



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-2020

for

S.Y. B. Sc. (Biotechnology)

With effect from Academic Year

2024-2025

Semester	Paper	Paper Code	Paper Title	Credits
III	Major	BTH-200	Biotechnology Practical 3	2
		BTH-201	Cell Biology and Plant Development	4
	Minor	BTH -211	Instrumentation Techniques in Biology	2
		BTH-212	Biotechnology Practical 3	2
	OE	BTH-220	Bio-Entrepreneurship Agriculture and Environment	2
	VSC	BTH-230	Metabolic Pathways	2
	SEC	BTH-240	Basic Bioinstrumentation	2
	CEP	BTH-245	Community Engagement Program	2
IV	Major	BTH-250	Biotechnology Practical 4	2
		BTH-251	Molecular Biology and Animal Development	4
	Minor	BTH-261	Tissue Culture Techniques	2
		BTH-262	Biotechnology Practical 4	2
	OE	BTH-270	Food Biotechnology	2
	VSC	BTH-280	Genetics and Immunology	2
	SEC	BTH-290	Basics of Biostatistics and Computers	2
	FP	BTH-295	Field Project	2

S. Y.B.Sc. Semester III		
BTH-200	Biotechnology Practical 3 (Major-Practical)	Credits: 2
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Level
CO1	Demonstrate the specimen for presence of Barr body	1
CO2	Illustrate the steps of isolation of organelles by differential centrifugation technique and confirm the presence by performing enzyme assay.	2
CO3	Specify the phenomenon of programmed cell death during limb development in chick embryo.	3
CO4	Demonstrate the preparation of slides for observation of apical and florally induced meristem	4
CO5	Describe the development of male and female gametophytes.	5
CO6	Explain the developmental stages during plant embryogenesis	6

Sr. No	Topic	Practicals (15PX2H)
I	Buccal smear – Identification of Barr Body	1
II	Isolation of chloroplasts and estimation of chlorophyll.	2
III	Isolation of mitochondria from goat liver by differential centrifugation and qualitative mitochondrial succinate dehydrogenase assay	2

IV	Programmed cell death during limb development In Chick	2
V	Study of apical meristems and floral induced meristems	2
VI	Study of microsporogenesis and development of male gametophyte	2
VII	Dissection of seeds and excision of young and mature embryos.	2
VIII	Developmental stages during plant embryogenesis.	2

S. Y. B.Sc. Semester III		
BTH- 201	Cell Biology and Plant Development (Major-Theory)	Credits: 4 Hours: 60
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Level
CO1	Describe and discuss the roles of different types of cell membrane and intracellular proteins	1
CO2	Interpret the effects of various survival factors and proteins on cell signaling outcomes.	2
CO3	Interpret the dysregulation of cell cycle and cell death pathways.	3
CO4	Analyze unique features of plants w.r.t. growth and development.	4
CO5	Discriminate vegetative and reproductive development at gene level.	5
CO6	Integrate the cellular processes in developmental stages of a plant.	6

Sr. No	Topic	Number of lectures
	Cell Biology	30
I	Types and modes of membrane transport: Passive transport, active and secondary active transport, membrane potential. Channels and carriers. Exocytosis, endocytosis, pinocytosis and phagocytosis	5
II	Cell signaling and communication: communication between cells and environment. Signaling at cell surface, signaling molecules, hormones and receptors signaling pathways, signal transduction and secondary messengers.	7
III	Protein trafficking and targeting: Intracellular protein trafficking to nucleus, mitochondria, chloroplasts and lysosomes, vesicle transport; formation and fusion of vesicles and important proteins involved. Diseases and disorders related to trafficking and targeting.	7
IV	Cell death: Programmed cell death and necrosis, molecular mechanism and apoptotic pathways. Autophagy. Regulation and control of apoptosis.	6
V	Dysregulations of cell cycle during cancer: Properties of tumor cells. Oncogenes and tumour suppressors. Examples of important pathways involved in cell cycle control and cancer.	5
	Plant development	30
I	Unique features of plant development Concept of totipotency, Differentiation, Dedifferentiation,	3

	Redifferentiation, Competence with example.	
II	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
III	Vegetative development: Zygote to seed embryo to seedling till vegetative maturity, Embryogenic mutants Pattern formation in plants- vegetative; axial and radial patterning, Genes in radial, axial development Reproductive development: Shift from vegetative to reproductive phase Induction- perception of inductive stimuli and subsequent changes, Pattern formation in plants- flowering; inflorescence meristem, floral whorls specification, whorl boundary specification, ABC model for Flower development	11
IV	Microsporogenesis, development of male gametophyte and male gamete. Megaspores, development of female gametophyte and female gamete. Double fertilization and triple fusion. Development of endosperm.	4
V	Fucus as model system to understand plant development	2
VI	Role of Senescence and Programmed Cell Death in plant development Light mediated regulation, photoreceptors and circadian rhythm	5

References:

1. Principles of Development, Wolpert L and Tickle C, 4th edition (2010), Oxford University Press.
2. Embryology of Angiosperms, Bhojwani S.S. and Bhatnagar S.P. (2009) –Vikas Publishing House, New Delhi
3. Plant physiology , Taiz L , and Zeiger E (2010) Sinauer Associates, USA.
4. Plant embryology: Classical and experimental , Sharma HP (2009) (alpha sci)
6. Patterns in plant development. Steeves TA & Sussex IM (2004). Cambridge University Press, Cambridge.
7. Keith Roberts, Peter Walter, 7th Edition (2022) ,WW Norton and Co.USA
8. Molecular Cell Biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Anthony Bretscher, Monty Krieger, 9th Edition, (2021) W.H Freeman and Co., USA
9. Karp's Cell and Molecular Biology: Concepts and Experiments, Gerald Karp, Janet Iwasa, Wallace Marshall, 8th edition, (2015) John Wiley & Sons., USA
10. Becker's World of the Cell, Jeff Hardin, Gregory Bertoni, Lewis J. Kleinsmith, 9th Edition (2017), Pearson Education Limited, USA

S.Y.B.Sc. Semester III		
BTH- 211	Instrumentation Techniques in Biology (Minor-Theory)	Credits: 2 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	Content	No of Hrs. 30
I	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
II	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
III	Centrifugation: Principles and working and types of centrifuges, rotor types and applications.	5
IV	Spectroscopy: Beer Lambert's Law, principle and working of Colorimeter, Spectrophotometer, and their applications	5
V	Electrophoresis: Introduction to: Agarose gel electrophoresis, Polyacrylamide gel electrophoresis, Applications	5

VI	Chromatography: Introduction to Paper chromatography, Thin Layer Chromatography; Column chromatography and their applications	5
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References:

1. Instrumentation measurements and analysis – 4th edition (2016), Nakra and Choudhari, Tata McGraw Hill, India.
2. Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, Nath, 2010, Himalaya Publishing House
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. Seventh edition. Edited by Andreas Hofmann and Samuel Clokie, 8th edition, 2018, Cambridge University Press

S.Y.B.Sc. Semester III		
BTH-212	Biotechnology Practical 3 (Instrumentation Techniques used in Biological Sciences) (Minor-Practical)	Credits: 2 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	Design experiments to validate the use of instruments	6

Sr. no.	List of Practicals	No of Practicals (15 P)
I	Standardization and calibration of micropipette and pH meter	2
II	Protein estimation techniques- Biuret, Lowry and Bradford method	3
III	Quantification of proteins and nucleic acid by UV-Vis Spectroscopy	3
IV	Demonstration of different types of microscopes and their applications	2
V	Agarose gel electrophoresis	2
VI	Paper Chromatography/ TLC for detection of biomolecules	3

Class: S.Y.B.Sc. Semester: III

BTH-220	Bio-Entrepreneurship in Agriculture and Environment OE	Credits:2C Hours: 30
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Level
CO1	Outline the concept of Bioentrepreneurship development	1
CO2	Discuss scope of entrepreneurship in agriculture.	2
CO3	Define the scope of entrepreneurship in environmental sustainability.	3
CO4	Explain the scope of entrepreneurship in bioremediation and fermented foods.	4
CO5	Understand methods of evaluation of project proposal.	5
CO6	Prepare the business plan for mushroom cultivation	6

Unit. No	Title of Unit and Contents	No. of hours 30
I	Entrepreneurship Opportunity in Agri Biotechnology: Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant tissue culture technique, polyhouse culture. Nutraceuticals, value added herbal products.	8
II	Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management.	7
III	Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Bio pesticide/insecticide production. Fermented products-probiotic and prebiotics.	8
IV	Cultivation of Mushroom, Analysis of demand and market for mushroom. Why mushroom farming business? development of mushroom business plan, Investment or cost of mushroom cultivation, profits in mushroom cultivation	7

References:

1. National Biotechnology Development Strategy – Promoting bioscience research, education and entrepreneurship Department of Biotechnology, Ministry of Science & Technology, Government of India, 2015.
2. Good Incubation in India – Strategies for supporting social enterprise in challenging contexts Madeleine Gabriel, Florence Engasser and Kirsten Bound, January 2016
3. Entrepreneurship A study by National Knowledge Commission, 2008
4. Strategic management aspects of Indian pharmaceutical industry, Ritu Mahajan & Keshav Sharma, Asian Journal of Management Research Volume 2 Issue 1, 2011.
5. A textbook on mushroom cultivation: Theory and Practice, Aggarwal, A., Sharma, Y.
6. P. and Jangra, E., Newrays Publishing House.
7. Mushroom Cultivation, Tripathi, D.P. (2005) , Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi.
8. Mushroom cultivation technology, Acharya, K., Roy, A. and Sarkar, J., Technoworld, Kolkata.
9. Mushroom production and processing technology (2010), Pathak Yadav Gour, Agrobios (India).
10. Department of Biotechnology; Ministry of Science and Technology
11. <http://www.dbtindia.nic.in/#>
12. Biotechnology Industry Research Assistance Council
13. <http://www.birac.nic.in/>

S.Y. B.Sc. Semester III		
BTH-230	Metabolic Pathways (VSC)	No of Credits: 02
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's Cognitive Level
CO1	Describe anabolism and catabolism. Explain principal characteristics of metabolic pathways.	1
CO2	Explain different pathways of carbohydrate, protein and lipid metabolism.	2
CO3	Illustrate the linking of different pathways.	3
CO4	Analyze the effect of malfunctioning of metabolic pathways that result in various metabolic disorders.	4
CO5	Review regulation of carbohydrate, lipid and protein metabolism	5
CO6	Integrate carbohydrate and non-carbohydrate metabolism	6

Unit No.	Title of Unit and Contents	No. of Lectures
I	Introduction to metabolism: Metabolic pathways: Metabolites, Catabolism, Anabolism, Principal characteristics of metabolic pathways.	2
II	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 and Electron Transport Chain: Sequence of electron carriers, Oxidative Phosphorylation, ATP synthesis	13
III	Non-carbohydrate metabolism Lipid metabolism: Triglycerides, Transport of fatty acid into mitochondria, β -oxidation of fatty acids, reactions and energetic of beta oxidation, Biosynthesis of fatty acid, Overview of biosynthesis of Phospho-lipids and Cholesterol, Metabolism of ketone bodies Protein metabolism: General reactions of amino acid metabolism (Oxidative deamination, Transamination, Decarboxylation), Glucogenic and ketogenic amino acids, Urea cycle, amino acid metabolism disorders	15

References:

1. Outlines of Biochemistry, Erice Conn and Paul Stumpf, 5th edi, 2009, Wiley and Sons, USA.
2. Biochemistry, Donald Voet and Judith Voet, 4th edi, 2012, John Wiley and Sons, Inc. USA Biochemistry, Jeremy Berg, LubertStryer, 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.

S. Y. B. Sc. Semester III		
BTH-240	Basic Bioinstrumentation (SEC)	Credits: 2 Hours: 30
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Levels
CO1	List basic Good Laboratory Practices (GLPs), MSDS of chemicals and concept of SOP's	1
CO2	Demonstrate basic aseptic techniques	2
CO3	Demonstrate the handling of common equipments	3
CO4	Analyze working, use and care and safety measures of equipment.	4
CO5	Acquire knowledge of basic techniques, quantitative assays and troubleshooting to identify and resolve common issues.	5
CO6	Write scientific report	6
Unit	Topic	No of hours (30)
I	Good Laboratory Practices (GLP)s, safety, MSDS, neurotoxicity and disposal of hazardous chemicals and their importance in industry.	2
II	Basic Aseptic Techniques	3
III	Introduction to various instruments routinely used in the laboratory and their SOPs preparation.	3
IV	Handling of Micropipette, pH meter and their calibration.	2
V	Working, handling and cleaning of Centrifuge, Compound microscopes.	4
VI	Introduction to Beer-Lambert's Law. Concept and applications of Colorimetry Vs Spectrophotometer. Demonstration of quantitative analyses.	3
VII	Demonstration of Dot/Strip ELISA.	2
VIII	Principle, working and applications of Chromatography.	3
IX	Amino acid separation by paper chromatography and Thin Layer Chromatography.	4
X	Report writing and visit to industry/instrumentation facility.	4

References:

1. Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, Nath
2. Principles and Techniques of Biochemistry and Molecular Biology. Seventh edition. Edited by Keith Wilson and John Walker.
3. Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata McGraw Hill, India

S.Y.B.Sc. Semester IV		
BTH-250	Biotechnology Practical 4 (Major-Practical)	Credits: 2 Hours: 60
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Level
CO1	Describe the concepts involved in reagent preparation.	1
CO2	Compare different lysis methods for genomic DNA isolation from prokaryotic and eukaryotic sources	2
CO3	Demonstrate protein separation by SDS-PAGE	3
CO4	Analyse the quality and the concentration of biomolecules by UV-Vis Spectrophotometry	4
CO5	Observe different types of egg and correlate the amount of yolk and cleavage pattern and understand the concepts of regeneration and metamorphosis	5
CO6	Integrate the isolation, mounting and staging of chick embryo of various stages and analyse the indicators of embryonic development	6

Sr. no.	List of Practicals	No of Practicals 15P
	MOLECULAR BIOLOGY	
I	Isolation of DNA from a prokaryotic source and agarose gel electrophoresis; Quantification and quality analysis by UV-Vis Spectrophotometry	2
II	Isolation of DNA from a eukaryotic source and agarose gel electrophoresis; Quantification and quality analysis by UV-Vis Spectrophotometry	2
III	Quantitation, separation and analysis/visualization of proteins by SDS-PAGE.	3
	ANIMAL DEVELOPMENT	
I	Study of different types of eggs	1
II	Study of frog developmental stages and regeneration in hydra.	1
III	Chick embryo culture by filter paper ring technique/ shell less culture	2
IV	Chick embryo mounting, staging and staining (24h, 48h, 72h, 96h)	4

S.Y.B.Sc. Semester IV		
BTH-251	Molecular Biology and Animal Development (Major-Theory)	Credits: 4 Hours: 60
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Level
CO1	Describe the organisation of genomes and understand DNA compaction.	1
CO2	Compare and contrast the process of DNA replication and its regulation in prokaryotes and eukaryotes.	2
CO3	Build an understanding of pathways involved in DNA damage, repair and recombination.	3
CO4	Summarize the processes in early development and understand the different cellular organizations during development that lead to development of multicellular organism from a zygote	4
CO5	Organize a play to explain cellular movements and rearrangements. Explain the concept of pattern formation using various model systems	5
CO6	Cite and debate different theories of aging	6

Unit	Content	No of Hours
	MOLECULAR BIOLOGY	60 (30)
I	Genome Structure and Organization Organization of viral, prokaryotic and eukaryotic genomes Structure of chromatin, nucleosome, DNA compaction of prokaryotes and eukaryotes Higher order organization- chromosome, centromere, telomere Repetitive DNA elements	7
II	DNA Replication and Regulation DNA polymerases in prokaryotes and eukaryotes Mechanism of DNA replication and regulation in prokaryotes and eukaryotes	10
III	DNA damage and Repair Types of mutations Types of DNA damage: radiation, chemical, oxidative, intercalating agents DNA repair mechanisms- nucleotide excision repair, base excision repair, mismatch repair	7

IV	Recombination Homologous and site-specific recombination. Proteins involved in recombination- RecA, RuvA, B, C	6
	ANIMAL DEVELOPMENT	(30)
I	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
II	Cleavage patterns and importance: Correlation with amount of yolk. Blastula and fate maps;	5
III	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
IV	Induction: Different experiments to prove inductive interactions, genes influencing development Concept of Cell Lineage, Cell potency, determination commitment and differentiation Neurulation, Optic Induction and overview of Organogenesis Induction; Different experiments to prove inductive interactions, Neurulation, Optic Induction and overview of Organogenesis	10
V	Post embryonic Development: Metamorphosis (Frog and Drosophila), Regeneration (Hydra and Salamander model systems), Aging and Death	2

References:

1. Genes XI, 12th edition (2018), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
2. Molecular Biology of the Gene, 7th Edition (2017), 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., McGraw Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India
5. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp, Jones & Bartlett Learning, USA
6. Developmental Biology (VIII edition) S. F. Gilbert.
7. Principles of Development (III edition) Lewis Wolpert
8. An Introduction to Embryology (V edition). B. I. Balinsky.
9. Developmental Biology: R. M. Twyman. Bios Scientific Publishers LTD. New Delhi (2001)

Class: S.Y. Semester-IV		
BTH-261	TITLE: Tissue Culture Techniques (Minor-Theory)	Credits: 2
	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 <i>in vitro</i> and <i>in vivo</i> conditions.	4
CO5	Analyze types of mushrooms and the nutritive value of Mushrooms	5
CO6	Develop suitable methods of mushroom cultivation.	6

Unit No.	Topic	No. of Lecture
I	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
II	Need for plant tissue culture: Concepts of Cell theory & Cellular totipotency PTC Laboratory: Organization of facility and equipment. Aseptic manipulation - washing, capping, packing and sterilization. Culture media- Nutritional requirements of the explants. Micropropagation - Advantages over conventional methods. Stages of Micropropagation (stage 0 to stage 4);	10
III	Mushroom Cultivation Introduction and Significance of Mushrooms Types of mushrooms Pleurotus. Food value and uses of mushrooms. Method of Cultivation:	15

	Preparation of spawn Selection and preparation of substrate Inoculation, Incubation, Harvesting of fruiting bodies.	
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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. S. Bhojwani, and M. K. Razdan. *Plant Tissue Culture: Theory & Practice*. New Delhi, India Elsevier.
5. S. R. Mishra. *Techniques of Mushroom Cultivation* (English, Hardcover).
6. *Hand Book of Mushroom Cultivation, Processing and Packaging* Publisher: Engineers India Research Institute

S. Y.B.Sc. Semester IV		
BTH- 262	Biotechnology Practical 4 (Minor-Practical: Tissue Culture Techniques)	Credits: 2
	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 <i>in vitro</i> germination of seeds	5
CO6	Compose standardized protocol for mushroom cultivation	6

Sr. No	Topic	Practicals (15PX2H)
I	Introduction to animal tissue culture laboratory.	1
II	Observation of different types of cells.	2
III	Introduction to Plant tissue culture laboratory.	1
IV	Media composition for plant tissue culture.	2
V	<i>In vitro</i> germination of seeds.	2
VI	Standardize the method for mushroom cultivation.	7

S.Y.B.Sc. Semester IV		
BTH-270	Food Science and Biotechnology (OE)	Credits: 2 Hours: 30
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Level
CO1	Introduce basic concepts of Food Science	1
CO2	Outline different areas of food biotechnology	2
CO3	Identify key applications of biotechnology in food industry	3
CO4	Compare different chemical reactions affecting the quality and texture of food	4
CO5	Justify the importance of determination of food adulteration and various tests	5
CO6	Design a Survey to study various aspects of food biotechnology	6

Unit	Content	No of Hrs. 30
I	Introduction to Food Science and Biotechnology General concepts, different food products and applications of Biotechnology in food	10
II	Food Science: Different methods, processes and components that affect food texture flavor, shelf life etc.	10
III	Food Adulteration and Quality Control	10

S.Y. B.Sc. Semester-IV		
BTH- 280	Genetics and Immunology (VSC)	No of Credits:02
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive Level
CO1	Describe the fundamentals of Genetics	1
CO2	Compare Mendelian genetics and modern genetics	2
CO3	Determine the need for understanding chromosomal aberrations and chromosomal disorders	3
CO4	Analyze the basis of immune system	4
CO5	Articulate components of the immune system, types of immunity and the complement system.	5
CO6	Compare and Contrast various antigen antibody reaction and types of vaccines	6

Unit No.	Title of Unit and Contents	No of Lectures (30)
	GENETICS	15
I	Genetic basis of Inheritance- Variations, Heredity, Pre - Mendelian concept, Importance of Genetics	1
II	Mendelian Genetics: Laws of Inheritance, Monohybrid and Dihybrid Ratio, Back cross and Test cross.	1
III	Post-Mendelian Discoveries- Incomplete Dominance, Codominance, Dominant and Recessive Epistasis, Complementary genes, Supplementary genes, Pleiotropy, Multiple alleles, Lethal genes. Extra Chromosomal Inheritance Maternal effect- Snail shell coiling, Drosophila Cytoplasmic male sterility in plants	5
IV	Chromosomal aberrations- Variations in chromosome structure. Duplications, inversions, Translocations Giant polytene Chromosomes Variations in Chromosome number	4

	Euploidy Aneuploidy Trisomy in Humans.	
V	Linkage and Linkage maps- Concept, Complete and Incomplete linkage, Three point cross, Genetic mapping, Recombination, recombination maps in diploids for 2 point and 3 point test cross, determination of gene order with suitable examples. Sex linked Inheritance (X linked and Y linked), sex- influenced and Sex-limited genes, Significance of Linkage.	4
	Immunology	15
I	Overview of the immune system: Introduction to Immune system and types of immunity	1
II	Cells and organs of Immune system: Types of blood cells Primary, Secondary, and Tertiary immune organs Understanding the physical and chemical barriers, Process of inflammation.	5
III	Antigen and Antibody: Concept of antigen and epitope Antibody structure , types and function of Immunoglobulins	3
IV	Complement system: Three pathways of complement activation and generation of MAC	2
V	Antigen- Antibody Reactions and Vaccines Precipitation reaction (Immunodiffusion/Immuno-electrophoresis), Agglutination reaction (Haemagglutination or Blood typing), Types of vaccines	4

References:

1. Concepts of Genetics (2019) Klug, Cummings, Spencer, Palladino and Killian 12th edition (Pearson Education, UK)
2. Principles of Genetics (2006) Gardner, Simmons, Snustad (Wiley, India) 8th edition
3. Genetics: A Conceptual Approach (2017) Pierce (W H Freeman & Co, New York) sixth edition
4. Genetics (2015) Strickberger 3rd edition (Pearson Education, UK) (Pearson Education, India)
5. Introduction to Genetics: a Molecular approach (2011) Brown 1st edition (Garland Science, New York)
6. Molecular genetics of bacteria (2014) Snyder, Peters, Henkin and Champness 4th edition (ASM Press, USA)

7. Introduction to Genetic Analysis (2015) Griffith, Wessler, Carroll and Doebley 11th edition (W H Freeman & Co, New York)
8. Kuby Immunology, Judy Owen, Jenni Punt, Sharon Stranford., 8th edition (2022), Freeman and Co., NY
9. Cellular and Molecular Immunology, Abul Abbas, Andrew H. Lichtman, Shiv Pillai 10th Edition 2021 Elsevier.
10. Janeway's Immunobiology, Kenneth M. Murphy, Casey Weaver 9th Edition 2016 W. W. Norton & Company
11. Immunology, 9th edition (2020), David Male, Jonathan Brostoff, David Roth Roitt and Mosby, USA.
12. Roitt's Essential Immunology (2017), 13th edition, Wiley and Black Well.
13. The Elements of Immunology, F.H. Khan (2009), Pearson Education.
14. Textbook of Basic and Clinical Immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India.

S.Y. B.Sc. Semester IV		
BTH-290	Basics of Biostatistics and Computers (SEC)	Number of Credits : 02
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's Cognitive Level
CO1	Understand fundamental concepts in biostatistics.	1
CO2	Apply appropriate statistical methods to analyze biological data	2
CO3	Interpret statistical results in biological data.	3
CO4	Analyse the biological data by computational methods.	4
CO5	Evaluate different hypothesis testing method for scientific data.	5
CO6	Develop statistical methods and computational techniques to analyze.	6

Unit	Contents	No. of Lectures
	Biostatistics	15
I	Introductory Statistics: The need of statistics in biology; Variables and constants Types of variables – discrete, continuous Types of data – raw, grouped Graphical representation of data – bar graphs, scatter plots, frequency diagrams, pie chart, histogram, polygon, curve	3
II	Descriptive Statistics: Definition and simple problems related to Measures of Central Tendency – Mean, median and mode, Quartiles Measures of dispersion – Standard deviation, variance, coefficient of variance, correlation and regression	4
III	Hypothesis Testing: Hypothesis formulation- Null and alternative hypothesis. Parametric and non-parametric tests: Z-test, t-test, Chi-square test, ANOVA. Std error, Type I and Type II errors, Confidence, Significance.	5
IV	Probability: Classical definitions and its limitations, Independence and conditional probability, Probability sampling Population, sample,	3

	sampling methods – Simple random, stratified	
	Computers	15
I	History of Computers: Evolution, generations of computers – I to V	1
II	Microsoft Excel: The Excel environment, Entering and editing data, Modifying a worksheet, Using functions, Formatting, Printing, Charts : Chart basics, Pie Chart, Bar Chart, Line Diagram, Trend lines, Range names and Filter date : Define and apply cell and range names : Use names in Formulas, Filter data based on complex criteria, Use conditional filters, Copy filtered results to another range, Pivot Tables: Prepare data in a table format and name the table, Create a PivotTable for analysing.	3
III	Microsoft Word: Creating the documents and Tabulating the data using word and its formatting, Find & Replace, Spell Checker & Grammar Checker. Citation and Referencing using Microsoft word and Mendeley Microsoft word plugin. Use of Microsoft word while writing research paper, collaboration and sharing in word, Tracking the changes in the documents, Creation of Hyperlinks, Bookmarks and Cross Referencing.	2
IV	Microsoft Powerpoint: Creation of Presentations with graphics, Creation of slides, Preparation of scientific presentations. Insert and Format Text, Shapes and Text Boxes, Images, Order and Group Objects. Insert and Format Tables,Charts,SmartArt graphics, Insert and Manage Media. Apply Slide Transitions,Animate Slide Content,Set Timing for Transitions and Animations. Infogram: A very easy-to-use tool for creating template, visually appealing data visualisations and infographics. BioRender Scientific Image and Illustration Software: BioRender figures to PowerPoint presentations & keep them updated in a click.	2
V	Databases: Basic concepts in: Data abstraction, Data models , Instances and schemes, E-R model (Entity and entity sets, relations and relationship sets, E-R diagrams, reducing E-R diagrams to tables),Network data model, Basic concepts, multimedia databases, Text databases. Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files, Access Modes; Updating Records, Querying, Reports, Forms & subforms,	7

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2. Chap T. Le. Introductory Biostatistics. 1st ed. New Jersey, USA: John Wiley& Sons, Inc., USA, 2003.
3. Antony N Glaser. High-Yield™ Biostatistics. Maryland, USA: Lippincott Williams and Wilkins, USA, 2005.
4. Edward Batschelet. Introduction to Mathematics for Life Scientists. 3rd ed. Berlin, Germany: Springer-Verlag Berlin Heidelberg, Germany, 1979.
5. R.G. Bartle and D.R. Sherbert 2nd edition, (1992), Introduction to real analysis, John Wiley,USA
6. Introductory biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
7. High Yield T M Biostatistics. (2001) Antony N Glaser. Lippincott Williams and Wilkins, USA
8. Sinha P & Sinha P. 2011. Computer Fundamentals. BPB Publications, Connaught Place, Delhi,478 pp.