Syllabus for B.Sc.(Biotechnology)
SEP- 2024

Semester I								
Sl. No	**Course Code**	**Title of the Course**	**Category of Courses**	**Teaching Hours per Week**	**SEE**	**IA**	**Total Marks**	**Credits**
1		Cell Biology and Genetics	Theory	4	80	20	100	3
2		Cell Biology and Genetics practical	Practical	4	40	10	50	2
Semester II								
3		Biochemistry and Biophysics	Theory	4	80	20	100	3
4		Biochemistry and Biophysics Practical	Practical	4	40	10	50	2
SEMESTER III								
5		Microbiology and Immunology	Theory	4	80	20	100	3
6		Microbiology and Immunology practical	Practical	4	40	10	50	2
SEMESTER IV								
7		Molecular Biology and Recombinant DNA Technology	Theory	4	80	20	100	3
8		Molecular Biology and Recombinant DNA Technology Practical	Practical	4	40	10	50	2
SEMESTER V								
9		Plant Biotechnology	Theory	4	80	20	100	3
10		Animal Biotechnology	Theory	4	80	20	100	3
11		Plant Biotechnology	Practical	4	40	10	50	2
Semester VI								
12		Bioprocess and Environmental Biotechnology	**Theory**	**4**	**80**	**20**	**100**	**3**
13		Biostatistics and Bioinformatics	**Theory**	**4**	**80**	**20**	**100**	**3**
14		Bioprocess, Environmental Biotechnology, Biostatics and Bioinformatics Practical	Practical	4	40	10	50	2

Core Courses

SEMESTER-I

Code :CELL BIOLOGY AND GENETICS 56 hours

Course Outcomes: After successful completion of this Course, students will be able to:
CO 1. Understand concepts of Biotechnology and demonstrate knowledge acquired in interdisciplinary skills in cell biology, genetics, biochemistry, microbiology, and molecular biology
CO 2. Describe the ultrastructure of cells, structure and function of organelles, cytosol and cytoskeleton
CO 3. Understand phases of cell cycle, cell division, reductional division in gametes, molecular mechanisms that regulate life and death of a cell including programmed cell death or apoptosis and cell cycle regulation.
CO 4. Comprehend organization and structure of chromosomes, and Mendelian laws of inheritance, deviations and exceptions to these laws.
CO 5. Describe mutations at the molecular level, types of mutations, genetic or hereditary disorders and concepts in population genetics

UnitI (14 hours)

Discovery of cell, the cell Theory, classification of cell types. Levels of organization in cell biology: cell, tissue, organs and organism. Ultra structure of a eukaryotic cell- (Both plant and animal cells),Surface Architecture: Structural organization and functions of plasma membrane and cell wall of eukaryotes. Cellular Organelles: Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin). Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments)

UnitII (14 hours)

Chromosomes and cell division: General Introduction, Discovery, Morphology and structural organization –chromatids, Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype. Nucleosome organisation. Special type of chromosomes: Salivary gland and Lamp brush chromosomes.
Cell Division: Cell cycle, phases cell division. Mitosis and meiosis, regulation of cell cycles cell cycle checkpoints. Significance of cell cycle,synaptonemal complex.Cell Senescence and programmed cell death.

UnitIII (14 hours)

Mendelian laws of inheritance - dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross. Deviations to Mendelian inheritance, complementary, supplementary and interaction of genes (13:3 ratio), epistasis, polygenic inheritance and multiple alleles.
Maternal Inheritance: Extrachromosomal inheritance, mitochondria and chloroplast genetic systems.Sex-linked inheritance, Chromosome theory of inheritance.
Sex determination in plants and animals: Concept of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types.

UnitIV **(14 hours)**

Finestructureof gene-recon,mutonand cistron.

Mutations: Types of mutations, Spontaneous and induced mutations, Mutagens chemicalandphysicalmutagens,inducedmutationsin plants and microbes and its applications.

Structural and numerical aberrations of chromosomes; evolutions of wheat, and cotton

Hereditary defects: Kleinefelter, Turner, Cri-du- Chat and Down syndromes. Analysis of mutations in Biochemical pathways, one gene - one enzyme hypothesis. Population genetics: Hardy- Weinberg equilibrium, gene, genotypes and gene frequencies.

References

DaleJW.1990.*Molecular genetics of Bacteria*.John Wileyand Sons.

DeRobertisEDPandDeRobertisEMF.1995.*CellandMolecularBiology*.8th edition, BI Waverly Pvt.Ltd., New Delhi.

Gardner*etal*.2003.*PrincipleofGenetics*-8th edition.JohnWileyandSons,New York.

GuptaML.andML.Jangir.2002.*CellBiology-FundamentalsandApplications*. Argosies, Jodhpur, India.

Lewin B.1994. *GenesVII*5th edition. Oxford University Press,London.

PowarCB.*CellBiology*3rd edition.HimalayaPublishingHouse,Mumbai.

Rajeshwari S Setty and V.Sreekrishna.2002.*Biotechnology*-2(Cellbiology, Genetics, Microbiology). New Age International Publishers, New Delhi.

TaylorDJ.GreenNPOandStoutGW.1998.*BiologicalScience*3rd Edition, Cambridge edition, Cambridge University Press, UK.

Sub Code :CELL BIOLOGY AND GENETICS PRACTICAL

1. Study and maintenance of simple and compound microscope
2. Use of Micrometer and calibration, measurement of onion epidermal cells
3. Study of divisional stages in mitosis from onion root tips
4. Study of divisional stages in meiosis in grasshopper testes/onion or Rheo flower buds.
5. Salivary gland chromosome isolation and staining.
6. Buccal smear – Barr bodies
7. Counting of RBC/WBC by Haemocytometer.
8. Karyotype analysis
9. Isolation of chloroplast.
10. Study of drosophila.
11. Separation of drosophila eye pigment by paper chromatography
12. Simple genetic problems based on theory

SEMESTER–II

Sub Code :BIOCHEMISTRY AND BIOPHYSICS 56 hours

Course Outcomes (COs): At the end of the course the student should be able to:

CO 1. Acquire knowledge about types of biomolecules, structure, and their functions

CO 2. Will be able to demonstrate the skills to perform bioanalytical techniques

CO 3. Apply comprehensive innovations and skills of biomolecules to biotechnology field

Unit I ` **(14 hours)**

Aimsand scopeof biochemistryand biophysics

General classification, structure and functions of biomolecules: carbohydrates, proteins,lipids and nucleic acids. Detailed structure and general properties of monosaccharides, glycosidic bond; structural polysaccharides - cellulose, chitin, peptidoglycans; storage polysaccharides - starch, glycogen. Classification of standard amino acids, peptide bonds, general properties of amino acids, titration curve. Protein structure - primary, secondary, tertiary and quaternary with examples.

UnitII **(14 hours)**

Enzymes: History, general properties, active site, Michelis Mentonequation,allosteric enzymes; nomenclature and classification. Enzyme inhibition types- reversible, non-competitive and uncompetitive with examples. Multienzyme and isoenzyme with examples. Brief account of applications enzymes: enzymes in genetic engineering - restriction enzymes and polymerases; enzymes in clinical significance - LDH, SGOT, SGPT and diagnostic kits.

UnitIII **(14 hours)**

Structure and function of water, pH impact on biomolecular reactions, Handerson and Hasselbach's equation with applications. Buffers- types and applications. Laws of thermodynamics, free energy, ATP as biological energy currency.

Lambert - Beer's law, absorption spectrum, absorption maxima. UV-Vis spectroscopy; mass spectroscopy, atomic absorption spectroscopy with applications. Brief account of principles and applications to understand the structure of molecules: X-ray crystallography and NMR.

UnitIV **(14 hours)**

Microscopy: Magnification, Resolution power, Optical - Bright field, dark field, phase contrast and fluorescence; Electron microscopy - TEM and SEM. Partition coefficient, Paperandthinlayerchromatography-principle,methodology,applications and significance of Rf value. Gel filtration chromatography, affinity chromatography, gas liquid chromatography and high performance liquid chromatography. Principle, procedure and applications of electrophoresis- agarose and polyacrylamide gel electrophoresis. Centrifugation: differential, density gradient and ultra - principle, instrumentation and applications

References

AroraMP.2007.*Biophysics.*Himalaya PublishingHouse,NewDelhi.

Bialek W. 2012. *Biophysics: Searching for Principles*. Princeton University Press.

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LeningerAL,NelsonDLandCoxMM.1993.*PrincipleofBiochemistry.*CBSPublications. Nickolas CPL.1982. *Fundamentals of Enzymology*. Oxford Publishers.

StryerL.1988.*Biochemistry*3rdedition,Freeman&Co,New York.

Trevor.Enzymebiochemistry,BiotechnologyandClinicalChemistry.HarwoodPublishers.

UpadhyayandUpadhyay A.2000.*BiophysicalChemistry-PrinciplesandTechniques*. HimalayaPublishers,NewDelhi,

ZubayJ.1988. *Biochemistry*2ndedition.MacMillanPublishingCompany,NewYork.

Sub Code :BIOCHEMISTRY AND BIOPHYSICS PRACTICAL

1. Introduction to basic instruments (Principle, standard operating procedure) with demonstration.
2. Microscopy
3. Preparation of standard buffers– Citrate and phosphate, determination of pH of solution using pH meter.
4. Qualitativetestsforcarbohydrates-monosaccharides,disaccharidesandpolysaccharides.
5. Qualitative tests for proteins.
6. Estimation of maltose by DNS method
7. Determination of α-amylase activity by DNS method
8. Estimation of proteins by Lowry's and Biuret method
9. Lambert – Beer's law
10. Absorption maxima of a solution
11. Paper chromatography
12. Thinlayerchromatography
13. Gel Electrophoresis

SEMESTER–III

Sub Code :MICROBIOLOGY AND IMMUNOLOGY 56 hours

After successful completion of this Course, students will be able to:

CO 1. Understand Historical prospective and scope Microbiology

CO 2. Experiment with various methods of sterilization in microbiological work

CO3. Prepare different types of media, perform culture methods, preservation of microorganisms for isolation, characterization of microbes

CO 4. Handle and use antimicrobial agents and perform anti-microbial assays

CO 5. Demonstrate the Laboratory skills in basic and applied microbiology with reference to technological aspects.

CO6.Demonstrate comprehension of the underlying structure and function of the immunesystem and related disorders.

CO 7. Demonstrate an understanding of the role of cells and molecules in immune reactions and responses

CO8. Demonstrate technical skillsin immunological tools and techniques

CO 9. Explain the fundamental concepts of immunity, and the contributions of the organs and cellsin immune responses.

CO 10. Realize how the MHC molecule's function and host encounters an immune insult.

CO 11.Understand the antibodies and complement system

CO12. Comprehend the overreaction by our immune system leading to hypersensitive conditions and its consequences

UnitI (14 hours)

Aim, scope and historical perspectives of microbiology. Contributions of early microbiologists: Leeuvenhoek, LouisPasteur,RobertKoch andEdwardJenner.General classification of microbial kingdom - classical, nutritional and molecular approaches. Conceptsof sterilization and disinfection: dry heat, moist heat, radiation, chemical and filtration. Introductive concepts in virology- classification, structure and life cycle - lysogenic and lytic cycle.Antibiotics:classification and mode of action.

UnitII (14 hours)

Prokaryotic and eukaryotic microbesand theircharacteristics.Structureand functions of microbial cell wall, lipopolysaccharides, flagella, capsules, endospores, pili (fimbriae), cell membranes and cell inclusions.

Culture Media: Components of media, natural and synthetic media, selective, differential, indicator, enriched media.

Pure culture methods: Serial dilution and plating methods (pour, spread, streak); maintenance and preservation/stocking of pure cultures

Microbes in extreme environments- thermophiles, psychrophiles, acidophiles, alkaliphiles, halophiles and barophiles. Microbe -microbe interactions.

UnitIII (14 hours)

Historical perspectives in immunology, Origin and diversity of immunology. Classificationofimmunity:innateandadaptiveimmunity. Immune systems:organs,cells ofimmune system. Role of B cell and T cell in humoral and cell mediated immunity.Majorhistocompatibilitycomplexes(MHCs)-types,structureandtheir functions.Structure, types and functions of antigens. Haptenes and adjuvants, Structure, types and functions of antibodies.

UnitIV (14 hours)

Antigen-antibodyreactions - precipitin test, agglutination test, complement fixation (or complement cascade) reaction and ELISA. Immunoblot - types, principle and applications. Immunological disorders -autoimmune diseases - Brief descriptions of two autoimmune diseases- Rheumatoid arthritis and myasthenia gravis. Acquired immunodeficiency syndrome: description of causative agent, and briefly description of mechanisms. Hypersensitivity and allergy. Vaccines-classical and modern.

References

AbbasA, Lichtman AHand Pillai S. 2015.*Cellular and Molecular Immunology.*Elsevier Saunders Co.

BrockTBandMadigon.1988.*BiologyofMicroorganisms*.PrenticeHall,NewJersey. Cassida, L.E. 1968. *Industrial Microbiology*John Wiley & Sons.

Ivan Riott JonathanBrostoffandDavidMale.*Immunology*3rdedition.MosbyPublishers. Janeway and Travers.*Immunobiology* 3rd edition. Churchill Livingstone Publications.

KubyJ. 2000. *Immunology*.Freemanand CompanyPublishers.

Maloy SR. Friefelder 1994. Microbial Genetics. Jones and Bartlett Publishers.PelczarJ.andChanECS.1993.*ElementofMicrobiology*MacGrawHill,NewYork.

PelczarMJ,ReidRDandChanECS.1997.*Microbiology,dynamicsanddiversity*.Haricot Brace College Publishers.

PrescottLM,HarleyJKandOxfordDA.1993.*Microbiology*.WMCBrownPublishers, USA.

SchlegelHarisG.1988.*GeneralMicrobiology*6thedition. CambridgeUniversityPress, UK.

Sharma PD.1991.*Microbiology*, Rastogi Publications, Meerut.

Subba Rao N.S. 1974. *Soil Microbiology*, 4th edition, Oxford & IBH Publishers, New Delhi

Torture GJ, Frank BR, and CaseCL.1992. *Microbiology- An Introduction.*Communing Publishing Company Inc, California.

Sub Code :MICROBIOLOGY AND IMMUNOLOGY PRACTICAL

1. Instrumentation and microscopy with special reference to microbiology andimmunology.
2. Sterilization techniques – dry heat sterilization with hot air over, wet heat sterilization with autoclave, membrane filtration and assessment for sterility
3. Preparation of culture media for bacteria, fungi and their cultivation
4. Plating technique –pour plate and spread plate
5. Isolation of microorganisms - air, water, human body and soil.
6. Study of bacterial colony characteristics.
7. Purification of bacterial and fungal cultures using streak plate technique/mycelial bit transfer
8. Culture preservation techniques – slant and stab culture
9. Staining of microorganisms - Gram staining, capsule staining, spore staining, negative staining.
10. Biochemical activitiesofmicroorganisms -indole,methyl red,VogesProskauerandcatalase tests.Starch hydrolysis, Catalase test, Gelatin hydrolysis
11. Antibioticsensitivityof microorganisms. .
12. Blood grouping and Rh factor determination.
13. Studyofdifferenttypesofleucocytes.
14. Immunodiffusionstudies.
15. Dot ELISA

SEMESTER-IV

Sub Code :MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
56 hours

Course Outcomes (COs): At the end of the course the student should be able to:

CO 1. Study the advancements in molecular biology with latest trends.

CO 2.Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids.

CO 3. Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms.

CO 4. Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.

CO 5. Apply the knowledge of genetic engineering to diverse applications in agriculture, medicine, biotechnology, and environmental science.

CO 6. Perform laboratory procedures and develop practical skills in genetic engineering techniques.

CO 7. Evaluate genetic engineering's ethical, social, and legal implications and propose responsible solutions.

CO 8. Stay updated with recent advancements in genetic engineering, critically evaluate emerging trends, and assess their potential impact on various fields.

UnitI **(14 hours)**

Discovery, structure and types of DNA and RNA. Experiments on DNA as genetic material. ReplicationofDNAinprokaryotesandeukaryotes.– Enzymes and proteins involved in replication, Theta model and rolling circle model. Polymerases and all enzyme components.Mechanisms of DNA recombination in prokaryotes and eukaryotes. DNA damage and Repair mechanism: photo reactivation, excision repair, mismatch repair and SOS repair.

UnitII **(14 hours)**

Structureofprokaryoticandeukaryotic genes.Cerntral dogma of molecular biology. Transcription in prokaryotes RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, mechanism of transcription initiation, promoter clearance, elongation and termination. Post transcriptional modification. RNA splicing and processing: Genetic code and its characteristics, Translation- in prokaryotes and eukaryotes.Prokaryoticgeneexpression- *lac* And*trip*..

UnitIII **(14 hours)**

Aims, objectives and scope of gene cloning and steps involved recombinant DNA technology. Isolation and purification of DNA from bacterial, plant and animal cells. Tools of DNA modification: restrictionenzymes-properties,classification,typeswithexamples;ligation,DNAmodifying enzymes.DNA vectors: plasmids, bacteriophages,cosmids, BAC, YAC,plant and animal viruses. Gene transfer technique.

UnitIV **(14 hours)**

Genomic and cDNA libraries: features, construction and application. Screening and selection of recombinants by selection media, insertional inactivation. PCR- principle, protocol and applications. DNA sequencing- Sanger's, next generation sequencing. Gene editing techniques principle and applications. Blotting techniques: Southern, Northern and Western-principle and applications. Probes - types, preparation and application. DNA finger printing-principle and applications. Hazards and biosafety measures for recombinant DNA technology and GMOs.

References

Alberts B, Bray D, Lewis J, Raff M, Roberts K and Watson JD. 2002. *Molecular Biology of the Cell* 4th edition. Garland Publishing, Inc., New York.

Cooper GM. 2000. *The Cell - A Molecular Approach* 2nd edition. Sunderland (MA): Sinauer Associates, Inc.

De Robertis EDP and De Robertis EMF. 1995. *Cell and Molecular Biology*. 8th edition, BIWaverly Pvt.Ltd., New Delhi.

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PrimroseSB,RichardM.TwymanRMandOldRW.2002.*PrinciplesofGeneManipulation* 6th edition.Blackwell Publishers.

Watson JD, Gilman M, Witkowski J and Zoller M. 1992. *Recombinant DNATechnology* 2nd edition.Scientific American Books, New York.

WatsonJD*etal*.1987.*MolecularBiologyofgene*.4th edition.BenjaminCumming Publishers,

WilsonK.andWalkerJ.2005. *Principls andTechniquesofBiochemistryandMolecular Biology*6th edition. Cambridge UniversityPress.

Sub Code :MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY PRACTICAL

1. Preparation of DNA model
2. IsolationofDNAfrombacteria,plantandanimaltissues.
3. Isolation of RNA
4. TestsforDNA/RNA/proteinsisolatedfromtissues
5. Estimation of DNA by DPA method
6. Estimation of RNA by Orcinol method
7. Column chromatography – gel filtration (Demo)
8. Agarose gel electrophoresis to separate DNA
9. SDSPAGE
10. ligation
11. Restriction digestion
12. Bacterial transformation
13. Western blotting technique

SEMESTER-V

Sub Code : PLANT BIOTECHNOLOGY 56 hours

Course Outcomes: After completing this course, the student is expected to learn the following:

CO 1. Demonstrate a comprehensive understanding of plant biology, physiology, genetics, andmolecular biology.

CO 2. Explore methods of introducing foreign genes into plants through transformation techniques.

CO 3. Gain practical skills in plant tissue culture for improvement.

CO 4. Design strategies for plant genetic manipulation against biotic and abiotic stressors.

CO 5. Hypothesize strategiesto increase plant yield and fruit/seed quality.

CO 6. Apply biotechnological tools and techniques used in plant research and agriculture, such asplant tissue culture, genetic engineering and transgenics.

CO 7. Execute plant tissue culture techniques for callus induction, somatic embryogenesis, andmicropropagation, and apply them in plant breeding and propagation.

CO 8. Perform plant transformation methods and demonstrate the ability to introduce foreign genesinto plants using different techniques.

CO 9. Apply knowledge about ethical considerations and regulatory frameworks associated with plant biotechnology and genetically modified crops.

Unit I (14 hours)

History of plant tissue culture, technical terms and definitions in tissue culture. Establishing sterile cultures - plant tissue culture lab set up, sterilization methods for instruments and explants. Tissue culture media, plant growth regulators. Principles, methodology and applications of clonal or micropropagation– axillary bud culture, shoot tip culture, mesistem and mericlone culture. Haploid culture-principle, protocol and applications. Embryo culture – types, principle, protocol and applications. Embryo rescue.

Unit II (14 hours)

Callus induction, introduction to the process of embryogenesis- types and organogenesis. Synthetic seeds- principle, protocol and applications. Somaclonal variations- introduction, types, process, factors affecting process and applications. Single cell suspension cultures - types, methods, viability tests and applications. Secondary metabolites - introduction, classification, production *invitro* methods and applications. Cryopreservation of plant tissues -introduction, principle, types, protocol and applications.

Unit III (14 hours)

Protoplast-introduction, principle ;isolation methods-mechanical, enzymatic. CPW medium, source of enzymes. Isolation of protoplasts from intact tissue, callus, suspension cultures and haploid cells - protocols. Testing the viability of isolated protoplasts. Various steps and methods involved in the regeneration of protoplast. Markers used in the selection of hybrid cells. Somatic hybridization - introduction, principle, protocol; hybrids and cybrids. Protoplast fusion methods: chemical and electrical. Applications of protoplasts, hybrids and cybrids.

Unit IV **(14 hours)**

Genetic manipulations of plant cells- single cells, protoplasts protocols and applications. Structure of *Agrobacterium tumefaciens*, tumour formation in monocots and dicots, reporter genes used in genetic transformations. Root formation using *Agrobacterium rhizogenes*and applications. Genetic transformation – transgenic cotton, edible vaccines and transgenic brinjal: protocol and applications. GM food and ethical issues.

Diseases development in plants caused by bacteria (bacterial blight or rice), fungi (late blight of potato), virus (tobacco mosaic disease) classification, symptoms, disease cycle and control measures.

References

Bajaj YPS series. 1986. *Biotechnology in Agriculture and forestry*. Springer Verlag Publishers.

Bajaj YPS. 2007. *Biotechnology in Agriculture and Forestry*. Springer Verlag Publishers.

Chawla HS. 2004. *Introduction to Plant Biotechnology*. Science Publications. Inc.

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Narayana Swamy S.1994. *Plant cell and tissue culture*. Tata McGraw Publishing House, New Delhi.

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Russell, G.E.1988.*Biotechnology of Higher Plants*. Intercept Publications.

Srivatsava P.S.*Plant tissue culture and Molecular Biology*: Applications and prospects. Narosa Publishing House, New Delhi.

Sub Code : PLANT BIOTECHNOLOGY PRACTICAL

1. Plant tissue culture laboratory set up
2. Different plant tissue culture media
3. Methods of sterilization of glass ware, media and explants
4. Establishment of callus culture, seed, embryo culture
5. Anther and pollen culture
6. Clonal propagation-shoot tip and axillary bud culture
7. Establishment of suspension culture
8. Protoplast isolation and culture
9. Somatic embryogenesis and artificial seeds
10. Organogenesis from callus culture, and hardening of plantlets
11. Isolation of *Agrobacterium* from plants or soil and *in vitro* culture
12. Cocultivation of *Agrobacterium* with plant of interest
13. Cryopreservation methods

Sub Code : ANIMAL BIOTECHNOLOGY 56 hours

Course Outcomes: After completing this course, the student is expected to learn the following:

CO 1. To learn the fundamental aspects of animal biotechnology.

CO 2. Discuss about biotechnological tools and techniques used in animal research.

CO 3. Understand the biology and characterization of cultured cells, including their adhesion, proliferation, differentiation, morphology, and identification.

CO 4. Gain practical skills in basic mammalian cell culture techniques, measuring growth parameters, assessing cell viability, and understanding cytotoxicity.

CO 5. Learn about germplasm conservation techniques and the establishment of gene banks, along with large-scale culture methods for cell lines.

CO 6. Explore methods of introducing foreign genesinto animals through transformation techniques..

CO 7. Explore organ and histotypic culture techniques, biotransformation, 3D cultures, whole embryo culture, somatic cell cloning, and the ethical considerations surrounding stem cells and their applications

CO 8. Apply knowledge to real-world challenges in veterinary medicine, conservation, and biomedical research

CO 9. Understand the need for animal biotechnology for human welfare.

Unit I (14 hours)

History of the development of cell culture. Contributions of R.G.Harrison, Alexis Carrel. Hanging drop technique, watch glass technique. Equipments and materials for animal cell culture. Essential, beneficial and useful equipments. Substrates (glass, plastic, treated surface, feeder layer).

Animal cell culture media. Media for immediate survival of cells (BSS). Media forprolonged survival of cells (natural and artificial). Natural media - embryo extract, lymph serum; artificial (defined) media- media with serum and media without serum. Importance of serum in culture media.

Basic techniques of mammalian cell culture *in vitro*: primary explants culture - technique, advantages and disadvantages; primary cell culture - technique. Disaggregation of tissue: trypsinization - cold and warm, collagenase treatment, mechanical methods. Measurement of cells - cell count and cell viability. Cell counting - hemocytometer, electronic cell counter; cell viability - trypan blue, MTT assay.

Cell separation techniques - density gradient centrifugation, MACS, FACS.

Maintenance of cell culture: medium change-need, method; sub culturing – factors affecting, methods - monolayer and suspension culture.

Unit II (14 hours)

Cell lines: types (finite and continuous), characteristics, examples for commonly used cell lines - BHK 21 - C13, HeLa. Routine maintenance – medium change, sub culturing.

Growth kinetics of cells in culture: growth curve–lag, log, stationary and plateau phase; PDT, multiplication rate, generation number.

Measurement of cell proliferation- MTT assay, ^{3}[H]:thymidine incorporation. Cell synchronization: methods - chemical blockade (^{3}H: thymidine: double thymidine block, colcemid, vinblastin sulfate), low temperature procedure, starvation, centrifugation. Somatic

cell fusion techniques: chemical/virus mediated, elctrofusion, Production of MAbs by hybridoma technology : technique, applications of MAbs. Selection of hybrids: HAT selection; cell cloning- types: dilution and suspension (agar gel and methocis). Stem cell cultures: types- totipotent, pluripotent, multipotent, unipotent; embryonic and adult. Cryopreservation - technique (freezing and thawing) and applications.

Unit III **(14 hours)**

Animal cloning- reproductive cloning (Dolly- nuclear transplantation), therapeutic cloning (Xeno transplantation). Gene transfer methods (transfection): chemical methods- $CaPO_4$ co precipitation, DEAE dextran mediated, lipofaction; physical - microinjection, electroporation; biological method – retroviral infection. Reporter genes - GFP, antibiotic resistance markers (neomycin phosphotransferase). DNA microarray - method, applications. Gene therapy - somatic and germline. Somatic (SCID), gene therapy in cancer treatment (TNF gene, p53 gene replacement).

Study of animal diseases: Symptoms, disease diagnosis and treatment of AIDS, salmonellosis and Candidiasis and malaria.

Unit IV **(14 hours)**

Genetic engineering - Factor VIII, tissue plasmogen activator (tPA), hormones (growth hormone, insulin), hepatitis B vaccine. Organ culture (3 dimensional cultures): methods- watch glass technique, raft method, agar gel method, grid method cyclic exposure to light and gas phase. Tissue engineering (artificial skin): methods-collagen method and mesh scaffolding method. Transgenic animals:transgenic cattle - tPA, AAT production; Animals as bioreactors (biopharming): mammary glands asbioreactors- production of regulatory proteins (alpha -1- antitrypsin[AAT], tPA), Silk worm as bioreactors: heterologus proteins (OFP, human growth hormone) transgenic fish– GH induced fish, AFP (fish antifreeze protein) - method and production.

References

Butler M. 2004. *Animal Cell Culture and Technology* 2nd edition. BIOS Scientific Publishers.

Cibelli JB,Lanza RP,Campbell K andWestMD. 2002 .*Principles of Cloning.* Academic Press.

Davis JM.2002. Basic Cell Culture: A Practical Approach (Practical Approach Series) 2nd edition. Oxford University Press, Oxford.

Houdebine LM.2003. *Animal Transgenesis and Cloning*. John Wiley &Sons.

Ian Freshney R. 2000.*Culture of Animal Cells*: A Manual of Basic Technique 4th edition. Wiley-Liss.

Panno J. 2005. *Animal Cloning*: The Science of Nuclear Transfer. Factson File Inc.

Sub Code : ANIMAL BIOTECHNOLOGY PRACTICAL

1. Lab set up and fumigation of the lab
2. Preparation and filtration of animal tissue culture media
3. Primary explants culture
4. Chick embryo culture (Spratt culture)
5. Isolation of bone marrow cells by flushing and primary culture
6. Culture of lymphocytes
7. Determination of viability of cells
8. Buffy coat preparation of WBC
9. Mammalian cell counting by Hemocytometer
10. Estimation of viability of cells by trypan blue dye exclusion
11. Staining for monolayer culture and suspension culture
12. Cryopreservation

SEMESTER-VI

Sub Code :BIOPROCESS AND ENVIRONMENTAL BIOTECHNOLOGY

56 hours

Course out comes: After completing this course, the student is expected to learn the following:
CO1. Exploitation of microorganisms for industrial use and their improvement, and formulation of media for efficient growth and production of microbial or cell-based products.
CO 2. The design, operation, and specific applications of various bioreactors.
CO 3. Demonstrate a comprehensive understanding of the fundamental concepts and principlesof environmental biotechnology.
CO 4. Apply knowledge of biotechnological techniques to address environmental challenges,such as pollution control and waste management.
CO 5. Analyze and evaluate environmental biotechnology case studies, research findings, andreal-world applications.
CO 6. Design and implement biotechnological approaches for environmental remediation,utilizing microbial processes and biodegradation principles.
CO 7. Evaluate the ethical and sustainable aspects of environmental biotechnology practices andmake informed decisions regarding their application in environmental conservation.
CO 8. Communicate scientific concepts and research findings related to environmentalbiotechnology effectively, both in written and oral forms, to diverse audiences

Unit I (14 hours)

Basic principle components of fermentation technology. Strain improvement of industrially important microorganisms. Types of microbial culture and its growth kinetics– Batch, Fed-batch, and Continuous culture. Principles of upstream processing – Media preparation, Inocula development, and sterilization.

Unit II(14 hours)

Bioreactors- Significance of Impeller, Baffles, Sparger; Specialized bioreactors- design and their functions: airlift bioreactor, membrane bioreactors, fluidized bed reactor, packed bed reactors Downstream processing- cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization, Microbial production of amylase and Single Cell Proteins.

Unit III(14 hours)

Basic principles of environmental biotechnology and its relevance to environmental protection: definition, its role in waste management, manufacturing process and pollution control.

Microbiological treatment solid wastes: composting, vermicomposting, Biological treatment of liquid wastes (sewage): primary treatment, secondary treatment (activated sludge system, trickling filters), sludge digestion, septic tanks, oxidation ponds. Tertiary treatments.

Bioremediation: Importance of bioremediation in environmental cleanup. Types of contaminants suitable for bioremediation. Microorganisms used in bioremediation. *In-situ* Bioremediation Methods. – Bioaugmentation. Biostimulation. Bioventing. Phytoremediation. *Ex-situ* Bioremediation Methods – Composting, Land farming, Biopile and bioslurry systems.

Unit IV **(14 hours)**

Conventional and non-conventional sources of energy. Methanogenic bacteria and biogas, microbial H_2 production, bioethanol production. solar energy and solar energy converters, wind and tidal energy and its utilization. Coastal regulatory zone (CRZ). Energy gardens - *Pongamia*and *Jatropha.*

Microbial degradation of xenobiotics: pesticides, detergents, plastics. Degradation of organic compounds: hydrocarbon. eutrophification, biomagnification Biomining (e.g. copper and gold)..Biocontrol agents: Bacterial, viral, fungal of plants as Biopesticides. Biofertilizers: utilization of Rhizobia, cyanobacteria, arbuscular mycorrhizae.

References

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (3rd Edn.).2022
6. Cambridge University Press. 2002.
7. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
8. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor &Francis Ltd, UK, 2007.
9. Jogdand SN.2010. *Environmental Biotechnology.*Himalaya Publishing House, Bangalore, New Delhi.
10. Odum EP. *Ecology* 1983.W B. Saunders Co.,Philadelphia and London.
11. OdumEP.and BarrettGW.2004. Fundamentals of Ecology WB. Saunders Co., Philadelphia and London.
12. SubbaRao N.S.1974. *SoilMicrobiology*, 4th edition, Oxford & IBH Publishers, New Delhi
13. Wang LK, Ivanov V, Tay JH and Hung YT. 2010.*Environmental Biotechnology.* Sringer publishers.

Sub Code : BIOSTATISTICS AND BIOINFORMATICS 56 hours

Course Outcomes: After successful completion of this Course, students will be able to:
CO 1: Describe the scope and importance of biostatistics and explain types of data their presentation in easily understandable way.
CO 2: Demonstrate analysis of data using different statistical methods which helps to draw inference from the data
CO3: Explain the organization and working of computers and illustrate the use of computers in biological science especially in automated control of fermenters
CO 4: Describe the scope and importance of bioinformatics and demonstrate the use of basic bioinformatics tools for analysis of biological data
CO 5: Discuss biological databases, their types and importance and discuss the applications of bioinformatics in biology

Unit I(14 hours)

Biostatistics: Definition and Importance;

Data: Definition, Types: Qualitative Data and Quantitative Data, Categories of Data: Primary Data, Secondary Data

Classification and Tabulation of Data

Frequency Distribution: Discrete Frequency Distribution, Continues Frequency Distribution

Presentation of Data: Bar Diagram, Histogram, Line diagram, Pie chart

Measures of central tendencies: definitions with examples- mean, mode, median, Geometric mean, Harmonic mean

Unit II (14 hours)

Measures of dispersion: definitions with examples - range, quartile deviation, mean deviation, standard deviation

Probability: definition, sample space, event, complement of an event, subevent, union of events. Introduction of events, equally likely events, mutually exclusive and exhaustive events with illustrations.

Correlation: definition, types of correlation, Karl Pearson's coefficient of correlation, Spearman's rank correlation.

Regression: definition, regression equations, properties of regression equations with problems

Unit III (14 hours)

Introduction to computer and organisation of computers: Hardware CPU, memory, input device, output device, memory Modules, RAM;ROM-different types: Flash memory, Auxiliary storage, Magnetic device, optical device, floppy device, hard disk, CD,DVD.

Digital and analogue computers,

Computer algorithm, computers in monitoring and automation.

Application of computers in coordination of solute concentration, pH and temperature of fermentors. Computers as computational tools for bioinformatics

Unit IV (14 hours)

Bioinformatics – An Overview: Definition, Scope, Importance of Bioinformatics in Biological Research, History of Bioinformatics. Bioinformatics and its relation with molecular biology Examples of related tools (FASTA, BLAST, RASMOL)

Biological Databases: Definition, Types: Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary) Database Management System (DBMS).

Sequence analysis: Pairwise and multiple sequence alignment

Biological Data visualization: PyMol,Cn3D. Application of bioinformatics in agriculture, pharmacogenomics and aquaculture.

References

Arnold E. 1979. Introductory statistics for Biology 2 nd edition, London.
Attwood T and Parry-Smith D. 1999. Introduction to Bioinformatics. Prentice Hall Publications.
Lewis AE. 2010. Biostatistics. Prentice Hall. New Jersey. Parker RE.
1979. Introductory Statistics for Biology. Hodder Arnold Publications
Zar J. H. 1974. Biostatistical analysis. Prentice Hall, New Jersey

Sub Code : BIOPROCESS, ENVIRONMENTAL BIOTECHNOLOGY, BIOSTATISTICS AND BIOINFORMATICS PRACTICAL

1. Estimation of alkalinity and salinity from water, soil or sewage
2. Determination of BOD and COD
3. Estimation of hardness of water
4. Estimation of total solids, dissolved and suspended solids
5. Estimation of inorganic phosphate and nitrogen in soil, sewage and water
6. Estimation of dissolves oxygen and carbon dioxide
7. Estimation of organic carbon.
8. Analysis of polluted water
9. Bacterial growth curve
10. Calculation of the thermal death point (TDP) of a microbial sample.
11. Study of fermentor- Demonstration.
12. Production of wine
13. Estimation of the percentage of alcohol, total acidity & volatile acidity in wine.
14. Production and analysis of amylase.
15. Production and analysis of lactic acid.
16. Problems in biostatistics
17. Problems in bioinformatics

Sub Code :Project