B.ScBIOTECHNOLOGY

(Effective from the ACADEMIC year 2024- 2025)

SUBJET TITLES, SCHEME **FOR INSTRUCTION AND EXAMINATION**

Subject titles

SEMESTER SCHEME

Paper Code	Title of the Paper	Type of paper	Periods/ Week	Duration of Exam (Hours)	IA	EA	Max. Marks	Credits
FIRST SEMESTER								
BSCB TV 131	Cell Biology and Genetics	Theory	4	3	20	80	100	3
BSCB TP 132	Cell Biology and Genetics Practical	Practical	4	3	10	40	50	2
Total Marks and Credits							**150**	**5**
SECOND SEMESTER								
BSCB TV 181	Biochemistry and Biophysics	Theory	4	3	20	80	100	3
BSCB TP 182	Biochemistry and Biophysics practical	Practical	4	3	10	40	50	2
Total Marks and Credits							**150**	**5**
THIRD SEMESTER								
BSCB TV 231	Microbiology and Immunology	Theory	4	3	20	80	100	3
BSCB TP 232	Microbiology and Immunology Practical	Practical	4	3	10	40	50	2
Total Marks and Credits							**150**	**5**
FOURTH SEMESTER								
BSCB TV 281	Molecular Biology and Recombinant DNA Technology	Theory	4	3	20	80	100	3
BSCB TP 282	Molecular Biology and Recombinant DNA Technology Practical	Practical	4	3	10	40	50	2
							150	5
Total Marks and Credits							**150**	**5**

Paper Code	Title of the Paper	Type of paper	Periods/ Week	Duration of Exam (Hours)	IA*	EA	Max. Marks	Credits
FIFTH SEMESTER								
BSCBT V 331	Plant Biotechnology	Theory	4	3	20	80	100	3
BSCBT P 332	Plant Biotechnology practical	Practical	4	3	10	40	50	2
BSCBT V 333	Animal Biotechnology	Theory	4	3	10	40	100	3
BSCBT P 334	Animal Biotechnology Practical	Practical	4	3	10	40	50	2
Total Marks and Credits							**300**	**10**
SIXTH SEMESTER								
BSCMB C 701	Bioprocess and Environmental Biotechnology	Theory	4	3	20	80	100	3
BSCMB P 702	Biostatistics and Bioinformatics	Theory	4	3	20	80	100	3
BSCMB C801	Environmental Biotechnology, Biostatistics and Bioinformatics Practical	Practical	4	3	10	40	50	2
BSCMB P 802	Project	Project	4	3	10**	40	50	2
Total Marks and Credits							**300**	**10**
Total Marks and Credits (All Six Semesters)							**1200**	**40**

*Based on internal test or tests
**Continuous assessment during project

SCHEME OF THEORY EXAMINATION

Time 3 Hours		**Max. Marks 80**
Section A		
Write brief notes on **any Ten** of the following (3 questions from each unit)	2x10=20	1 – 12 questions
Section B		
Answer **any Four** full question from each unit	4 X 15 = 60	13-24 questions

SCHEME OF ELECTIVE THEORY EXAMINATION

Time 2 Hours		**Max. Marks 40**
Section A		
Write brief notes on **any FIVE** of the following (3 questions from each unit)	2x5=10	1 – 6 questions
Section B		
Answer **any TWO** full question from each unit	2 X 15 = 30	7- 18 questions

SCHEME OF PRACTICAL EXAMINATION

Time 3 hours			**Max. Marks 40**
Question No.	**Experiment**	**No. of Questions and Marks**	**Marks**
1	Major Experiment	Experiment **1** = 15 marks	15
2	Minor Experiment	Experiment **1** = 08 marks	08
3	Spotters	3 x 3 = 09	09
3	Record/Viva-voce	5 + 3 = 08	08
Total			40

SCHEME OF INTERNAL ASSESSMENT

Assessments	**Theory Examination**	**Practical Examination**	**Elective**
Tests	10	10	10
Seminar	05	00	00
Assignment	05	00	00
Total	**20**	**10**	**10**

Syllabus forB.Sc.(Biotechnology)
CBCS- 2024
Group I Core Courses

SEMESTER-I

BSCBTV181: 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 ultra structure 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

Unit I (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)

Unit II (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.

Unit III (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.

Unit IV **(14 hours)**

Fine structure of gene-recon, muton and cistron.

Mutations: Types of mutations, Spontaneous and induced mutations, Mutagens chemical and physical mutagens, induced mutations in 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

Dale JW.1990. *Molecular genetics of Bacteria*. John Wiley and Sons.

De Robertis EDP and De Robertis EMF.1995.*Cell and MolecularBiology*. 8th edition, BI Waverly Pvt.Ltd., New Delhi.

Gardner *et al*.2003.*Principle of Genetics* -8thedition. John Wiley and Sons, New York.

Gupta ML. and ML.Jangir. 2002. *Cell Biology-Fundamentals and Applications*. Argosies, Jodhpur, India.

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

Powar CB. *Cell Biology* 3rd edition. Himalaya Publishing House, Mumbai.

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

Taylor DJ. Green NPO and Stout GW.1998. *Biological Science* 3rd Edition, Cambridge edition, Cambridge University Press, UK.

BSCBTP182: 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

BSCBTV131: 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)**

Aims and scope of biochemistry and 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.

Unit II **(14 hours)**

Enzymes: History, general properties, active site, Michelis Menton equation, 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.

Unit III **(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.

Unit IV **(14 hours)**

Microscopy: Magnification, Resolution power, Optical - Bright field, dark field, phase contrast and fluorescence; Electron microscopy - TEM and SEM. Partition coefficient, Paper and thin layer chromatography-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

Arora MP.2007.*Biophysics.* Himalaya Publishing House, New Delhi.

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

DaSkooge Holt-Saunders. 1985. *Principles of instrumental analysis*. Holt Saunders.

Leninger AL, Nelson DL and Cox MM.1993. *Principle o fBiochemistry.*CBS Publications.

Nickolas CPL.1982. *Fundamentals of Enzymology*. Oxford Publishers.

StryerL.1988.*Biochemistry* 3rd edition, Freeman & Co, New York.
Trevor. Enzyme biochemistry, Biotechnology and Clinical Chemistry. Harwood Publishers.
Upadhyay and Upadhyay A.2000. *Biophysical Chemistry-Principles and Techniques*. Himalaya Publishers, New Delhi,
ZubayJ.1988. *Biochemistry* 2nd edition. MacMillan Publishing Company,New York.

BSCBTP132: 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. Qualitative tests for carbohydrates- monosaccharides, disaccharides and polysaccharides.
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. Thin layer chromatography
13. Gel Electrophoresis

SEMESTER–III

BSCBTV231: 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
CO 8. Demonstrate technical skills in immunological tools and techniques
CO 9. Explain the fundamental concepts of immunity, and the contributions of the organs and cells in 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

Unit I **(14 hours)**

Aim, scope and historical perspectives of microbiology. Contributions of early microbiologists: Leeuvenhoek, Louis Pasteur, Robert Koch and Edward Jenner. General classification of microbial kingdom - classical, nutritional and molecular approaches. Concepts of 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.

Unit II **(14 hours)**

Prokaryotic and eukaryotic microbes and their characteristics. Structure and 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.

Unit III **(14 hours)**

Historical perspectives in immunology, Classification of immunity: innate and adaptive immunity. Immune systems: organs, cells of immune system. Role of B cell and T cell in humoral and cell mediated immunity. Major histocompatibility complexes (MHCs)-types, structure and their functions. Structure, types and functions of antigens. Haptens and adjuvants, Structure, types and functions of antibodies.

Unit IV **(14 hours)**

Antigen-antibody reactions - 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

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

Brock TB and Madigon.1988. *Biology of Microorganisms*. Prentice Hall, New Jersey.

Cassida, L.E. 1968. *Industrial Microbiology* John Wiley & Sons.

Ivan Riott Jonathan Brostoff and David Male. *Immunology* 3rdedition.Mos by Publishers.

Janeway and Travers. *Immunobiology* 3rd edition. Churchill Livingstone Publications.

Kuby J. 2000. *Immunology*. Freeman and Company Publishers.

Maloy SR. Friefelder 1994. Microbial Genetics. Jones and Bartlett Publishers.PelczarJ.and Chan ECS. 1993. *Element of Microbiology* MacGraw Hill, NewYork.

Pelczar MJ, Reid RD and Chan ECS. 1997. *Microbiology, dynamics and diversity*. Haricot Brace College Publishers.

Prescott LM, Harley JK and Oxford DA. 1993.*Microbiology*.WMC Brown Publishers, USA.

Schlegel Haris G.1988.*GeneralMicrobiology* 6thedition. Cambridge University Press, 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.

BSCBTP 232: MICROBIOLOGY AND IMMUNOLOGY PRACTICAL

1. Instrumentation and microscopy with special reference to microbiology and immunology.
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 activities of microorganisms -indole, methyl red, Voges Proskauer and catalase tests. Starch hydrolysis, Catalase test, Gelatin hydrolysis
11. Antibiotic sensitivity of microorganisms. .
12. Blood grouping and Rh factor determination.
13. Study of different types of leucocytes.
14. Immunodiffusion studies.
15. Dot ELISA

SEMESTER-IV

BSCBTV 281: 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.

Unit I **(14 hours)**

Discovery, structure and types of DNA and RNA. Experiments on DNA as genetic material. Replication of DNA in prokaryotes and eukaryotes. – 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.

Unit II **(14 hours)**

Structure of prokaryotic and eukaryotic genes. Central 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. Prokaryotic gene expression- *lac* and *trp* operon.

Unit III **(14 hours)**

Introduction to recombinant DNA technology, Gene cloning and steps involved in recombinant DNA technology. Isolation and purification of DNA from bacterial, plant and animal cells. Tools of DNA modification: restriction enzymes- properties, classification, types with examples; ligation, DNA modifying enzymes.DNA vectors: plasmids, bacteriophages, cosmids, BAC, YAC. Gene transfer technique.

Unit IV **(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. IPR and patents.

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* 2ndedition. Sunderland (MA): Sinauer Associates, Inc.

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Jogdand SN. 2004. *Gene Biotechnology.* Himalaya Publishing House, Bangalore, New Delhi.

Karp, G. 1999. *Cell and Molecular Biology* - Concepts and experiments. 2ndedition. Wiley& Sons, New York

Lodish H, Berk A, Zipursky SL, Paul Matsudaira and David Baltimore. 2000. Molecular cell Biology, 4th edition. WH. Freeman and Company, New York.

Old RW and Primrose SB. 1994. *Principles of gene manipulation*: an introduction to genetic engineering 5th edition. Blackwell Scientific Publishers, Oxford, Boston.

Primrose SB, Richard M. Twyman RM and Old RW.2002.*Principles of Gene Manipulation* 6th edition.Black well Publishers.

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

Watson JD *et al*.1987.*Molecular Biology of gene*. 4thedition. Benjam in Cumming Publishers,

Wilson K.and WalkerJ. 2005. *Principls and Techniques of Biochemistry and Molecular Biology* 6th edition. Cambridge University Press.

BSCBTP282: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY PRACTICAL

1. Preparation of DNA model
2. Isolation of DNA from bacteria, plant and animal tissues.
3. Isolation of RNA
4. Tests for DNA/RNA/proteins isolated from tissues
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. SDS PAGE
10. ligation
11. Restriction digestion
12. Bacterial transformation
13. Western blotting technique

SEMESTER-V

BSCBTV331: 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, and molecular 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 strategies to increase plant yield and fruit/seed quality.

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

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

CO 8. Perform plant transformation methods and demonstrate the ability to introduce foreign genes into 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.

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

Kalyan kumar De. 2004. *Plant tissue culture*. New Central Book Agency (P) Limited, New Delhi.

Mantell SH and Smith H.1983.Plant Biotechnology. Cambridge University Press.

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

Reinert J and Yeoman MM. 1982. *Plant Cell and Tissue Culture* - A Lab manual. Springer.

Reinert J.1982. *Plant cell and tissue culture*- A Lab manual. Narosa Publications, New Delhi.

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.

BSCBTP333: 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

BSCBTV 332: 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 genes into 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 as bioreactors- 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

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

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BSCBTP334: 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

BSCBTV 381: 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 principles of 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, and real-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 and make informed decisions regarding their application in environmental conservation.
CO 8. Communicate scientific concepts and research findings related to environmental biotechnology 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

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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. Odum EP. and Barrett GW.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.

BSCBTP 383: 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.
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Zar J. H. 1974. Biostatistical analysis. Prentice Hall, New Jersey

BSCBTP 383: 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

BSCBTP384: Project

Syllabus for B.Sc.(Biotechnology)
CBCS-2025
ELECTIVE COURSES

SEMESTER III

BSCBTOE283: BIOTECHNOLOGY IN DAILY LIFE **28 hours**

Unit I **(14 hours)**

Definition and History of Biotechnology, Scope and Importance of Biotechnology. Microbial world, fermentation. Applications of Biotechnology in Industry: Production of citric acid, alcoholic beverages, Enzymes like proteases, lipases and amylases. Plant biotechnology- GM crops, gene transfer technology, bioreactors, disease control through Bt genes. Applications of Biotechnology in Agriculture: Biofertilizers, Biopesticides, Transgenic plants, Mushroom production

Unit II **(14 hours)**

Applications of Biotechnology in Medicine and pharmaceuticals: Insulin therapeutic molecules like tPA, factor VIII, antibiotics. Animal biotechnology – transgenic animals, test tube babies (*In-vitro* fertilization), ethical issues, animal bioreactors, stem cells, stem cell therapy, Environmental biotechnology- composting, biodegradation, biotransformation, biomining. Applications of Biotechnology in Environmental pollution control: Municipal Solid waste management, sewage and industrial effluent treatment, biofuels, Petroleum degradation.

References

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SEMESTER IV

BTC 302APPLICATIONSOFBIOTECHNOLOGY INAGRICULTURE

28 hours

Course Outcomes:

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

CO1.Understand the biotechnological applications in agriculture

CO2.Understandtheimportanceofbiotechnologicalmethodssuchasplanttissueculture

CO 3.Comprehend the pros and cons of GM crops and their plant products

CO4.Appreciatethebiotechnologicalapplicationsforeffectivepestcontroland crop improvements

Unit I (14hours)

Agricultural Biotechnology: Concepts and scope of biotechnology in Agriculture. Plant tissue culture, micro propagation, entrepreneurship in commercial plant tissue culture. Banana tissue culture–primary and secondary commercial setups, Small scale bioenterprises: Mushroom cultivation.

UnitII (14hours)

Transgenic plants: The GM crop debate–safety, ethics, perception and acceptance of GM crops GM crops case study: Bt cotton, Bt brinjal. Plants as biofactories for molecular pharming; edible vaccines, plantibodies, nutraceuticals.

Genetic engineering for quality improvement: Seed storage proteins, Flavours- capsaicin, vanillin.

References:

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