetics	
1	**Genetic basis of Inheritance:** ● Introduction to Heredity, Variations, Pre - Mendelian concept, Importance of Genetics ● **Mendelian Genetics:** Laws of Inheritance, Monohybrid and Dihybrid Ratio, Back cross and Test cross.	2
2	**Post-Mendelian Discoveries**: ● Incomplete Dominance, Codominance, Dominant and Recessive Epistasis, Complementary genes, Supplementary genes, Pleiotropy, Multiple alleles, Lethal genes. ● Cytoplasmic male sterility in plants ● Maternal Inheritance, Maternal effect.	6
3	**Chromosomal aberrations:** ● Variations in chromosome structure and chromosome number; mechanism and causes of aberrations with examples.	2
	Plant development	
4	**Unique features of plant development:** ● Concept of totipotency, Differentiation, Dedifferentiation, Redifferentiation, Competence with example.	2
5	**Plant development at:** ● Cellular, organ and whole-plant levels ● Concept of plant growth regulators, mode of action of Auxin, Gibberellic acid, Cytokinin, Ethylene and abscisic acid.	5
6	**Vegetative development:** ● Zygote to seed embryo to seedling till vegetative maturity (Dicot and Monocot), Embryogenic mutants ● Vegetative Growth and Organogenesis ● Pattern formation in vegetative organs: Axial and radial patterning	3

7	**Reproductive development:** ● Shift from vegetative to reproductive phase ● Microsporogenesis: Development of male gametophyte and male gamete. ● Megasporogenesis : Development of female gametophyte and female gamete. ● Double fertilization and triple fusion. Development of endosperm.	4
8	**Floral Organ Development:** Induction- perception of inductive stimuli and subsequent changes ● Pattern formation in plants- flowering; inflorescence meristem ● ABC model for Flower development.	4
9	**Role of Senescence and Programmed Cell Death in plant development**	2
	Suitable model systems to be used for explanation.	

Learning Resources- References

Sr. No.	References
1.	Genetics (2015) Strickberger 3rd edition (Pearson Education, UK) (Pearson Education, India)
2.	Principles of Genetics (2006) Gardner, Simmons, Snustad (Wiley, India) 8th edition
3.	Concepts of Genetics (2019) Klug, Cummings, Spencer, Palladino and Killian 12th edition (Pearson Education, UK)
4.	Principles of Development, Wolpert L and Tickle C, 4th edition (2010), Oxford University Press.
5.	Embryology of Angiosperms, Bhojwani S.S. and Bhatnagar S.P.(2009) –Vikas Publishing House, New Delhi
6.	Plant physiology , Taiz L , and Zeiger E (2010) Sinauer Associates, USA.

	BTH-2023 - Biotechnology Practical -3 (Cell, Molecular Biology and Plant Development) Major - Practical	
	Number of Credits: 02 No. of Hours:60	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall essential concepts of cell division and its regulation	1
CO2	Differentiate between procedures for various organelle isolations	2
CO3	Employ different techniques for isolation of prokaryotic genomic DNA	3
CO4	Analyze the quality of isolated DNA using agarose gel electrophoresis	4
CO5	Contrast between different techniques and sources to study plant development	5
CO6	Integrate concepts of Mendelian genetics to solve problems	6

BTH-2023 - Biotechnology Practical -3
(Cell, Molecular Biology and Plant Development)
(Major – Practical)

Unit No.	**Title of Unit and Contents**	**No. of Practical**
1	Effect of colchicine on cell division	1P
2	Isolation of nuclei by differential centrifugation and counting using Neubauer chamber	1P
3	Isolation of chloroplasts and estimation of chlorophyll	2P
4	Isolation of genomic DNA from Prokaryotic source; Agarose Gel Electrophoresis	3P
5	Determination of mononucleosome size by action of micrococcal nuclease	1P
6	Study of plant tissues important in development: vegetative (apical meristems) and reproductive (floral meristem, microsporangium)	3P
7	Dissection of seeds and excision of young and mature embryo/endosperm & Study of plant embryogenesis	2P
8	Problems in Genetics	2P

	BTH-2113 - Analytical Techniques in Biology **Minor - Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Introduce basic working principles of laboratory instruments	1
CO2	Describe construction of microscopes and applications of microscopy.	2
CO3	Demonstrate different components and types of centrifuges and their uses.	3
CO4	Compare the working principles of spectroscopy, electrophoresis and chromatography in estimating and separating biomolecules.	4
CO5	Justify the need of important laboratory procedures and instruments.	5
CO6	Design experiments to test the applications of instruments.	6

Unit No	Title of Unit and Contents	No of Hours (30)
1	**Introduction to Common Laboratory Instruments:** ● General safety measures, personal protection, spillage and waste disposal. ● pH Meter, Colorimeter, Distillation Unit, Chemical Balance, Laminar air flow hood, Clinical centrifuge, Refrigerator, Lyophilizer, Shaker incubator.	5
2	**Microscopy:** ● Construction and working principles of Dissecting and Compound microscope. ● Features of inverted microscope, estimation of cell size using Micrometry and representation of data; cell counting using Neubauer chamber. ● Use and care of microscopes.	5
3	**Centrifugation:** ● Principles and working and types of centrifuges, rotor types and applications.	5
4	**Spectroscopy:** ● Beer Lambert's Law, principle and working of Colorimeter, Spectrophotometer, and their applications	5
5	**Electrophoresis**: ● Introduction to: Agarose gel electrophoresis, Polyacrylamide gel electrophoresis. ● Applications.	5
6	**Chromatography:** ● Introduction to Paper chromatography, Thin Layer Chromatography; Column chromatography and their applications	5

Learning Resources- References

Sr. No.	References
1.	Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, Nath (2010) Himalaya Publishing House
2.	Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th edition. Edited by Keith Wilson and John Walker.
3.	Instrumentation measurements and analysis (2016) Nakra and Choudhari 4th edition Tata McGraw Hill, India

	BTH-2123 - Biotechnology Practical-4 **(Analytical Techniques in Biology)** **Minor-Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define the rationale behind using various laboratory instruments and learn basic handling procedures.	1
CO2	Describe the working principles of microscopy and electrophoresis.	2
CO3	Apply spectroscopic techniques for quantification of biomolecules.	3
CO4	Test different estimation methods for proteins.	4
CO5	Compare the instrumentation of different types of microscopes.	5
CO6	Perform experiments to validate the use of instruments.	6

BTH-2123 - Biotechnology Practical-4
(Analytical Techniques in Biology)
Minor-Practical

Sr. No.	Title of Unit and Contents	No of Practicals
1	Standardization and calibration of micropipette and pH meter	2P
2	Protein estimation techniques- Biuret, Lowry and Bradford method	3P
3	Quantification of proteins and nucleic acid by UV-Vis Spectroscopy	3P
4	Demonstration of different types of microscopes and their applications	2P
5	Agarose gel electrophoresis	2P
6	Paper Chromatography/ TLC for detection of biomolecules	3P

	BTH-2303 - Metabolic Pathways **VSC - Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define anabolism and catabolism. Describe principal characteristics of metabolic pathways.	1
CO2	Explain different pathways of carbohydrate metabolism. Illustrate how glucose is oxidized and how it is synthesized from non-carbohydrate sources in case of emergency.	2
CO3	Examine why fats and oil are the best source of energy. Outline the synthesis of important lipids including phospholipids and cholesterol. Describe the role of ketone bodies.	3
CO4	Explain key reactions of protein metabolism. Differentiate how amino acids are synthesized. Explain how toxic ammonia is removed from our body.	4
CO5	Validate regulation of carbohydrate, lipid and protein metabolism	5
CO6	Integrate carbohydrate and non-carbohydrate metabolism	6

BTH-2303 - Metabolic Pathways
VSC - Theory

Unit No	**Title of Unit and Contents**	**No of Hours (30)**
1	**Introduction to metabolism:** ● Metabolic pathways: Metabolites, Catabolism, Anabolism. ● Principal characteristics of metabolic pathways.	2
2	**Carbohydrate and energy metabolism:** ● Intracellular metabolism of glucose - Glycolysis, fates of pyruvate, Gluconeogenesis, TCA cycle, Glycogenesis, Glycogenolysis, Pentose Phosphate Pathway. ● Regulation of Glycolysis, TCA cycle and Glycogen metabolism. Oxidative phosphorylation. ● Electron Transport Chain: Sequence of electron carriers, Oxidative Phosphorylation, ATP synthesis	12
3	**Non-carbohydrate metabolism Lipid metabolism:** ● Triglycerides, Transport of fatty acid into mitochondria, β-oxidation of fatty acids, reactions and energetics of beta oxidation. ● Biosynthesis of fatty acid, Overview of biosynthesis of Phospho-lipids and Cholesterol,	6
4	**Non-carbohydrate metabolism Amino acid and Purine metabolism:** ● Metabolism of ketone bodies. ● Protein metabolism: General reactions of amino acid metabolism (Oxidative deamination, Transamination, Decarboxylation), Glucogenic and ketogenic amino acids, Urea cycle ● Introduction to purine and pyrimidine metabolism. ● Metabolism disorders	10

Learning Resources- References

Sr. No.	References
1.	Outlines of Biochemistry, Erice Conn and Paul Stumpf, 5th edi, 2009, Wiley and Sons, USA.
2.	Biochemistry, Donald Voet and Judith Voet, 4 th edi, 2012, John Wiley and Sons, Inc. USA Biochemistry, Jeremy Berg, Lubert Stryer, 7th edi. 2006, W.H. Freeman and company, NY.
3.	Principles of Biochemistry, Albert Lehninger, David Nelson and Michael Cox, 5th edi., 2008, W.H. Freeman and company, NY.
4.	Harper's illustrated biochemistry, Victor Rodwell, David Bender, Kathleen Botham, Peter Kennelly, P Weil, 30th edi., 2015, McGraw Hills Publications.

	BTH-2403 - Biomolecules and Bioinstrumentation **SEC - Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	List MSDS of chemicals, basic aseptic techniques, and concept of SOP's.	1
CO2	Explain importance of biomolecules derivatives in the cell.	2
CO3	Demonstrate the quantitation of biomolecules.	3
CO4	Analyze working, use and care and safety measures of equipment.	4
CO5	Validate basic techniques, quantitative assays and troubleshooting to identify and resolve common issues.	5
CO6	Integrate the basic techniques and assays with the usage of various instruments in the laboratory.	6

BTH-2403 - Biomolecules and Bioinstrumentation
(SEC – Theory)

Unit No	Title of Unit and Contents	No of hours
	Biomolecules	
1	**Carbohydrates:** ● Sugar derivatives relevant to the cell and their functions. ● Quantitative methods for sugar estimation. **Proteins:** ● Structures of different classes of proteins, protein derivatives and their importance. ● Structure function relationship of proteins. ● Quantitative methods for protein estimation. **Nucleic acids:** ● Types and functions of DNA and RNA. **Lipids:** ● Derivatives of lipids and their importance in biology.	10
	Bioinstrumentation	
2	● MSDS, neurotoxicity and disposal of hazardous chemicals and their importance in industry. ● Basic aseptic techniques.	1
3	● SOPs preparation of various instruments routinely used in the laboratory and Report writing.	1
4	● Handling of Micropipette, pH meter and their calibration.	2
5	**Microscopy:** ● Principle, Instrumentation, basic staining techniques and applications.	2

6	**Centrifuge:** ● Principle, Working, handling, types and applications.	2
7	**Spectroscopy:** ● Principle, Working, handling and applications of UV-Vis Spectrometer and Fluorimeter.	4
8	**Chromatography:** ● Principle, types and applications.	4
9	**Electrophoresis:** ● Principle, types and applications.	4

Learning Resources- References

Sr. No.	References
1.	Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, Nath (2010) Himalaya Publishing House
2.	Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th edition. Edited by Keith Wilson and John Walker.
3.	Instrumentation measurements and analysis (2016) Nakra and Choudhari 4th edition Tata McGraw Hill, India

BTH-2453 Community Engagement Programme
(Community Engagement Programme-Theory/Practical)
Credits 2
No. of Hours 30/60

	BTH-2004 -Biomolecular Interactions and Pathways **Major - Theory**	
	Number of Credits: 02 No. **of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Outline the structure of genes, regulatory elements, and operons.	1
CO2	Illustrate the processes and regulation of gene expression.	2
CO3	Interpret the mechanisms of translation and its regulation in prokaryotic and eukaryotic systems.	3
CO4	Distinguish between the pathways involved in protein trafficking, targeting and vesicular transport.	4
CO5	Assess the role of cell signaling & signal transduction in maintaining cellular activity and communication.	5
CO6	Design strategies to study cellular & molecular processes using experimental techniques.	6

BTH-2004 -Biomolecular Interactions and Pathways
Major - Theory

Unit No.	Title of Unit and Contents	No. of hours
1	**Structural features of coding and non-coding DNA**: ● Structure of gene ● Organisation of intergenic and intragenic regulatory sequences- introns, promoters, enhancers and silencers, insulators; ● Operons (*Lac,Trp,Ara*); ● Gene families, clusters, super-families	5
2	**Transcription and its Regulation:** ● Properties and types of RNA polymerases ● Mechanisms of transcription in prokaryotes and eukaryotes and its regulation; ● Post-transcriptional modifications: capping, tailing, splicing	7
3	**Genetic Code & Translation:** ● Concept of reading frame, codon ● Features of genetic code ● Mechanisms of Translation in prokaryotes & eukaryotes and its regulation	5
4	**Protein trafficking and targeting:** ● Biogenesis of membrane proteins in organelles ● Intracellular protein trafficking, vesicle transport.	5
5	**Cell signaling and communication:** ● Quorum sensing in prokaryotes ● Communication between cells and environment: Intercellular and intracellular signaling ways ● Signaling molecules, hormones, signaling receptors- cell surface and cytoplasmic ● Important signaling pathways, signal transduction and second messengers	8
	Discussion on relevant techniques to study cellular and molecular processes, disorders and dysfunction of pathways.	

Learning Resources- References

Sr. No.	References
1.	Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular biology of the cell* (6th ed.). Garland Science. ISBN: 978-0815344322.
2.	Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). *Molecular cell biology* (9th ed.). W.H. Freeman and Company. ISBN: 978-1319208520.
3.	Karp, G., Iwasa, J., & Marshall, W. (2019). *Karp's cell and molecular biology: Concepts and experiments* (9th ed.). Wiley. ISBN: 978-1119598244.
4.	Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular biology of the gene* (7th ed.). Benjamin Cummings. ISBN: 978-0321762436.
5.	Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's GENES XII* (12th ed.). Jones & Bartlett Learning.
6.	Cooper, G. M., & Adams, K. (2022). *The cell: A molecular approach* (9th ed.). Sinauer Associates, an imprint of Oxford University Press. ISBN: 978-0197583722
7.	Weaver, R. F. (2011). *Molecular biology* (5th ed.). McGraw Hill. ISBN: 978-0073525327.
8.	Pal, J. K., & Ghaskadbi, S. (2009). *Fundamentals of molecular biology*. Oxford University Press. ISBN: 978-0195697810.
9.	Tropp, B. E. (2012). *Molecular biology: Genes to proteins* (4th ed.). Jones & Bartlett Learning. ISBN: 978-1449647910.

	BTH-2014 - Introduction to Animal Development **Major - Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Cite the processes in early development and understand the different cellular organizations during development	1
CO2	Describe the concept of cellular potency and lineage	2
CO3	Explain the concept of pattern formation using various model systems	3
CO4	Summarize the processes that lead to development of multicellular organisms from a zygote.	4
CO5	Organize a play to explain cellular movements and rearrangements.	5
CO6	Cite and debate different theories of aging	6

BTH-2014 - Introduction to Animal Development
(Major – Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	**Gametogenesis:** ● Oogenesis; Continuous and Discontinuous with examples Spermatogenesis: Meiosis and Spermiogenesis Structure of mature gametes **Fertilization:** ● Sperm Hyperactivation, Egg Metabolic Activation, Early and Late Responses, Cytoplasmic Rearrangement	**8**
2	**Cleavage patterns and importance:** ● Correlation with amount of yolk. Blastula and fate maps;	**5**
3	**Gastrulation**: ● Comparative account of Gastrulation in Amphioxus, Frog and Chick Morphogenetic Movements**,** **Pattern formation:** ● Formation of body plan using Drosophila as a model system	**5**
4	**Induction:** ● Different experiments to prove inductive interactions, genes influencing development (activation and silencing) **Concept of Cell Lineage**: ● Cell potency, determination commitment and differentiation ● **Neurulation**, Optic Induction and overview of Organogenesis Induction; Different experiments to prove inductive interactions.	**10**
5	**Post embryonic Development:** ● Metamorphosis (Frog and Drosophila), Regeneration (Hydra and Salamander model systems), ● Aging and Death	**2**

Learning Resources- References

Sr. No.	References
1.	Gilbert, S. F., & Barresi, M. J. F. (2023). *Developmental biology* (13th ed.). Sinauer Associates.
2.	Wolpert, L., Tickle, C., & Martinez Arias, A. (2019). *Principles of development* (6th ed.). Oxford University Press.
3.	Balinsky, B. I. (1981). *An introduction to embryology* (5th ed.). Saunders College Publishing.
4.	Twyman, R. M. (2001). *Developmental biology*. BIOS Scientific Publishers.

	BTH-2024 - Biotechnology Practical-5 **(Molecular, Cell Biology and Animal Development)** **Major - Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Outline key concepts and protocols for DNA isolation	1
CO2	Estimate the yield and quality of isolated DNA using gel electrophoresis & UV-spectrophotometry	2
CO3	Apply centrifugation techniques for mitochondrial isolation and perform enzyme assay	3
CO4	Categorize different developmental stages in model organisms.	4
CO5	Grade stages of early embryonic development using chick embryo	5
CO6	Design protocols to study programmed cell death using appropriate models.	6

BTH-2024 - Biotechnology Practical-5
(Molecular, Cell Biology and Animal Development)
Major - Practical

Unit No.	Title of Unit and Contents	No. of Practicals
1	Isolation of genomic DNA from Plant source; Agarose Gel Electrophoresis, quantification and quality analysis using UV-Spectrophotometry	3P
2	Isolation of genomic DNA from Animal source; Agarose Gel Electrophoresis, quantification and quality analysis using UV-Spectrophotometry	2P
3	Isolation of mitochondria from goat liver by differential centrifugation, mitochondrial staining and quantitative mitochondrial succinate dehydrogenase assay	2P
4	Observation of developmental stages of different model organisms	1P
5	Chick embryo mounting, staging and staining (24h, 48h, 72h, 96h)	4P
6	Chick embryo culture by filter paper ring technique/ shell less culture	1P
7	Programmed cell death during limb development in Chick	2P

	BTH-2114 -Tissue Culture Techniques **Minor - Theory**	
	Number of Credits:02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define and describe different aspects for successful cell culture	1
CO2	Compare in vivo and in vitro growth of plants and animals.	2
CO3	Describe Infrastructural requirements and basic facilities necessary in a tissue culture laboratory	3
CO4	Compare nutritional requirements of plant cells /animal cells in *in vitro* and *in vivo* conditions	4
CO5	Analyze types of mushrooms and the nutritive value of Mushrooms	5
CO6	Develop suitable methods of mushroom cultivation.	6

BTH-2114 -Tissue Culture Techniques
Minor - Theory

Unit No	Title of Unit and Contents	No of Hours
1	**Animal Tissue culture:** ● Introduction; ● Comparison with bacterial culture; **Equipment and infrastructure:** ● Laboratory design, ● Instruments and equipment used in ATC ● Laminar Air Flow, Incubators, Inverted Microscope, specialised tissue culture equipment **Nutrition & Physiology:** ● Media formulation.	5
2	**Need for plant tissue culture:** ● Concepts of Cell theory & Cellular totipotency **PTC Laboratory:** ● Organization of facility and equipment. ● Aseptic manipulation - washing, capping, packing **Culture media**- Nutritional requirements of the explants. **Micropropagation** - Advantages over conventional methods. ● Stages of Micropropagation (stage 0 to stage 4)	10
3	**Mushroom Cultivation** Introduction and Significance of Mushrooms Types , food value and other uses of mushrooms Method of Cultivation: ● Preparation of spawn ● Selection and preparation of substrate Inoculation, Incubation, Harvesting of fruiting bodies.	15

Learning Resources- References

Sr. No.	References
1.	R. Ian Freshney. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.* 6th ed. Wiley & Sons, Inc., USA, 2010.
2.	Sudha Gangal, *Principles and Practice of Animal Tissue Culture,* 2nd ed. University Press, India,2010.
3.	M. K. Razdan. *Introduction to Plant Tissue Culture*. 2nd ed. New Delhi, India: Oxford & IBH Publishing Co., 2007
4.	S. R. Mishra. *Techniques of Mushroom Cultivation* (2014) (English, Hardcover).
5.	*Hand Book of Mushroom Cultivation, Processing and Packaging* (2007) Publisher: Engineers India Research Institute

	BTH-2124 - Biotechnology Practical-6 (Tissue Culture Techniques) Minor - Practical	
	Number of Credits: 02 No. of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify the infrastructural requirements for ATC	1
CO2	Interpret the importance of aseptic conditions and transfer the understanding in practice	2
CO3	Describe the facilities required for PTC	3
CO4	Demonstrate media preparation, selection and sterilization of explants.	4
CO5	Demonstrate the *in vitro* germination of seeds.	5
CO6	Compose standardized protocol for mushroom cultivation	6

BTH-2124-Biotechnology Practical-6
(Tissue Culture Techniques)
(Minor – Practical)

Unit No	Title of Unit and Contents	No of Practicals
1	Introduction to animal tissue culture laboratory.	1P
2	Observation of different types of cells.	2P
3	Introduction to Plant tissue culture laboratory.	1P
4	Media composition for plant tissue culture.	2P
5	*In vitro* germination of seeds.	2P
6	Standardize the method for mushroom cultivation.	7P

	BTH-2304 - Immunology **VSC - Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define the basis of the immune system.	1
CO2	Articulate components of the immune system, types of immunity and the complement system.	2
CO3	Outline the autoimmune diseases in immunology.	3
CO4	Analyze the Complement system.	4
CO5	Compare and Contrast various antigen antibody reactions.	5
CO6	Design and develop various types of vaccines.	6

BTH-2304 – Immunology
(VSC – Theory)

Unit No	Title of Unit and Contents	No of lectures
1	**Innate immunity:** ● Understanding the physical and chemical barriers. ● Cells of the immune system. ● Primary and secondary lymphoid organs, tertiary lymphoid tissues. ● Process of inflammation.	3
2	**Adaptive immunity:** ● Structure and function of MHC molecules. ● Antigen presentation and processing. ● Cells of the adaptive immune system, TCR structure and BCR structure, Functions of immunoglobulins. ● T and B cell signaling.	5
3	**Complement system:** ● Pathways of complement activation.	6
4	● Antigen-Antibody Reactions Precipitation reaction (Immunodiffusion/Immunoelectrophoresis). ● Agglutination reaction (Haemagglutination or Blood typing). ● Dot-ELISA, Radial Immunodiffusion techniques.	4
5	**Autoimmunity:** ● Immune checkpoints ● Immunodeficiency and AIDS. ● Immune Tolerance and Autoimmunity. ● Immunity to Infections. ● Immunotherapy ● Tissue and Organ Transplantation. ● Immunological Hypersensitivity. ● Mucosal Immunity	7
6	**Vaccines:** ● Active and Passive Immunization. ● Types of Vaccines ● Immunization/ vaccination schedule	5

Learning Resources- References

Sr. No.	References
1.	Kuby Immunology, Judy Owen, Jenni Punt, Sharon Stranford., 7th edition 2012, Freeman and Co., NY
2.	Cellular and Molecular Immunology, Abul Abbas, Andrew H. Lichtman, Shiv Pillai 9th Edition 2017 Elsevier.
3.	Janeway's Immunobiology, Kenneth M. Murphy, Casey Weaver 8th Edition 2011 W. W. Norton & Company
4.	Immunology, David Male, Jonathan Brostoff, David Roth Mosby, 7th edition 2006, USA.
5.	Roitt and Roitt's Essential Immunology 2011, 12th edition, Wiley and Black Well.
6.	Textbook of Basic and Clinical Immunology, Sudha Gangal and Shubhangi Sontakke, 1st edition 2013, University Press, India.
7.	https://ser-infotech.com/category/index/531
8.	https://onlinelibrary.wiley.com/journal/13652567

	BTH-2404 - Introduction to Genetic Engineering **SEC - Theory**	
	Number of Credits: 02 No. **of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe basic elements of cloning.	1
CO2	Discuss various vectors and hosts suitable for different applications.	2
CO3	Examine methods employed for gene transfer.	3
CO4	Analyse various components of genetic engineering to create recombinant organisms.	4
CO5	Review the advantages and limitations of transgene technology.	5
CO6	Integrate genetic engineering tools to produce transgenics.	6

BTH-2404 - Introduction to Genetic Engineering

SEC - Theory

Unit No.	Title of Unit and Contents	No. of hours
1	**Genetic Engineering - Introduction:** ● What is genetic engineering? Laying the foundations	2
2	**Plasmids:** ● Types, properties and significance and their applications in RDT **Transposable elements:** ● Characteristics, ● Transposable elements in prokaryotes (insertion sequences, Transposons) and eukaryotes (yeast Ty elements, Ac/Ds elements in maize. ● Copia and P elements in Drosophila, Alu sequences in humans). ● Mechanisms of transposition, excision of transposons.	6
3	**Tools of Recombinant DNA Technology**: ● Restriction enzymes; Types, properties and application of REs. **Other DNA modifying enzymes:** ● ligases, polymerases, alkaline phosphatase, reverse transcriptase, polynucleotide kinase, terminal transferase. PCR and RT-PCR	6
4	**Host cells and vectors:** ● Host cell types: Prokaryotic and Eukaryotic ● Vectors: Significance of vectors in RDT and their designing. ● Types, properties and applications of vectors: cloning vectors, expression vectors: Strategies depending on integration into the genome, insert size and desired applications.	10

5	**DNA transfer mechanisms:** ● Horizontal Gene Transfer: Conjugation, Transformation, Transduction ● Physical, Chemical and Biological mechanisms to transfer DNA into organisms.	4
6	**Concept of GMOs, ethical concerns and their applications**	2

Learning Resources- References

Sr. No.	References
1.	Sambrook, J., et al. Molecular Cloning: A Laboratory Manual: Vol. 2. 3. ed, Cold Spring Harbor, 2000.
2.	Watson, James D. Molecular Biology of the Gene. 2017.
3.	Https://International.Neb.Com/Tools-and-Resources/Troubleshooting-Guides/Restriction-Enzyme Troubleshooting-Guide.
4.	Https://Nptel.Ac.in/Courses/102/103/102103013/.
5.	Http://Www.Addgene.Org/Mol-Bio-Reference.

BTH-2454 Field Project
Theory/ Project
Number of credits: 2
Number of Hours: 30/60