



**Maharashtra Education Society's
Abasaheb Garware College
(AUTONOMOUS)**

**Three Year Degree Program in Biotechnology
(Faculty of Science & Technology)**

Syllabi under Autonomy

For

S.Y.B.Sc. Biotechnology

Choice Based Credit System Syllabus

To be implemented from Academic Year 2023-2024

B. Sc. Biotechnology (CBCS Semester Pattern)

Structure of the course**S.Y.B. Sc. Biotechnology****Semester: III****THEORY**

Course Code	Course Title	Credits	Number of lectures	Marks
USBT-231	Cell Biology I	2	30	50 (35 External +15 Internal)
USBT-232	Molecular Biology I	2	30	50 (35 External +15 Internal)
USBT-233	Genetics	2	30	50 (35 External +15 Internal)
USBT-234	Metabolism	2	30	50 (35 External +15 Internal)
USBT-235	Environmental Biotechnology	2	30	50 (35 External +15 Internal)
USBT-236	Bioanalytical techniques	2	30	50 (35 External +15 Internal)
USEVS-231	AECC-I Environment Science Theory Paper 1	2	30	50 (35 External +15 Internal)
USLGA-231	AECC-II Language Theory Paper 1	2	30	50 (35 External +15 Internal)

PRATICAL

Course Code	Course Title	Credits	Number of lectures	Marks
USBTP-237	Practical in Cell Biology and Genetics	2	15 P	50 (35 External +15 Internal)
USBTP-238	Practical in Bio-analytical Techniques and Metabolism	2	15 P	50 (35 External +15 Internal)
USBTP-239	Practical in Molecular Biology and Environmental Biotechnology	2	15 P	50 (35 External +15 Internal)
	Total Credits (Theory + Practical)		22	

S.Y.B. Sc. Biotechnology**Semester: IV****THEORY**

Course Code	Course Title	Credits	Number of lectures	Marks
USBT-241	Cell Biology II	2	30	50 (35 External +15 Internal)
USBT-242	Molecular Biology II	2	30	50 (35 External +15 Internal)
USBT-243	Immunology	2	30	50 (35 External +15 Internal)
USBT-244	Animal Development	2	30	50 (35 External +15 Internal)
USBT-245	Plant Development	2	30	50 (35 External +15 Internal)
USBT-246	Microbial Biotechnology	2	30	50 (35 External +15 Internal)
USEVS-241	AECC-I Environment Science Theory Paper 2	2	30	50 (35 External +15 Internal)
USLGA-241	AECC-II Language Theory Paper 2	2	30	50 (35 External +15 Internal)

PRATICAL

Course Code	Course Title	Credits	Number of lectures	Marks
USBTP-247	Practical in Molecular Biology and Microbial Biotechnology	2	15 P	50 (35 External +15 Internal)
USBTP-248	Practical in Animal and Plant Development	2	15 P	50 (35 External +15 Internal)
USBTP-249	Practical in Cell Biology and Immunology	2	15 P	50 (35 External +15 Internal)
	Total Credits (Theory + Practical)		22	

S.Y.B.Sc. Biotechnology**Semester III****Course Code and Title: USBT-231 Cell Biology I****Credits: 2****Total Lectures: 30****Course outcome:**

1. To understand structure and functions of different types of cell organelles.
2. To help students to understand the basic cellular organization and functional categorisation.

Units	Topics	Number of Lectures
1	Introduction To Cell <ul style="list-style-type: none"> • Cell Theory • Types of Cells- Prokaryote & Eukaryotic Cell, Plant & Animal Cell. • Cellular Diversity- Cell structure & related functions. 	5
2	Cell Membrane <ul style="list-style-type: none"> • Chemical components of biological membranes- Organization and Fluid Mosaic Model, • Membrane as a dynamic entity, • Functions of cell membrane. • Transport – Active and Passive transport with one example. • Bulk transport: Exocytosis, Endocytosis. 	6
3	Structure, components and functions of Cell Organelles <ul style="list-style-type: none"> • Nucleus • Mitochondria • Chloroplast • Lysosomes and Vacuoles • ER and SER • Golgi Bodies • Cell Junctions • Extracellular Matrix • Cytoskeleton & Basal Bodies. 	19

Reference Books:

1. Molecular Cell Biology. 9th Edition, (2021) 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, 7th Edition (2022) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 9th edition, (2020) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 8th edition (2020), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2017. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

Course Code and title: USBT-232 Molecular Biology I**Credits: 2****Total Lectures: 30****Course outcome:**

1. Understand the types of nucleic acids and their structures.
2. To help students to understand the chromosomal organization in all life forms.
3. To introduce the process of DNA replication with suitable examples.
4. To introduce the types of DNA damage and repair mechanisms.

Units	Topics	Number of Lectures
1	Historical and conceptual Background- <ul style="list-style-type: none"> • Molecular basis of heredity & Central dogma of Molecular Biology, • Discovery of DNA as genetic material: Griffith's experiment, Hershey and Chase warring blender experiment, Miescher to Watson and Crick- Historic perspective. • Nucleic acids- structure, properties and function, Nucleoside and nucleotide, • Structure of DNA: DNA forms; A, B & Z. • Salient features of double helix, Chargaff's rule. • Types and structure of RNA : tRNA, rRNA , mRNA and noncoding RNA (miRNA, SiRNA) 	8
2	Concept and Organization of Genome <ul style="list-style-type: none"> • Chromosomal organization and structure, • Chromatin structure: Euchromatin, heterochromatin, nucleosomes- histone, non-histone proteins. • Organization of DNA: Prokaryotes, Viruses. • Organelle DNA – mitochondria and chloroplast DNA. • Definition of gene – introns/exons, Regulatory sequences, promoters, enhancers and suppressors, gene families 	8
3	Replication of DNA <ul style="list-style-type: none"> • DNA synthesis: general principles, bidirectional replication, Semiconservative nature of DNA replication, • Meselson and Stahl Experiment • Rolling circle Replication. • The replication complex: Enzymes involved in DNA replication, unique aspects of eukaryotic & prokaryotic DNA replication, Fidelity of replication. 	10
4	DNA damage and repair <ul style="list-style-type: none"> • Causes and types of DNA damage. • Mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, SOS repair, recombination repair 	4

Reference Books:

1. Genes X, 10th edition (2009), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc. USA
2. Molecular Biology of the Gene, 7th Edition (2013), James D. Watson, Tania Baker,
3. Molecular Biology, 5th Edition (2011), Weaver R., Publisher-McGraw Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India

Course Code and title: USBT 233 Genetics**Credits: 2****Total Lectures: 30****Course Outcomes:**

1. Understanding fundamentals of genetics.
2. Introduction to recombination and sex determination.
3. Knowing consequences of mutations and genetic disorders and subsequent counselling.

Unit	Topic	No. of Lectures
1	Mendelism <ul style="list-style-type: none"> • Genetic basis of Inheritance, Variations, Heredity, Pre- Mendelian Concept, Importance of Genetics Mendelian Genetics <ul style="list-style-type: none"> • Mendel's Experiments Mendel's Laws <ul style="list-style-type: none"> • Law of Segregation: Mono Hybrid cross. • Law Of Independent Assortment : Di Hybrid and Tri Hybrid crosses • Deviation From Mendel's Law : Partial or Incomplete Dominance, Co-Dominance, Multiple Allele, polygenic inheritance • Penetrance and expressivity : Pleiotropism • Gene Interaction : Modified Di Hybrid Ratio, Epistasis 	8
2	Chromosomal aberrations and Mutations <ul style="list-style-type: none"> • Variation in chromosome number – types, dosage compensation and Barr bodies (Human) • Variation in chromosome structure – types, generation of variation • Mutations Classification and types, molecular basis of mutations • Mutagens – types and their action, hot spot mutations 	9
3	Sex Determination and Recombination Linkage and Recombination- Discovery of Linkage, Complete and incomplete linkage, crossing over, Cytological Proof Of Crossing Over, three point cross, Recombination Frequency and Map Distance Mechanism of Sex Determination <ul style="list-style-type: none"> • Homo and Heterogametic Theory • Coincidence and interference • X-Linked Inheritance • Non Mendelian Inheritance • Pedigree Analysis 	9
4	Genetic Disorders <ul style="list-style-type: none"> • Sickle Cell Anaemia • Hemophilia • Colour Blindness • Albinism • Down's and Klinefelter's Syndrome Genetic Counselling <ul style="list-style-type: none"> • Reasons for genetic counselling • Clinical diagnostic tests 	4

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| | <ul style="list-style-type: none">● Karyotype analysis, amniocentesis and CVS | |
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Reference Books:

1. Genetics: Strickberger M W, 3rd Edition (2015) Prentice Hall, India
2. Fundamentals of Genetics. B.D Singh (2022) Medtech Science Press
3. GENES IX : Benjamin Lewin, (2007) Jones and Bartlett Publishers, Inc
4. Genetics: Gupta P.K (2018) Rastogi Publication
5. Genetics: A Mendelian Approach (2007): Peter J. Russell

Course Code and title: USBT-234 Metabolism**Credits: 2****Total Lectures: 30****Course Outcomes:**

1. Gain knowledge of basic laws of thermodynamics
2. Learn the anabolic and catabolic aspects of basic building biomolecules

Units	Topics	Number of Lectures
1	Introduction to Metabolism <ul style="list-style-type: none"> • Bioenergetics: Basic law of thermodynamics, internal energy, enthalpy, entropy, concept of free energy, standard free energy change of a chemical reaction, Oxidation–reduction reaction • ATP energy cycle 	6
2	Carbohydrate Metabolism <ul style="list-style-type: none"> • Glycolysis, sequence of reactions in glycolysis • Pyruvate metabolism • Citric acid cycle (TCA Cycle) Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role • Gluconeogenesis Synthesis of glucose from non-carbohydrate sources • Glycogenesis, glycogenolysis • Pentose-phosphate pathway and glyoxalate cycle 	10
3	Amino acid Metabolism <ul style="list-style-type: none"> • Essential & nonessential amino acids, Brief outline of amino acid synthesis • Catabolism of Amino acids, Transamination, Deamination • Urea Cycle • Metabolic breakdown of amino acids – Glucogenic and ketogenic amino acids 	8
4	Lipid Metabolism <ul style="list-style-type: none"> • Outline of lipid synthesis, Fatty acid synthase complex(FAS), • significance of FAS catabolism of Fatty acid • Beta oxidations fatty acids 	6

Reference books:

1. Conn EE and Stump PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.
2. Voet D and Voet JG. 2020. Voet's Biochemistry. 5th Ed. John Wiley and Sons, Inc. NY, USA
3. Nelson DL and Cox MM. 2021. Lehninger's Principles of Biochemistry, 7th Ed . Macmillan Learning, NY, USA.
4. Berg JM, Tymoczko JL, Stryer L and Gatto GJ. 2019. Biochemistry, 9th Ed. W.H. Freeman and Company, NY, USA
5. Murray, R.K., etal "Harper's Biochemistry", 31st Edition, Prentice Hall International, 2018.

Course Code and title: USBT-235 Environmental Biotechnology**Credits: 2****Total Lectures: 30****Course Outcomes:**

1. Gaining the knowledge on concepts of environment, ecology and ecosystem.
2. Understanding of the global environmental issues and mitigation options through sustainable development.

Units	Topics	Number of Lectures
1	Foundations of Environment and Ecology <ul style="list-style-type: none"> • Environment: Definitions • Components - Atmosphere, Hydrosphere, Lithosphere, Biosphere • Inter- relationships, Ecology and Ecosystems: Interconnections in nature 	4
2	Ecosystem <ul style="list-style-type: none"> • Principles and its concepts- Introduction, Characteristics, Components of ecosystem and Types- Aquatic and terrestrial ecosystems, Homeostasis Biotic Community <ul style="list-style-type: none"> • Types; Characteristics , Structure • Ecological succession: Introduction • Energy flow • Food chain, food web, Trophic Levels 	4
3	Threats to Environment and Ecosystem <ul style="list-style-type: none"> • Environmental pollution : Types, sources • Consequences of : Air, Water, Soil, Radiation • Biotechnological approaches for pollution control 	5
4	Biotechnology in Protection and Restoration of Ecosystem <ul style="list-style-type: none"> • Bioremediation: Importance of bioremediation • Use of microorganisms for Bioremediation • Phytoremediation • Bioindicators and detectors 	4
5	Environmental Priorities in India <ul style="list-style-type: none"> • Environmental Impact Assessment (EIA case study) • Introduction and Functions of Central Pollution Control Board of Government of India • Introduction to sustainable tourism for India 	3
6	Waste and Disaster Management <ul style="list-style-type: none"> • Biomedical waste management • Integrated waste management • Hazards to the environment 	3
7	Microbial Biodegradation of	3

	<ul style="list-style-type: none"> • Plastic • Hydrocarbons • Dyes, pesticides/ insecticides and herbicides 	
8	<p>Current global environmental issues</p> <ul style="list-style-type: none"> • Ozone layer depletion (Montreal protocol), El Nino • Acid rain - causes and effects • Green House Effect • Global climate change • Greenhouse gases and their impact on the environment • Global warming – effect on oceans, coastline and marine ecosystem • Impact of global warming on India 	4

Reference books:

1. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd, Kolkata
- 2.Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. (2016). Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (Eds.). CRC Press.
3. Evans & Furlong. Environmental Biotechnology. Theory& Applications. 2nd ed 2011. Wiley-Blackwell.
4. Introduction to Environmental Biotechnology (2007) Chattergy PHI Learning Pvt. Ltd, Delhi
5. <https://cpcb.nic.in/functions/> and <https://tourism.gov.in/sites/default/files/2020-01/Document.pdf>

Course Code and Title: USBT 236 Bioanalytical Techniques**Credits: 2****Total Lectures: 30****Course Outcomes:**

1. Gain the knowledge of basic bioanalytical techniques
2. Develop understanding of applications of these techniques

Units	Topics	Number of Lectures
1	Introduction <ul style="list-style-type: none"> • Lab safety, Scientific notation & Units, errors & accuracy in experimentation, Biochemical Calculations, Buffer solutions, Measurement of pH, Calibration of pipettes & balance 	2
2	Spectroscopy <ul style="list-style-type: none"> • The electromagnetic spectrum • Concept & Measurement of transmittance and absorbance. The Chromospheres Concept • Beers Lamberts law, molar extinction coefficient, limitations of Beers Lamberts law • Types of spectrometers – UV & visible; Principles Instrumentation and applications 	8
3	Centrifugation techniques <ul style="list-style-type: none"> • General Principle, Sedimentation velocity • Sedimentation equilibrium • Types of Centrifuge- preparative and analytical centrifugation differential centrifugation, density gradient centrifugation • Rate zonal centrifugation, Isopycnic centrifugation • Types of rotors, Analytical ultracentrifuge • Applications 	6
4	Chromatographic techniques <ul style="list-style-type: none"> • Introduction to chromatography, general principle, planar chromatography • Partition chromatography, Thin layer chromatography, paper chromatography • Column Chromatography-columns, stationary phases, packing of column, application of sample, column development, fraction collection and analysis • Adsorption chromatography, Ion exchange chromatography, size exclusion chromatography 	8
5	Electrophoresis <ul style="list-style-type: none"> • General Principle, Factors affecting electrophoresis voltage, current resistance, buffer, composition, concentration, pH • Agarose gel electrophoresis • SDS Page, Native Page, denaturing gels • Applications 	6

Reference Books:

1. Wilson K and Goulding K.H., A biologist's guide to Principles and Techniques of Practical Biochemistry.
2. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house.
3. Willard and Merrit, Instrumental Methods and Analysis
4. Ewing GW, Instrumental Methods of Chemical analysis.
5. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.

Course Code and title: USBTP-237 Practical in Cell Biology and Genetics**Credits: 2****Total Practical= 15 P (15x3hrs)****Course outcome:**

1. Understanding structures of Prokaryotic and Eukaryotic cells.
2. Study the process of enzyme extraction and enzyme kinetics.
3. Exposure to students about various cell lysis methods.
4. Understand Mendelian and Non-Mendelian inheritance through numerical problems.

Units	Title of Experiments	Number of Practicals
	Practicals in Cell Biology	
1	<ul style="list-style-type: none"> • Study of Prokaryotic and Eukaryotic cell structure (plant and animal). • Study of Electron Micrographs of all important cell organelles 	1
2	Micrometry- Measurement of cell size of different types of cells.	1
3	Staining and Observation of human cheek epithelial cells	1
4	Isolation and characterization of the following subcellular components, using appropriate samples, by differential centrifugation <ul style="list-style-type: none"> • Nuclei : staining and counting • Mitochondria : Succinate Dehydrogenase assay • Chloroplast : Microscopic Observation • Lysosomes: Acid Phosphatase assay 	4
5	Methods of cell lysis and its confirmation	1
	Practicals in Genetics	
1	Problem Sets of – <ul style="list-style-type: none"> • Mendelian inheritance and Non Mendelian inheritance Monohybrid cross. Dihybrid cross and Trihybrid cross • Incomplete Dominance, Co-dominance. • Epistasis. • Gene interactions 	4
2	Problems set of Linkage and Pedigree analysis <ul style="list-style-type: none"> • 2 point cross. 3 point cross and genetic mapping. • Sex linked inheritance 	2
3	Studies on karyotype analysis	1

Reference Books:

1. Genetics, by Strickberger M W (2015) (Prentice Hall, India)
2. Genetics: Gupta P.K (2018) Rastogi Publication
3. Current Protocols in Cell Biology , Volume 89, Issue 1, December 2020.

Course Code and title: USBTP-238 Practical in Bio Analytical Technique and Metabolism
Total Practical= 15 P (15x3hrs)

Course Outcome:

1. Gain hands on training of basic bioanalytical techniques
2. Knowhow of estimation methods of important biomolecules

Units	Title of Experiments	No. of Practicals
	Biochemical & Biophysical Techniques	
1	Safety measures in laboratory	1
2	The separation of amino acids by ion exchange chromatography	2
3	The separation of dyes by using Gel filtration Chromatography	1
4	Native gel electrophoresis of proteins	2
5	Determine λ max of DNA, protein, bromophenol blue solutions using spectrophotometer	1
	Metabolism	
6	Estimation of reducing sugar by DNSA (dinitrosalicylic acid) method	1
7	Estimation of amylase activity from a given sample.	1
8	Qualitative determination of Glucose by Benedict Method	1
9	Estimation of protein by Lowry's method	1
10	Estimation of alkaline phosphatase activity from a given sample.	1
11	Quantitative determination of free amino acid content from biological sample.	1
12	Estimation of cholesterol from given sample	1

Reference Books:

1. Jayaram T. 2011. Laboratory manual in Biochemistry, second edition Wiley Estern Ltd. New Delhi.
2. Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
3. Nath RL. 1996. Practical Biochemistry in Clinical Medicine. Academic Pub.
4. Sadasivam S and Manickam A. 2018. Biochemical Methods. 3rd Ed. New Age International (P) Ltd. Publisher, New Delhi.

Course Code and Title: USBTP-239 Practical in Molecular Biology and Environmental Biotechnology**Credits: 2****Total Practical= 15 P (15x3hrs)****Course Outcomes:**

1. Understand principal and techniques in DNA isolation from a given source
2. Learn qualitative and quantitative analysis methods for nucleic acids
3. Hands-on training on community sampling and estimation
4. Hands-on training problems associated with pollution and analysis of soil samples

Units	Title of the experiments	No. of Practicals
	Molecular Biology	
1	Reagent and buffer preparation	2
2	Estimation of Nucleic acids by UV-Vis spectrophotometry	1
3	DNA isolation from eukaryotic system-plant and purity check by using A 260/280.	2
4	Agarose gel electrophoresis for DNA	1
5	Estimation of DNA by diphenylamine method	1
	Environmental Biotechnology	
1	Testing genotoxicity of water sample: Polluted and non-Polluted	1
2	Community sampling - By Quadrature method for plants: Percentage of frequency, density, abundance.	1
3	Setting and observation of Winogradsky column to study microbial ecology	1
4	Microbial (Bacterial, Algal and Fungal) community estimation	1
5	Study of polluted and unpolluted soil by i) Physical properties : Colour, Texture, Water holding capacity	1
	ii) Chemical properties: pH, Organic content	1
6	Demonstration of pollution indicator plants in terms of morphology and anatomy (any 5-7 plants)	1
7	Visit to waste water/ sewage waste/ soild waste/ industrial waste treatment plant. Submit a report for the same.	1

References: .

1. Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J. G. Seidman, John A. Smith, Kevin Struhl, Short Protocols in Molecular Biology, Wiley, 2002
2. Brenda D. Spangler, Methods in Molecular Biology and Protein Chemistry: Cloning and Characterization of an Enterotoxin Subunit, Wiley, 2002
3. Molecular cloning – A laboratory manual – (Vol. 1-3), 4th edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA
4. Greig-Smith, Peter. Quantitative plant ecology. Vol. 9. Univ of California Press, 1983.
5. Benson, T. (2001) Microbiological Applications Laboratory Manual in General Microbiology. 8th Edition, The McGraw-Hill, New York

Semester IV**Course Code and title: USBT-241 Cell Biology II****Credits: 2****Total Lectures: 30****Course outcome:**

1. Develop understanding of the cell cycle and cell division process.
2. Get introduced to various types of cell signalling.
3. Gain knowledge of the different processes involved in cell death.

Units	Topics	Number of Lectures
1	Cell Cycle <ul style="list-style-type: none"> • Introduction • Phases and regulation of cell cycle. 	4
2	Cell Division in Plant & Animal Cells <ul style="list-style-type: none"> • Mitosis • Meiosis 	7
3	Cell Signaling <ul style="list-style-type: none"> • Signaling molecules • Signaling receptors: Cell surface receptors • Autocrine, Paracrine, juxtacrine signaling, • G-protein signaling (one example) • Calcium Signaling. 	12
4	Cell Death <ul style="list-style-type: none"> • Aging • Apoptosis and Necrosis • Neoplasia, • Autophagy 	7

Reference Books:

1. Molecular Cell Biology. 9th Edition, (2021) 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, 7th Edition (2022) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 9th edition, (2020) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 8th edition (2020), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2017. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

Course Code and title: USBT-242 Molecular Biology II**Credits: 2****Total Lectures: 30****Course outcome:**

1. Develop the understanding of the processes of Transcription and Translation.
2. Know the concept of genetic code
3. Learn the aspects of Gene regulation.

Units	Topics	Number of Lectures
1	Synthesis of RNA: Transcription: <ul style="list-style-type: none"> • Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination. • Transcription in Eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation. • Post-transcriptional modifications: processing of pre-mRNA: 5' cap formation, polyadenylation, introduction to splicing. 	8
2	Genetic Code <ul style="list-style-type: none"> • Concept of codon, reading frame, frame shift, • Major scientific contributions to decipher genetic code. • Properties of genetic code 	5
3	Synthesis of Protein: Translation <ul style="list-style-type: none"> • Structure of ribosome and assembly, • Protein Synthesis in Prokaryotes: properties of the prokaryotic Initiator tRNA-fMet, charging of tRNA, amino acyl tRNA synthetases. • Protein Synthesis in Eukaryotes: Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. • Posttranslational modifications of proteins 	10
4	Regulation of activity of Genes and Gene products in Prokaryotes <ul style="list-style-type: none"> • General aspects of gene Regulation: inducible and repressible system • The lactose operon: Catabolite repression • The Arabinose operon: Positive, negative regulation • The Tryptophan operon: Regulation by attenuation 	7

Reference Books:**1. Reference Books:**

1. Genes X, 10th edition (2009), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc. USA
2. Molecular Biology of the Gene, 7th Edition (2013), James D. Watson, Tania Baker,
3. Molecular Biology, 5th Edition (2011), Weaver R., Publisher-McGraw Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India

Course Code and title: USBT-243 Immunology**Credits: 2****Total Lectures: 30****Course outcome:**

1. Overview of the components and organs of immune system.
2. Learn the technique of various immunodiagnostic procedures based on antigen antibody interactions.
3. Give exposure to students about various types of vaccines.

Units	Topics	Number of Lectures
1	Immunology: Basic definitions and fundamentals of the immune system <ul style="list-style-type: none"> • Definitions- Infection, Invasion, Pathogen, Immunity, Antigen, Antibody. • Concept of Host pathogen interaction. • Organization of Immune system: <ol style="list-style-type: none"> a) Structure and function of the cells and tissues of immune system. b) Structure and function of Primary and Secondary lymphoid organs. • Types of immunity: <ol style="list-style-type: none"> a) Innate and Acquired immunity b) Cell mediated and Humoral immunity. • Immune Response: Primary and Secondary. • Phagocytosis. 	7
2	Components of the immune system <ul style="list-style-type: none"> • Antigens: Types and properties of an antigen. • Factors affecting immunogenicity. • Immunoglobulin: Structure and their types. • Properties and function of different Immunoglobulin classes. • Complement system: Components, function and pathways. • Major Histocompatibility Complex: Types, structure and function. • Cytokines: Types, properties and their function. 	8
3	Antigen-Antibody Interactions <ul style="list-style-type: none"> • General characteristics of Antigen-Antibody reaction. • Concept of Lattice hypothesis and Zone phenomenon. • Principle and example of different diagnostic tests: <ol style="list-style-type: none"> i. Precipitation, Agglutination, Immunodiffusion and Complement fixation test ii. Radioimmunoassay, Immunofluorescence, ELISA iii. Western blotting 	7
4	Clinical Immunology <ul style="list-style-type: none"> • Hypersensitivity reactions: Types of Hypersensitivity and clinical manifestation. • Autoimmunity: Mechanisms, Types of autoimmune diseases □ • Concept of Immunotherapy. • Vaccine Technology: 	8

	<p>i. Adjuvant- Properties and role with suitable example ii. Concept with suitable example of Killed and Live attenuated vaccines, Combined vaccines iii. Modern Techniques: Concept of Subunit vaccines, Recombinant DNA Vaccines, Conjugate vaccines, Polyvalent vaccines.</p> <ul style="list-style-type: none">● Monoclonal antibodies, chimeric antibodies with suitable example.	
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Reference Books:

- 1.A Text Book Of Immunology, P Madhavee Latha, 2022 Edition, S.Chand & Company.
2. Kuby Immunology, Jenni Punt , Sharon Stranford, Patricia Jones, Judith Owen, 8th edition (2018). Macmillan
3. Textbook Of Immunology, S F Basir, 2012, Prentice-Hall of India Pvt Ltd
4. Sudha Gangal and Shubhangi Sontakke, Textbook of basic and clinical immunology, 1st edition (2013), University Press, India.
5. Immune: A Journey Into The Mysterious System That Keeps You Alive, Philipp Dettmer, 1st Edition (2021), Hodder & Stoughton Ltd.

Course Code and title: USBT 244 Animal Development**Credits: 2****Total Lectures: 30****Course Outcomes**

1. Learn different events during embryonic development of various animal models
2. Understand various post embryonic developmental events
3. Learn basic concepts of different types of stem cell

Units	Topics	No. of Lectures
1	<ul style="list-style-type: none"> • History of developmental biology, • Model organisms in study of developmental biology: frog, chick, mouse, <i>Drosophila</i>, Sea urchin, Zebrafish, <i>Caenorhabditis elegans</i> 	2
2	Gametogenesis: <ul style="list-style-type: none"> • Basics of gametogenesis: Oogenesis, spermatogenesis and spermiogenesis • Detailed structure of gametes 	2
3	Fertilization <ul style="list-style-type: none"> • Detailed process in sea urchin and mammals • Types of eggs, types and patterns of cleavage • Cytoplasmic rearrangements 	4
4	Cleavage <ul style="list-style-type: none"> • Types of eggs • Cleavage patterns • Fate map 	2
5	Gastrulation <ul style="list-style-type: none"> • Morphogenetic movements • Gastrulation in Amphioxus, frog, chick, <i>Drosophila</i>, up to formation of three germinal layers 	8
6	Concept of pattern formation with the example of <i>Drosophila</i> <ul style="list-style-type: none"> • Maternal effect genes and their role in pattern formation 	3
7	<ul style="list-style-type: none"> • Primary embryonic induction • Basics of Neurulation • Introduction to organogenesis 	2
8	Concept of Stem cells, their types, cell lineages, determination, commitment and differentiation	1
9	Post embryonic development: <ul style="list-style-type: none"> • Regeneration- Different types of with one example of each type • Basics of metamorphosis • Apoptosis- Intrinsic and extrinsic pathways • Ageing 	5
10	Teratogenesis and other developmental abnormalities	1

Reference Books:

1. Development Biology, 12th edition, (2019), Barresi M.J.F. and Gilbert S.F. (Sinauer Associates, USA)
2. Principles of Development, 6th edition (2019), Wolpert L, Tickle C, A. M. Arias. Oxford University Press, USA.
3. An introduction to embryology, 5th edition, B. I. Balinsky, B.C. Fabian (2012) Cengage Learning India

Course Code and title: USBT 245 Plant Development**Credits: 2****Total Lectures: 30****Course Outcomes:**

1. Know how of plant development from seed to seed.
2. Get knowledge of morphological, physiological and genetic aspects of each phase in plant development
3. Get familiarise with the idea of applications of developmental studies in biotechnology

Unit	Topic	No. of Lectures
1	Plant as a living system <ul style="list-style-type: none"> • Principles and unique features of plant development • Comparisons of Plant and animal development 	2
2	Plant development at: <ul style="list-style-type: none"> • Cellular, organ and whole-plant levels • Whole plant as an interacting dynamic system 	2
3	Major phases of plant development i) Vegetative development <ul style="list-style-type: none"> • Zygote to seed embryo to seedling till vegetative maturity • Pattern formation in plants – vegetative 	5
	ii) Floral Evocation <ul style="list-style-type: none"> • Shift from vegetative to reproductive phase • Induction- perception of inductive stimuli and subsequent changes • Photoperiodism, Biological clock, Vernalization • Pattern formation in plants- flowering 	7
4	iii) Reproductive development <ul style="list-style-type: none"> • Microsporogenesis, development of male gametophyte and male gamete • Megasprogenesis, development of female gametophyte and female gamete • Double fertilization and triple fusion • Development of endosperm 	6
5	Concept of <ul style="list-style-type: none"> • Competence, • Determination, • Commitment, • Differentiation, • De-differentiation and • Re-differentiation (partial/ terminal) in vivo with one example each 	3
6	Model systems to understand plant development : <ul style="list-style-type: none"> • Molecular regulation of development in <i>Arabidopsis</i> 	2
7	Parthenogenesis- <ul style="list-style-type: none"> • Haploid , Diploid 	3

	<ul style="list-style-type: none">• Parthenocarpy – Natural , Induced• Applications of Plant development in Biotechnology	
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Reference Books:

1. Embryology of Angiosperms: Bhojwani S.S. and Bhatnagar S.P. 6th Edition (2018) Vikas Publ House, New Delhi
2. Plant physiology and Development: Taiz L, Zeiger E, 6th Edition (2018) Sinauer Associates, USA
3. Embryology of Angiosperms: Dr. V. Singh, Dr. P.C. Pande, Dr. D.K. Jain (2018) Rastogi Publication
4. Plant growth and development: B.P. Nautiyal, (2018) Medtech

Course Code and title: USBT-246 Microbial Biotechnology**Credits: 2****Total Lectures: 30****Course Outcome:**

1. Understand importance of pasteurisation of milk and food preservation
2. Learn in detail of various diseases
3. Understand the drinking water norms Sewage treatment
4. Learn the various applications of microbes

Units	Topics	Number of Lectures
1	History and Scope of Microbial Biotechnology	1
2	Food and Dairy Microbiology Food Microbiology : <ul style="list-style-type: none"> • Role of microorganisms in food spoilage, Factors affecting growth of microbes in food (intrinsic and extrinsic factors), Spoilage of meat and poultry, Fruits and vegetable, canned food. • Principles of Food Preservation. • Methods of preservation Chemical and Physical methods. Dairy Microbiology <ul style="list-style-type: none"> • Milk: Definition, Composition of milk, Normal and abnormal microflora of milk, Sources of contamination of milk, International standards of Milk. • Milk Spoilage- Flavour and colour defects, Stormy fermentation, Sweet curdling, Ropiness. • Grading of milk- Direct and Indirect Tests • Preservation of Milk- Pasteurization and efficiency of pasteurization. • Microbial processing of milk- Curd, Yogurt, Butter, Kefir, Cheese. • Food borne diseases- Food infection and intoxication 	7
3	Medical Microbiology: <ul style="list-style-type: none"> • Normal flora, • Diseases of various systems Tuberculosis, Leprosy, Typhoid, Polio, Syphilis, Tetanus, with respect to causative agent, symptoms, morphology, pathogenesis, diagnosis and treatment. 	7

4	<p>Microbes in Waste treatment Processes</p> <ul style="list-style-type: none"> • Water borne diseases: Indicators of faecal pollution, Routine bacteriological analysis of water for potability: Presumptive, Confirmed, Completed test, Membrane Filter Technique and Eijkman tests. • Bacteriological standards of drinking water.(ICMR, WHO) • Sewage and Industrial waste water: Types of wastes, relevance of COD and BOD determination in analysis of waste water • Methods and principles of treatment of sewage (primary, secondary and tertiary treatment methods • Microbial consortium for effluent treatment. 	8
5	<p>Applications of Microbial Biotechnology</p> <ul style="list-style-type: none"> • Geomicrobiology-Ore leaching (methods and examples), MEOR. <p>Bioweapons, Biofertilizers and Biopesticides and Microbial plant growth Promoters (gibberellins and IAA) GMOs-Norms and applications Microbial Sweeteners (Thaumatococcus, Monelin) Microbial toxins and their applications Microbial Polysaccharide production: any 2 examples Concept of Synthetic Biology and Bio metabolite Production</p>	7

References Books:

1. Food Microbiology, Frazier & Westhoff, 4th edition, Tata McGraw Hill Publications
2. Modern Food Microbiology, James Jay, 7th edition, Springer Publications
3. Advances in Biotechnology, S. N. Jogdand, Himalaya Publishing House
4. Milk & Milk Products, C. Eckles, 4th edition, Tata McGraw Hill Publications
5. Prescott, S.C. and Dunn, C.G., (1983) Industrial Microbiology, Reed G. AVI tech books
6. General Microbiology - Stanier R.Y., 5th edition, (1987) Macmillan Publication, UK.

Course Code and title: USBTP-247 Practicals in molecular biology and Microbial Biotechnology**Credits: 2****Total Practical= 15 P (15x3hrs)****Course outcome:**

1. Learn reagent and buffer preparation.
2. Learn the isolation of DNA from eukaryotic and prokaryotic system and agarose gel electrophoresis
3. Technical knowhow of estimation of DNA

Units	Title of experiment	No. of Practicals
	Molecular biology	
1	Bacterial DNA isolation and purity check by using A 260/280.	1
2	DNA isolation from eukaryotic system-animal cells and analysis by agarose gel electrophoresis	2
3	Animal DNA agarose gel electrophoresis	1
4	Isolation of RNA from Yeast/cauliflower	1
5	Qualitative analysis of RNA by agarose gel electrophoresis	1
6	Estimation of proteins by Bradford method	1
	Microbial Biotechnology	
1	Isolation and identification (Genus level) of spoilage causing microorganisms from spoiled foods.	2
2	Grading of raw milk (MBRT/RRT/DMC)	2
3	Determination of efficiency of Pasteurization by phosphatase test	1
4	Study of Normal flora of humans (Skin/ teeth and oral cavity)	2
5	Assessment of potability of water: a. Presumptive b. Confirmed and c. Completed test.	2
6	IMViC tests	2
7	Visit to any relevant industry and report writing	1

Reference Book:

- 1) Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J. G. Seidman, John A. Smith, Kevin Struhl, Short Protocols in Molecular Biology, Wiley, 2002
- 2) Brenda D. Spangler, Methods in Molecular Biology and Protein Chemistry: Cloning and Characterization of an Enterotoxin Subunit, Wiley, 2002
- 3) Molecular cloning – A laboratory manual – (Vol. 1-3), 4th edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA
- 4) Modern Food Microbiology, James Jay, 7th edition, Springer Publications
- 5) Madigan M.T, Martinko J.M. (2006) Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc
- 6) Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Text book of microbiology, 5th edition, Orient Longman. .Park and Park, Preventive and Social medicine. 2013, Publisher: Banarsidas Bhanot, Jabalpur

Course Code and title: USBT 248 Practical in Animal and Plant Development**Credits: 2****al Practical= 15 P (15x3hrs)****Course Outcomes:**

1. Learn the techniques to understand the developmental processes in various model systems
2. Hands on training on routine procedures used to study plant development

Units	Title of experiment	No. of Practicals
	Animal Development	
1	Study of oogenesis and spermatogenesis- T.S. of testis and ovary	1
2	Study of amphioxus development, observation different development stages (Permanent slides)	1
3	Study of frog development, observation of different development stages (Permanent slides or fixed embryos)	1
4	Study of staging & staining of Chick embryos (24 h, 48h, 72 h)	3
5	Demonstration of any one technique of chick embryo culturing	1
6	Demonstration of regeneration in <i>Hydra</i>	1
	Plant Development	
1	Methods of studying plant development (any suitable plant material) a) Dissection b) Sectioning c) Staining d) Mounting	2
2	Study of apices and meristem - RAM, SAM	1
3	Microsporogenesis- anther squash technique	1
4	Development of male and female gametophytes	1
5	Developmental stages during plant embryogenesis in dicots and monocots	1
6	Dissection of seed and excision of young embryo and endosperm (Two dicotyledon and Two monocotyledon example)	1

Reference Books:

1. Plant physiology and Development: Taiz L, Zeiger E, 6th Edition (2018) Sinauer Associates, USA
2. Sharma HP (2009) – Plant embryology: Classical and experimental, alpha sci
3. M.A. Gibbs. (2003), A Practical guide to Developmental biology. Oxford University Press
4. K.R. Rao. (2020), Developmental Biology Practical Manuals.

Course Code and title: USBTP-249 Practicals in Cell Biology and Immunology**Credits: 2****Total Practical= 15 P (15x3hrs)****Course outcome:**

1. Get to know the structure of chromosomes and different stages of cell divisions
2. Analyse the blood groups of different blood samples
3. Learn the technique of various immunodiagnostic procedures based on antigen Antibody interactions

Units	Title of Experiments	No. of Practicals
	Cell Biology	
1	Study of different stages of Mitosis	2
2	Effect of colchicine on mitosis	1
3	Study of different stages of Meiosis in <i>Tradescantia</i>	2
4	Study of polytene chromosomes (<i>Drosophila/ Chironomus</i> larva)	2
	Immunology	
1	Determination of blood group using slide agglutination Reaction	1
2	To determine total leukocyte count of given blood sample	1
3	Determine Differential leukocyte count of given blood sample	1
4	Immunodiffusion: a) Single Radial immunodiffusion b) Ouchterlony double diffusion technique (pattern of identity)	2
5	Determination of antibody titre by tube agglutination test (Widal Test)	2
6	Detection of presence of antigen by qualitative ELISA (Dot ELISA) (Demonstration only)	1

Reference Books:

1. Current Protocols in Cell Biology , Volume 89, Issue 1, December 2020.
2. A Text Book Of Immunology, P Madhavee Latha, 2022 Edition, S.Chand & Company.
3. Kuby Immunology, Jenni Punt , Sharon Stranford, Patricia Jones, Judith Owen, 8th edition (2018). Macmillan
4. Immune: A Journey Into The Mysterious System That Keeps You Alive, Philipp Dettmer, 1st Edition (2021), Hodder & Stoughton Ltd.