Mizoram University

UG/Bachelor's Degree Programme with Multiple Entry and Exit Options

Curriculum and Credit Framework for Undergraduate Programmes (CCFUP)
in

Biotechnology

2023

Undergraduate Biotechnology
Course Structure and Credit Distribution

Semester	Course Code	Course Name	Credits
I	BIOT/MJ/100	Systematics and Fundamental Concepts	4
	BIOT/MJ/101	Environmental Biotechnology	4
		[Minor course from other disciplines]	4
	MC/BIO/102	Fundamentals of Biology	3
		Language and Communication Skill	3
		Value Added Course	2
			20
II	BIOT/MJ/103	Cell Biology	4
	BIOT/MJ/104	Tools and Techniques in Biotechnology	4
		[Minor course from other disciplines]	4
	MC/BIO/102	Fundamentals of Biology	3
		Skill Enhancement Course	3
		Value Added Course	2
			20
	UG Certificate in Biotechnology		**40**
III	BIOT/MJ/200	Genetics	4
	BIOT/MJ/201	Genetic Engineering	4
		[Minor course from other disciplines]	4
	MC/BIO/102	Fundamentals of Biology	3
		Skill Enhancement Course	3
		Value Added Course	2
			20
IV	BIOT/MJ/203	Biomolecules	4
	BIOT/MJ/204	Medical Biotechnology	4
		[Minor course from other disciplines]	4
		Language and Communication Skill	3
		Skill Enhancement Course	3
		Value Added Course	2
			20
	UG Diploma in Biotechnology		**80**
V	BIOT/MJ/300	Biochemistry	4
	BIOT/MJ/301	Microbiology	4
	BIOT/MJ/302	Plant and Animal Biotechnology	4
		[Minor course from other disciplines]	4
		Language and Communication Skill	2
		Internship	2
			20
VI	BIOT/MJ/304	Immunology	4
	BIOT/MJ/305	Molecular Biology	4
	BIOT/MJ/306	Bioinformatics and Biostatistics	4
	BIOT/MJ/307	Introduction to Nanotechnology	4
		[Minor course from other disciplines]	4

			20
	UG Degree in Biotechnology		**120**
VII	BIOT/MJ/400	Cell signaling and cell communication	4
	BIOT/MJ/401	Genomics and proteomics	4
	BIOT/MJ/402	Molecular basis of human diseases	4
		[Minor course from other disciplines]	4
		[Minor course from other disciplines]	4
			20
VIII	BIOT/MJ/405	Plant and Animal Tissue Culture Techniques and its application	4
	BIOT/MJ/406	Research Methodology	4
	BIOT/RP/407	Research Project/Dissertation	12
			20
	Bachelor's degree/BSc in Biotechnology (Honours with Research)		**160**
OR			
VIII	BIOT/MJ/408	Plant and Animal Tissue Culture Techniques and its application	4
	BIOT/MJ/409	Research Methodology	4
	BIOT/MJ/410	Food and Industrial Biotechnology	4
	BIOT/MJ/411	Molecular Oncology	4
	BIOT/MJ/412	Biosafety, Bioethics and IPR	4
			20
	Bachelor's degree/BSc in Biotechnology (Honours)		**160**

Examination and Assessment

Assessment for different levels of qualification shall be done based on learning outcomes using the following norms:

i. Each course shall be assessed on the scale of 100 marks.
ii. Courses shall be assessed through Continuous Assessment in the form of sessional work and end-semester examination.
iii. The sessional work shall carry 25% of the total marks.

Assessment for sessional works:

For theory paper

Criteria	Total marks
Class test (average of two)	12
Assigment/seminar/project, etc	8
Regularity in the class	5
Grand Total	25

For practical paper

Criteria	Total marks
Lab activities and record	20
Regularity in the class	5
Grand Total	25

Attendance assessment

Attendance	Marks
90% and above	5
85-89%	4
80-84%	3
76-79%	2
75-75%	1

End-semester examination:

End-semester examination (separately for theory and practical) shall carry 75% of the total marks. Duration of theory and practical examination will be 3 hours.

For Research Project / Dissertation of 4 Year Bachelor's Degree (Honours with Research), the marks for sessional work (25%) shall be awarded by the college or course in-charge based on the performance of students and the level of progress made in the process of preparation and writing of Research Project / Dissertation report.

The final report of Research Project / Dissertation will carry a total of 75% as marks for end-semester examination.

Evaluation of Research Project/Dissertation

Criteria	Marks
Originality and relevance The research is carried out with sufficient originality and creativity	5
Purpose and Objective The research problems, questions and objectives are well defined	5
Literature Evidence of appropriate selection and discussion of relevant literature	5
Methodology Appropriateness and justification of the methodology to achieve the research objectives	10
Discussion of findings Discussion of findings reflect learning from analysis and understanding of the implications	10
Presentation, Structure & Language The research is presented in an academic style Language used is good and easy to understand Use of appropriate graphics, illustrations and accurate referencing. Well structured, logical and coherent, use appropriate chapter headings.	10
Conclusion Conclusions add new insight to the topic of the dissertation and identify clear and practical recommendations / opportunities for further development	10
Contribution to knowledge The research produces new results. The results are of interest to academia or industry or otherwise relevant to professionals in the field.	5
Viva-voce Presentation skills (style of presentation, language, structure, completeness and uses of time etc.)	15
Total	75

Systematics and Fundamental Concepts

BIOT /MJ/100
Credit: 4

Theory

Unit I. Principles of systematics: Linnaean classification and taxonomic hierarchy; binomial nomenclature: priority and homonymy rules; concept of kingdom and kingdom classifications.

Unit II. Discovery of Archaea and development of domain system. Species concepts: biological, morphological, ecological, evolutionary and phylogenetic. Speciation: types.

Unit III. The theory of natural selection; modern synthesis; sickle cell trait and resistance to malaria; RNA World hypothesis. Symbiogenesis. *Scala naturae* vs the tree of life.

Unit IV. Prebiotic soup theory and Miller's experiment. Spontaneous generation - Contributions of Francesco Redi, John Needham, Lazzaro Spallanzani, Louis Pasteur. Pangenesis – concept, Galton's and Weismann's experiments.

Suggested readings

1. Principles and Practices of Animal Taxonomy - Kapoor VC; Science Publishers Inc.; 2nd edition (2001).
2. Kingdoms and Domains: An Illustrated Guide to the Phyla of Life on Earth - Margulis L and Chapman MJ; Academic Press (2009).
3. Principles of Systematic Zoology - Mayr E and Ashlock PD; McGraw-Hill; 2nd edition (1991).
4. Science as a Way of Knowing: The Foundations of Modern Biology - Moore JA; United Kingdom: Harvard University Press (1993).
5. Thinking about Life: The History and Philosophy of Biology and Other Sciences - Wheatley DN and Agutter PS; Springer Netherlands (2008).
6. Evolution - Futuyma DJ; Sinauer Associates Inc.; 4th edition (2017).
7. Strickberger's Evolution - Hall BK and Hallgrimsson B; Jones and Bartlett Publishers; 5th edition (2013).

Environmental Biotechnology

BIOT/MJ/101
Credits: 4

Theory

Unit I Environmental contaminants (land, air, water). Concept of biodiversity and effect of climate change on biodiversity; cryopreservation.

Unit II. Biomagnification; bioremediation and phytoremediation - role of microbes, plants and other organisms in toxicants (heavy metal and xenobiotics) biotechnological exploitation.

Unit III. Agriculture contaminants; degradation of hydrocarbons and agricultural wastes; biofertilizers (nitrogen fixers, Mycorrhiza, PSBs, VAM). Biocontrol agents. Restoration of degraded lands, organic farming.

Unit IV. Energy resource- renewable and non-renewable; biofuels; bioenergy (green energy and carbon credits); biogas from wastes; biotechniques for air pollution control.

Suggested readings

1. Environmental Biotechnology – Fulekar MH; Oxford & IBH Publishing; 1st Edition (2008).
2. Environmental Biotechnology – Jogdand SN; Himalaya Publishing House, Mumbai; 3rd Edition (2006).
3. Environmental Biotechnology: Theory and Application – Evans GM & Furlong JC; John Wiley & Sons; 2nd Edition (2010).
4. Environmental Biotechnology – Hiremath MB, Baligar P & Prashanth MS; Prateeksha Publications; (2011).
5. Fundamentals of Ecology – Odum E, Barrick M & Barrett GW; Cengage Learning; 5th Edition (2005).
6. Ecology and Environment – Tripathi AK; Aph Publishing Corporation (2012).

Fundamentals of Biology

MC/BIO/102
Credits: 3

Unit 1 Contributions of Aristotle in biology. Development of physiology from Galen to William Harvey. Germ theory of diseases: works of Girolamo Fracastoro, Louis Pasteur and Robert Koch. Origin of evolutionary theories: Lamarckism and natural selection.

Unit 2 Discovery of cell: contributions of Robert Hooke and Antonie van Leeuwenhoek. Origin of cell theory: Matthias Schleiden, Theodor Schwann and Rudolf Virchow. Birth of genetics: Mendel's experiments and laws.

Unit 3 Discovery of antibiotics: Salvarsan, Prontosil (sulfonamide), penicillin, and streptomycin. Discoveries of DNA as a genetic material and the helical structure. Development of the Human Genome Project. Cloning – Dolly, and ethical issues.

Suggested readings

1. The Rise of Experimental Biology: An Illustrated History - Lutz PL; Springer (2002).
2. A History of the Life Sciences – Magner LN; CRC Press (2002).
3. The Path to the Double Helix: The Discovery of DNA - Olby RC; Dover Publications Inc. (1994).
4. Miracle Cure: The Creation of Antibiotics and the Birth of Modern Medicine - Rosen W ; Penguin (2018).
5. The Epic History of Biology - Serafini A. Springer (2013).

Cell Biology

BIOT/MJ/103
Credits: 4

Theory

Unit I Cell theory; structure of prokaryotic & eukaryotic cells; structure and function of motile cells (amoeboid, ciliary, flagellar), cytoskeletons- microfilaments, intermediate filaments, and microtubules.

Unit II Structure and function of cell organelles – nucleus, ribosomes, Golgi apparatus, endoplasmic reticulum, mitochondria, chloroplast, peroxisomes, lysosomes.

Unit III Cell membrane – fluid mosaic model; extracellular matrix; membrane transport mechanisms; cell-cell interactions; general overview of cell signalling.

Unit IV Cell cycle and regulation of cell cycle through cyclin-CDK complexes, stages of mitosis and meiosis; senescence and necrosis, apoptosis.

Suggested readings

1. Cell Biology & Molecular Biology – De Robertis EDP & De Robertis EMF; Lippincott Williams and Wilkins; 8th Edition (2006).
2. Cell and Molecular biology concepts and experiments – Karp G; John Wiley & Sons; 5th Edition (2007).
3. Molecular cell biology – Lodish H, Berk A & Matsudaira P; WH Freeman & Co.; 5th Edition (2003).
4. Cell biology Organelle Structure and function – Sadava DE; Panima Publishing Corporation; (2004).
5. Molecular Biology of the Cell – Alberts B, Lewis A, Lewis J, Raff M, Roberts K & Walter P; Garland Publications; 4th Edition (2002).

Tools and Techniques in Biotechnology

BIOT/MJ/104
Credits: 4

Theory

Unit I Electrophoresis: Principle and applications; polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis; blotting technique (western, southern and northern).

Unit II Chromatography: Principle and applications; paper chromatography, thin layer chromatography, column chromatography; gas chromatography, HPLC; centrifugation.

Unit III Calorimetry and spectroscopy: Principle and applications; colorimetry, spectrophotometry (visible, UV, infrared); principles and applications of pH meter.

Unit IV Microscopy: Principle, application; types - simple and compound microscopy, stereozoom, fluorescence, phase contrast microscopy, bright and dark field; Spectroscopy.

Suggested readings

1. Cell and Molecular Biology: Concepts and Experiments - Karp G; John Wiley& Sons. Inc. 2. 6th Edition (2010)
2. Cell and Molecular Biology - De Robertis EDP. and De Robertis EMF; Lippincott Williams and Wilkins, Philadelphia; 8th edition (2006)
3. The Cell: A Molecular Approach- Cooper GM. and Hausman RE; ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, 5th edition (2009)
4. The World of the Cell - Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP; Pearson Benjamin Cummings Publishing, San Francisco; 7th edition (2009)
5. Principles and Techniques of Biochemistry and Molecular Biology - Wilson K and Walker J; Cambridge University Press; 8th edition (2018).

Genetics

BIOT/MJ/200
Credits: 4

Theory

Unit I Mendelian genetics; incomplete dominance, co-dominance, multiple alleles; epistasis. Cytoplasmic inheritance.

Unit II. Chromosomal theory of inheritance; non-disjunction; chromosomal aberrations. Linkage and crossing over - types and significance. Construction of genetic map (Drosophila).

Unit III. Sex determination; sex influenced, sex limited characters; dosage compensation. Sex-linked inheritance; penetrance and expressivity. Pedigree analysis.

Unit IV. Transposable elements in prokaryotes and eukaryotes. Gene transfer in bacteria: conjugation, transformation & transduction.

Practical

1. Study of stages of mitosis from permanent slides
2. Study of stages of meiosis from permanent slides.
3. Preparation and observation of barr body
4. Test for ABH secretor status in saliva

Mark distribution of practical for end semester examination

1. Major Experiment	25
2. Minor experiment/spotting (2 slides/models)	20
4. Laboratory record	10
5. Viva voce	20
TOTAL	75

Suggested readings

1. Principles of Genetics – Tamarin R; Tata Mcgraw Hill Education; 7th Edition (2010).
2. Genetics – Strickberger WM; Phi Learning; 3rd Edition (2008).
3. Principles of Genetics – Simmons MJ, Snustad DP & Gardner EJ; Wiley; 8th Edition (2006).
4. Genes IX – Lewin B; Jones & Bartlett Learning; (2010).
5. Cell Biology & Molecular Biology – De Robertis EDP & De Robertis EMF; Lippincott Williams and Wilkins; 8th Edition (2006).
6. Textbook of Cell and Molecular Biology – Paul A; Books and allied (p) Ltd; 2nd Edition (2007).
7. iGenetics - A Molecular Approach - Peter J. Russell; Benjamin Cumming publisher; 3rd Edition. (2010)
8. Genetics: A Conceptual Approach - Benjamin A. Pierce; WH freeman; 7th Edition (2020)
9. Principles of Population Genetics - Daniel L. Hartl & Andrew G. Clark; 4th Edition (2006)

Genetic Engineering

BIOT/MJ/201
Credits: 4

Theory

Unit I. Principle and applications of genetic engineering; in agricultural, medical, industrial, environmental sectors. Vectors (cloning and expression: properties - plasmids, cosmids, lambda, M-13, phagemids).

Unit II. Enzymes in genetic engineering (DNA polymerases, restriction enzymes, ligases, kinases, endonucleases, phosphatase, reverse transcriptase). Direct DNA delivery methods (microinjection, biolistic method, liposome and virus mediated delivery, electroporation, CaCl2 mediated gene transfer).

Unit III. Principles of construction of DNA libraries (genomic and cDNA libraries). Screening by colony hybridization; chromosome walking; nucleic acid labelling and detection.

Unit IV. DNA Sequencing - Maxam and Gilbert, and Sanger methods, automated sequencing methods. DNA fingerprinting. Introduction to Human Genome Project, PCR: principle, methods and types.

Suggested readings

1. Recombinant DNA: Genes and Genomes-A Short Course – Watson JD, Caudy A, Myers R & Witkowski JA; WH Freeman/Cold Spring Harbor Laboratory Press; 3rd Edition (2007).
2. Principles of gene manipulation: An introduction to Genetic engineering – Old RW & Primerose SB; Blackwell Scientific Pub.; 6th Edition (2001).
3. Gene cloning and DNA Analysis: An Introduction – Brown TA; Wiley-Blackwell; 6th Edition (2010).
4. Molecular cloning: A Laboratory Manual – Sambrook J, Fritsch EF and Maniatis T; Cold Spring Harbor Laboratory Press; Volume I – III; 2nd Edition (1989).
5. Gene Probes 2: Practical Approach – Hames BD & Higgins SD; Oxford University Press, USA; 1st Edition (1996).
6. PCR Cloning Protocols- Bruce WA; Humana Press, Totowa, New Jersey; (1997).

Biomolecules

BIOT/MJ/203
Credits: 4

Theory

Unit I Carbohydrates: Classification, physicochemical properties, monosaccharides: Fischer projection and Haworth projection; oligosaccharides; polysaccharides (structural and storage).

Unit II Amino acids and proteins: Classification, structure, properties; functions of proteins (elastin, myoglobin and haemoglobin); denaturation and renaturation of proteins.

Unit III Fatty acids: Classification and properties, saturated and unsaturated fatty acids; simple, compound, and derived lipids and their biological role.

Unit IV Nucleic acids: Structure of purines and pyrimidines, properties of nucleic acids; types of RNA and DNA; denaturation and renaturation of DNA; Biologically important nucleotides.

Practical

1. Qualitative identification of carbohydrates
2. Qualitative tests for protein identification
3. Detection of lipids
4. Isolation of casein from milk.

Mark distribution of practical for end semester examination

1. Major Experiment	25
2. Minor experiment/spotting (2 slides/models)	20
4. Laboratory record	10
5. Viva voce	20
TOTAL	75

Suggested readings

1. Lehninger's Principles of Biochemistry – Nelson DL and Cox MM; Macmillan Pub.; 8th Edition (2008).
2. Molecular cell biology – Lodish H, Berk A & Matsudaira P; WH Freeman & Co.; 5th Edition (2003).
3. Molecular Biology of the Cell – Alberts B, Lewis A, Lewis J, Raff M, Roberts K & Walter P; Garland Publications; 4th Edition (2002).
4. Biochemistry - Satyanarayana U; Reed Elsevier India Pvt. Ltd & Books and Allied Pvt Lmt. India; 4th edition (2013)
5. Essentials of Biochemistry - Jain AI; S. Chand publications; 2nd edition (2004).
6. Biochemistry Laboratory: Modern Theory and Techniques – Rodney B; Boston, Mass Prentice Hall; 6th Edition (2012).

Medical Biotechnology

BIOT/MJ/204
Credits: 4

Theory

Unit I. Introduction to medical biotechnology; gene therapy- types, vectors (viral and non-viral) used in gene therapy. Case studies and ethical issues in gene therapy.

Unit II. Vaccine technology: Role and properties of adjuvants; nucleic acid vaccines; protein-based vaccine; cell-based vaccine, plant-based vaccines, peptide vaccines, conjugate vaccines; reverse vaccinology.

Unit III. Introduction to tissue engineering; triad of tissue engineering; cell sources and culture; artificial skin- anatomy of skin, wounds, methods of skin repair and replacement; organ transplantation; social and ethical issues.

Unit IV. Prenatal diagnosis - non-invasive, invasive methods, pre-implantation genetic testing; post-natal diagnosis - newborn screening; carrier screening; pre-symptomatic testing; genetic counselling.

Suggested readings

1. Medical Biotechnology – Pongracz J & Keen M; Churchill Livingstone; 1st Edition (2009).
2. Medical Biotechnology – Boyle P, Henningfield J & Gray N; Oxford University Press, USA; (2010).
3. Medical Biotechnology – Jogdand SN; Himalaya Publishing House; (2011).
4. Gene Therapy – Colavito MC; Benjamin-Cummings Publishing Company; 2nd Edition (2006).
5. Understanding the Human Genome Project – Palladino MA; Benjamin-Cummings Publishing Company; 2nd Edition (2005).
6. The Human Genome: The Book of Essential Knowledge – Quackenbush J & Sulston J; Imagine! Publishing, An Imprint of Charlesbridge; (2011).
7. Tissue Engineering - Eberli D; Bod Third Party Titles; (2010)
8. Medical Biotechnology - Glick BR,Patten CL,Delovitch TL; ASM Press; (2013)
9. Tissue Engineering – Fisher JP, MIkos AG, Bronzino JD; CRC Press; (2019)

Biochemistry

BIOT/MJ/300
Credits: 4

Theory

Unit I Enzymes: classification, properties, mechanism; basic concepts of metabolism, glycolysis, citric acid cycle, bioenergetics, gluconeogenesis, electron transport chain.

Unit II. Biosynthesis and regulation of purine and pyrimidine nucleotides; salvage pathway for purine and pyrimidine nucleotides; degradation of purines and pyrimidines to uric acid and urea.

Unit III. Biosynthesis of amino acids - assimilation of ammonia into amino acids, intermediates, and different pathway of biosynthesis of amino acids; feed-back regulation of amino acid synthesis; urea cycle

Unit IV. Fatty acid biosynthesis and its regulation, triacylglycerol synthesis, membrane phospholipids and prostaglandins; sphingolipids, transport of fatty acid to mitochondria; ketone bodies.

Practical

1. Preparation of buffers.
2. Effect of pH and temperature on enzyme Activity.
3. Quantitative estimation of DNA.
4. Quantitative estimation of RNA.

Mark distribution of practical for end semester examination

1. Major Experiment	25
2. Minor experiment/spotting (2 slides/models)	20
4. Laboratory record	10
5. Viva voce	20
TOTAL	75

Suggested readings

1. Biochemistry – Stryer L; WH Freeman & Co.; 6th Edition; (2006).
2. Lehninger Principles of Biochemistry – Nelson LD & Cox MM; WH Freeman & Co.; 5th Edition (2008).
3. Practical Biochemistry: Principles and techniques – Wilson K & WalkerJM; Cambridge Univ. Press; 5th Edition (2000).
4. Fundamentals of Biochemistry: Life at the Molecular Level – Voet D, Voet JG & Pratt CW; John Wiley and Sons; 4th Edition (2012).
5. Enzyme Technology – Pandey A, Webb C, Soccol CR & Larroche C; Springer; (2006).
6. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins – Price NC & Stevens L; Oxford Publishers; 3rd Edition (1999).
7. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry – Palmer T & Bonner TM; Horwood Publications; 2nd Edition (2007).

Microbiology

BIOT/MJ/301
Credits: 4

Theory

Unit I. Introduction and scope of microbiology; classification of microorganisms; branches of microbiology; contribution of Lazaro Spallanzani, Louis Pasteur, Joseph Lister, Robert Koch, Edward Jenner and Alexander Fleming.

Unit II. Binomial nomenclature of microbes; salient feature of structure and properties of bacteria, archaea, fungi, protozoa and algae. Preparation of culture media; nutritional requirements of microorganisms - macronutrients, micronutrients and growth factors.

Unit III. Principle and techniques of sterilization; pure culture techniques. Staining techniques- gram staining, acid fast staining, negative staining; structural staining- capsule staining, flagella staining and endospore staining.

Unit IV. Microbial growth - definition and measurement methods (turbidity, dry weight, total cell and viable cell counts); growth phases; growth yields and kinetics; effects of physical and chemical factors on microbial growth.

Practical

1. Preparation of bacterial culture medium.
2. Sterilization of media, glass wares and heat labile chemicals.
3. Sampling of micro-organisms from air, soil or water.
4. Bacterial isolation-techniques- plating, serial dilution, spreading and streaking.
5. Identification of micro-organisms using morphological features, gram staining and acid-fast staining.

Mark distribution of practical for end semester examination

1. Major Experiment	25
2. Minor experiment/spotting (2 slides/models)	20
4. Laboratory record	10
5. Viva voce	20
TOTAL	75

Suggested readings

1. Microbiology: Concepts and Applications – Pelczar MJ, Chan ECS & Krieg NR; McGraw-Hill Inc., US; 6th Edition (1993).
2. Microbiology – Pelczar MJ, Chan ECS & Krieg NR; Mcgraw hill Education; 5th Edition (1993).
3. Microbiology Essentials – McCormick T; Research & Education Association (1998).
4. Microbiology: An Introduction – Tortora GJ, Funke BR & Case CL; Benjamin Cummings; 9th Edition (2006).
5. Practical Microbiology – Dubey RC, Maheshwari DK; S. Chand Publishing; 2nd Edition; (2002).
6. Analytical Techniques in Biotechnology – Bhowmik G & Bose S; Tata McGraw-Hill Education; 1st Edition (2010).

Plant and Animal Biotechnology

BIOT/MJ/302
Credits: 4

Theory

Unit I. Plant defence mechanism against environmental constrains; plant adaptations to biotic and abiotic stresses, plant genetic transformations (Indirect).

Unit II. Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance, shelf-life improvement, biofortification.

Unit III. Transgenic animals; embryonic stem cell and its applications. Molecular pharming; therapeutic proteins- production, classification and applications.

Unit IV. Introduction to animal breeding. Biotechnology for improvement of poultry and livestock - reproductive technologies (artificial insemination, multiple ovulation, embryo transfer, invitro fertilization).

Suggested readings

1. Plant Biotechnology: The genetic manipulation of plants – Slater A, Scott NW & Fowler MR; Oxford University Press; 2nd Edition (2008).
2. Fundamentals of plant tissue culture – Agarwal V; Oxford University Press; (2012).
3. Plant Biotechnology: Methods in tissue Culture – Keshavachandran R & Peter KV; Orient Blackswan; 2nd Edition (2008).
4. College Botany – Pandey B P; S. Chand Publications; 5th Edition (2009).
5. Biotechnology in Animal Husbandry – Renaville R; Springer; (2008).
6. Textbook of Animal Biotechnology – Yadav PR; Discovery Publishing House Pvt. Ltd. (2009).
7. Transgenic Animals in Agriculture – Murray JD; New India Publishing Agency; 1st Edition (2005).
8. Transgenic Animal Technology: A Laboratory Handbook – Pinkert CA; Academic Press; 2nd Edition (2002).
9. The Role of Biotechnology in Improvement of Livestock - Abubakar M, Ali Saeed A, OKul O; Springer Berlin, Heidelberg (2015)

Immunology

BIOT/MJ/304
Credits: 4

Theory

Unit I. History of immunology; Innate and acquired immunity; cells & organs of the immune system: Haematopoiesis; activation of B cells and T cells.

Unit II. Antibodies: basic structure, structural deduction, function and properties; different classes and biological activities of antibodies.

Unit III. Antigens; antigen – antibody interaction, factors affecting antigen-antibody interaction; epitopes; cytokines. Immunological techniques- precipitation, agglutination, immunodiffusion, immuno-electrophoresis- ELISA.

Unit IV. Hybridoma technology; major histocompatibility complex; hypersensitivity. Infectious diseases- tuberculosis, typhoid, malaria; autoimmunity- SLE, AIDS.

Practical

1. Determination of ABO blood group and Rh factor.
2. To perform total leucocyte count on the given blood sample.
3. To perform total RBC count on the given blood sample.
4. Determination of haematocrit level.

Mark distribution of practical for end semester examination

1. Major Experiment	25
2. Minor experiment/spotting (2 slides/models)	20
4. Laboratory record	10
5. Viva voce	20
TOTAL	75

Suggested readings

1. Roitt's Essential Immunology – Delves PJ, Martin SJ, Burton DR & Roitt IM; Wiley-Blackwell; 12th Edition (2011).
2. Kuby Immunology- W. H. Freeman & Co. Owen, J., Punt, J., Stranford, S., Jones, P. 8th Edition (2018).
3. Janeway's Immunobiology – Murphy K, Travers P & Walport M; Garland Publishing; 8th Edition (2011).
4. Immunology – Hannigan BM, Moore CBT & Quinn DG; Scion Publishing Ltd; 2nd Edition (2009).
5. Immunology and Immunotechnology – Pandian RM & Kumar SB; Panima publishing co. (2007).

Molecular Biology

BIOT/MJ/305
Credits: 4

Theory

Unit I. DNA as genetic material- experimental evidence; RNA as genetic material; DNA packing in prokaryotes, eukaryotes; c-value paradox. Central dogma of molecular biology.

Unit II. Semi-conservative replication of DNA; mechanism of DNA replication in prokaryotes. Transcription in prokaryotes; post transcriptional modification of RNA.

Unit III. RNA transport. Genetic code; translation in prokaryotes; post-translational modifications. Gene regulation- Lac operon, Trp operon.

Unit IV. Mutations – types, DNA damage and causes; Ames test. DNA repair mechanisms- single strand and double strand break repair.

Practical

1. Isolation of DNA from plant/animal tissues
2. Extraction of plasmid DNA from bacterial cell.
3. Qualitative analysis of DNA using agarose gel electrophoresis.

Mark distribution of practical for end semester examination

1. Major Experiment	25
2. Minor experiment/spotting (2 slides/models)	20
4. Laboratory record	10
5. Viva voce	20
TOTAL	75

Suggested readings

1. Cell Biology & Molecular Biology – De Robertis EDP & De Robertis EMF; Lippincott Williams and Wilkins; 8th Edition (2006).
2. Molecular cell biology – Lodish H, Berk A, Matsudaira P & Kaiser CA; WH Freeman & Co.; 8th Edition (2016).
3. Molecular Biology of the Cell – Alberts B, Lewis A, Lewis J, Raff M, Roberts K & Walter P; Garland Publications; 4th Edition (2002).
4. Molecular Biology of the Gene – Watson JD; Pearson Education; 6th Edition (2011).
5. Molecular Biology – Freifelder D; Narosa Book Distributors Pvt Ltd; 2nd Edition (2008).
6. Concepts of Genetics – Klug WS, Spencer CA, Cummings MR; Pearson Education; 10th Edition (2011).
7. iGenetics - A Molecular Approach - Peter J. Russell; Bemjamin Cumming publisher; 3rd Edition. (2010)

Bioinformatics and Biostatistics

BIOT/MJ/306
Credits: 4

Theory

Unit I. Bioinformatics- definition and history; components of bioinformatics. Introduction to biological database- nucleotide, protein and cluster databases; secondary databases; specialized genome databases.

Unit II. Introduction to sequences alignments - DNA and protein; ORF. Phylogenetic tree – rooted and unrooted, phenetics vs cladistics, cladogram and phylogram. Phylogenetic tree building methods (neighbor-joining, maximum parsimony, maximum likelihood method).

Unit III. Levels of measurement of data; primary and secondary data; graphical and diagrammatic data representations; classification and tabulation of data; measures of central tendency: mean, median, mode and dispersion.

Unit IV. Introduction to probability; distribution, tests of significance; t-test, chi square and F-test.; analysis of variance; correlation and regression.

Practical

1. Calculation of mean, median and mode.
2. Tests of significance; Z-test, t-test, Chi square and F-test.
3. Calculation of correlation and regression.
4. Nucleotide sequence retrieval and comparison using NCBI BLAST
5. Multiple sequence alignment and phylogenetic tree construction using Clustal.

Mark distribution of practical for end semester examination

1. Major Experiment	25
2. Minor experiment/spotting (2 slides/models)	20
4. Laboratory record	10
5. Viva voce	20
TOTAL	75

Suggested readings

1. Fundamentals of Biostatistics: Practical Approach – Dutta NK; Kanishka Publishers Distributors; 1st Edition (2004).
2. Elements of Biostatistics – Satguru Prasad; Rastogi publications; 3rd Edition (2018)
3. Genetics and Molecular Biology: With Fundamentals of Biostatistics – Hyde DR; Tata McGraw-Hill Education; 1st Edition (2010).
4. Introduction to Bioinformatics – Lesk A; Oxford University Press; 3rd Edition (2009).
5. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Ouellette BFF & Baxevanis AD; Wiley; 3rd Edition (2009).
6. Bioinformatics: Sequence and Genome Analysis – Mount DW; CBS Publisher; 3rd Edition (2005).
7. Bioinformatics and Functional Genomics – Jonathan Pevsner; Wiley publishing; 3rd Edition (2015)

Introduction to Nanotechnology

BIOT/MJ/307
Credits: 4

Theory

Unit I. Nanomaterials: Definition, atomic structure and size; different type of nanomaterials: One dimensional, two dimensional and three-dimensional nanostructured materials.

Unit II. Nanomaterials synthesis: top-down and bottom-up approach; understanding the size, shape, optical properties; toxicity evaluation; cell uptake; shape and dose dependant toxic effects.

Unit III. Characterization of nanomaterials: Spectroscopy (FTIR, UV-Vis, Fluorescence) Transmission Electron Microscope (TEM) and Scanning Electron Microscopy (SEM).

Unit IV. Application of nanotechnology in biology and medicine (gene, drug delivery and nano biosensors), interaction of nanoparticles with biomolecules and their implications.

Suggested readings

1. Introduction to Nanotechnology- Poole CP; Owens FJ; Wiley; (2012)
2. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications- Cao G; Wang Y; World Scientific; (2004)
3. Design of Nanostructures: Self-Assembly of Nanomaterials- Bohidar HB and Rawat K; Wiley VCH; (2017)
4. The Essentials: Understanding Nanoscience and Nanotechnology- Pradeep T; Nano: McGraw-HillEducation; (2007)

Cell signalling and communication

BIOT/MJ/400
Credits: 4

Theory

Unit I. Cellular communications: General principles; cell-cell or cell-matrix communication (cell junctions, anchor junctions, gap Junctions, tight junctions.

Unit II. Cell signalling-I - types and stages; hormones receptors, cell surface receptor, signalling through G-protein coupled receptors, signal transduction pathways (GPCR pathways, RTK pathways, and gated ion channels),

Unit III. Cell signalling-I - Secondary messengers, regulation of signalling pathways, bacterial and plant two-component signalling systems, bacterial chemotaxis, and quorum sensing.

Unit IV. Intracellular trafficking - trafficking of biomolecules (protein and nucleic acids) within intracellular compartments (mitochondria, chloroplast, nucleus, endoplasmic reticulum, Golgi bodies).

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Suggested readings

1. The Cell: A Molecular Approach- Cooper GM; Hausman RE; (2013).
2. Biochemistry and Molecular Biology of Plants- Buchanan BB; Wiley; (2015).
3. Cell Biology & Molecular Biology – De Robertis EDP & De Robertis EMF; Lippincott Williams and Wilkins; 8th Edition (2006).
4. Molecular cell biology – Lodish H, Berk A, Matsudaira P & Kaiser CA; WH Freeman & Co.; 8th Edition (2016).
5. Molecular Biology of the Cell – Alberts B, Lewis A, Lewis J, Raff M, Roberts K & Walter P; Garland Publications; 4th Edition (2002).

Genomics and Proteomics

BIOT/MJ/401
Credits: 4

Theory

Unit I. Next Generation Sequencing, post sequencing studies - genome sequence assembly, analysis and interpretation of DNA Sequence; annotation; homology.

Unit II. Applications of genomics - functional and structural genomics, metagenomics, epigenetics, pharmacogenomics, personal genomics.

Unit III. Expression proteomics: Gel based proteomics (SDS-PAGE, 2D-PAGE, DIGE, Native PAGE), gel label free proteomics (basic), protein sequence identification tools (MALDI-TOF MS).

Unit IV. Functional proteomics (protein-protein interaction, gene-protein interaction), structural proteomics. Application of proteomics: Gene expression analysis (transcriptomic such as microarray, real time PCR and RNA seq).

Suggested readings

1. Modern Biotechnology- Primrose SB; Blackwell Publishing; 2nd Edition (1987).
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Glick BR; Pasternak JJ & Patten CL; 4th Edition (2010)
3. Molecular Cloning: A Laboratory Manual- Sambrook and Russell; 3rd Edition Vol. I to III (1989).
4. Principles of Gene Manipulation- Primrose SB; Twyman RM & Old RW; Blackwell Science; 6th Edition (2001).
5. Concepts of Genetics- Klug WS; Cummings MR; Spencer CA; Cummings B ; 9th Edition (2009).
6. iGenetics: A Molecular Approach- Cummings B; Russell PJ; 3rd Edition (2009).
7. Molecular Biotechnology: Principles and Applications of recombinant DNA- Glick BR; Pasternak JJ; ASM Press, Washington; (2003).
8. Bioinformatics and Functional Genomics- Pevsner J; John Wiley & Sons; 2nd Edition (2009).

Molecular basis of human diseases

BIOT/MJ/402
Credits: 4

Theory

Unit I. Molecular basis of cancer: Proto-oncogenes and tumor suppressor genes; structure and function of tyrosine-protein kinases, Src, Raf kinase, Ras proteins, c-Myc; p53, BRCA.

Unit II. Genetic basis of disorders: hypercholesterolemia; sickle cell anaemia; Tay-Sachs disease; thalassemia, cystic fibrosis, phenylketonuria; alkaptonuria; fragile X syndrome.

Unit III. Disorders of Human Immune System: Autoimmunity and autoimmune diseases, allergy and hypersensitivity. Cytokine-related diseases Congenital and acquired immunodeficiencies.

Unit IV. Genetic susceptibility to infectious diseases; human diseases database; animal models for the study of human diseases; research and development in human diseases.

Suggested readings

1. Basic Science of Oncology – Tannock I; Hill R; Bristow R; Harrington L; McGraw Hill; 5th Edition (2013).
2. *A* History of Infectious Diseases and the Microbial World - Magner LN; Praeger Publishers (2009).
3. Kuby Immunology- Owen J; Punt J; Stranford S; Jones PWH; Freeman & Co; 8th Edition (2018).
4. Approaches to Gene Mapping in Complex Human Diseases - Wiley H & Pericak (2006).
5. Thompson& Thompson Genetics in Medicine- Roderick RM and Huntington FW (2007).

Plant and Animal Tissue Culture Techniques and its application

BIOT/MJ/405 & 408
Credits: 4

Theory

Unit I. Introduction to plant tissue culture and its application: plant tissue culture media, micropropagation and application; somatic embryogenesis; somatic cell hybrids.

Unit II. Basic concept of breeding and advanced genome editing technologies; Somatic cell hybrids and their application, production of haploid plants and their utilization.

Unit III. Introduction to animal cell culture technology; aseptic technique-physical & chemical; biosafety levels. Media- basic components of culture media; natural and artificial media.

Unit IV. Sources of cell line; types of cell culture; cell adhesion molecules; maintenance of cell lines; growth response curve; cytotoxicity and viability assay. Cell line banking and authentication.

Practical

1. Explant preparation for callus induction.
2. Induction of callus from explant.
3. Maintenance of animal cell culture.
4. Estimation of viable cells using trypan blue viability test method.

Suggested readings

1. Plant Tissue Culture: Techniques and Experiments- Smith RH; Academic Press, San Diego; (1992).
2. Plant cell culture- Dixon RA and Gonzales RA; Oxford University Press; (2006).
3. Culture of Animal Cells- Freshney RI; Alan R. Liss, Inc., New York; 2nd Edition (1987).
4. Animal Cell Biotechnology: Methods and Protocols- Portner R; Humana Totowa NJ Press; 3rd Edition (2013).
5. Reproductive Techniques in Farm Animals- Gordon IR; CABI Publishing; 2nd Edition (2004).
6. Animal Cell Biotechnology- Spier RE and Griffiths JB; Academic Press Inc. London Ltd.; Vol I & II (1985).

Research Methodology

BIOT/MJ/406 & 409
Credits: 4

Theory

Unit I. Literature survey and review, impact factor and citation index. Identification and scope of research problems; design of experiments; data management. Scientific writings; plagiarism.

Unit II. Handling of biohazardous substances, disposal of biohazardous waste; biosafety issues - chemical, radiation, recombinant DNA, biological materials.

Unit III. Statistical methods: measurements of central tendency, standard deviation, standard error, student's t-Test, Chi square test, null hypothesis, correlation, regression.

Unit IV. Introduction to search engine/Data Base: NCBI, EMBL, DDBJ, SwissProt, TIGR. Multiple sequence alignment, phylogenetic analysis, primer designing.

Suggested readings

1. Statistical Methods in Biology- Bailey NTJ; Cambridge University Press, New York; 3rd Edition (1997.
2. Thesis and Project Work: A guide to research and writing- Parsons CJ; George Allen and Unwin Ltd, London (1973).
3. Biotechnology, Biosafety and Biodiversity: Scientific and Ethical isues for sustainable Development- Sivraiah; Shantharam; Jane FM; Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi (1999).
4. How to Write and Illustrate Scientific Papers- Bjorn G; Cambridge University Press, UK; 2nd edition (2008).
5. Scientists Must Write- Robert B; Chapman & Hall, London (2000).
6. Essentials of Computer Fundamentals- Rajagopalan K; CBS Publishers and Distributors, New Delhi; (1991).
7. Bioinformatics: Sequence and Genome Analysis- Mount DW; Cold Spring Harbor Laboratory Press, New York, USA; 2nd edition (2001).
8. Biotechnology, Biosafety and Biodiversity. Scientific and Ethical Issues for Sustainable Development- Shantharam S; Montgomery JF; Oxford and IBH Publishing Co., New Delhi; (1999).

Food and Industrial Biotechnology

BIOT/MJ/410
Credits: 4

Theory

Unit I. Global food scenario & food security; application of plant genetic engineering - crop improvement, Biotic (herbicide resistance, insect resistance and virus resistance) stress resistance crops.

Unit II. Food fortification- high fructose syrup, invert sugars; flavour enhancers: nucleosides, nucleotides and related compounds; organic acids (citric acid, acetic acid)

Unit III. Food processing- food fermentations; Industrially important microorganisms and their products - vinegar and cheese, citric acid, amino acids, amylases, proteases, vitamin B12.

Unit IV. Downstream processing of products– extraction, separation, concentration, recovery & purification; use of thermophilic microorganisms in industrial biotechnology

Suggested readings

1. Food Sciences and Food biotechnology – Lopez GFG, Canaas G & Nathan EV; CRC Press; (2003).
2. Principles of Food and Biotechnology – Singh B; Vista International Publishing House; (2011).
3. Fundamentals of Food Biotechnology – Lee J, Lee BH & Lee BH; Wiley-Interscience; (1996).
4. Technology of Food Processing Industries – EIRI Board, Engineers India Research Institute; (2011).
5. Microbiology: Concepts and Applications – Pelczar MJ, Chan ECS & Krieg NR; McGraw-Hill Inc., US; 6th Edition (1993).
6. Prescott and Dunn's Industrial Microbiology – Reed G; CBS Publishing; 4th Edition (2005).
7. Industrial Microbiology – Patel AH; Macmillan Publishers India (2007).
8. Industrial Biotechnology – Yadav PR & Tyagi R; Discovery Publishing House Pvt. Ltd; 1st Edition (2005).

MOLECULAR ONCOLOGY

BIOT/MJ/411
Credits: 4

Theory

Unit I. Cancer - definition; origin of neoplastic cells; causes of cancer - chemical carcinogens, radiation carcinogens, infectious agents; heredity carcinogenesis.

Unit II. Oncogenes - their role in cancer; mechanism of oncogenes activation; tumor suppressor genes; cell cycle regulation - mutations affecting the cell cycle, loss of check point control and genetic instability.

Unit III. Apoptosis in cancer; tumor angiogenesis; invasion and metastasis; Types of cancer – leukemias, lymphomas, carcinomas and sarcomas.

Unit IV. Tumor markers; immunotherapy and its limitations; tumour cell evasions of immune defenses; principles of chemotherapy and chemoprevention; molecular targeting.

Suggested readings

1. Principles of Cancer Biology – Lewis JK; Pearson Education, Benjamin Cummings (2005)
2. The molecular Biology of Cancer - Stella P and Micheal K; Wiley- Blackwell (2006)
3. Molecular Biology of Human Cancer – Wolfgang AS; Springer (2005)
4. Cancer Biology - Raymond W

Biosafety, Bioethics and IPR

BIOT/MJ/412
Credits: 4

Theory

Unit I. Biological safety cabinets & their types; primary containment for biohazards; Biosafety levels of specific microorganisms. Biosafety guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- concerns and challenges.

Unit II. Bioethics-Introduction. Animal ethics, biotechnology and ethics, ethical issues related to research in embryonic stem cell cloning. Ethical, Legal and Social Implications (ELSI) of Human Genome Project.

Unit III. Intellectual Property Right (IPR)- definition; types- patents, trademark, design, copyrights; geographical indication; nature and importance of IPR; patent classification- International Patent Classification (IPC), Cooperation Patent Classification (CPC).

Unit IV. Introduction to Indian Patent Law; patentability criteria and patentable subject matter; application for patents; international agreements linked to IPR (Trips agreement; Patent cooperation treaty. Patent cases studies- neem tree, basmati rice, turmeric.

Suggested readings

1. Biological Safety: Principles and Practices - Diane OF; Debra LH; ASM; 4th Edition (2006)
2. Intellectual Property Rights in Frontier Industries: Software and Biotechnology – American Enterprise Institute Press (2005).
3. Intellectual Property Rights: Basic Concepts – Karki MMS; Atlantic; 1st Edition (2009).
4. Ethical Biotechnology – Kerun M; Global Vision Publishing House; (2004).
5. Bioethics and Biosafety in Biotechnology - Sree KV; New Age International (P) Ltd., Publishers (2007).