

SYLLABUS Biotechnology (2019-2022)

**B.Sc. Sem I 2019
B.Sc. Sem II 2020
B.Sc. Sem III 2020
B.Sc. Sem IV 2021
B.Sc. Sem V 2021
B.Sc. Sem VI 2022**

DEPARTMENT OF BOTANY AND BIOTECHNOLOGY



LACHOO MEMORIAL COLLEGE OF SCIENCE AND TECHNOLOGY (AUTONOMOUS), JODHPUR

**Recognized by UGC under section 2 (f) and 12 (B)
Accredited by NAAC - UGC with 'A' grade in three consecutive cycles
Selected as College with Potential for Excellence (CPE) by the UGC
Selected under Star college scheme by the Department of Biotechnology, Govt. of India
Status of Model College (Centre for Excellence) awarded by Govt. of Rajasthan**

TEACHING AND EXAMINATION SCHEME
BIOTECHNOLOGY (as one of the subject)

Code	Description	Pd/Week		Exam (hours)	CIA*	ESE	Total
		Th.	Pr.				
BSBT 111	Principles of Biochemistry	3		3	20	80	100
BSBT 112	Cell Biology and Genetics	3		3	20	80	100
BSBT 121	Practical		6	3	20	80	100
BSBT 211	Microbiology	3		3	20	80	100
BSBT 212	Molecular Biology	3		3	20	80	100
BSBT 221	Practical		6	3	20	80	100
BSBT 311	Biophysics and Instrumentation	3		3	20	80	100
BSBT 312	Biology of the Immune system	3		3	20	80	100
BSBT 321	Practical		6	3	20	80	100
BSBT 411	Biostatistics and Computational Biology	3		3	20	80	100
BSBT 412	Environment and Biotechnology	3		3	20	80	100
BSBT 421	Practical		6	3	20	80	100
BSBT 511	Genetic Engineering	3		3	20	80	100
BSBT 512	Plant Biotechnology	3		3	20	80	100
BSBT 521	Practical		6	3	20	80	100
BSBT 611	Industrial Biotechnology	3		3	20	80	100
BSBT 612	Animal Biotechnology	3		3	20	80	100
BSBT 621	Practical		6	3	20	80	100

*CIA for practical includes marks for practical record, regularity, practical skills & viva -voce (as applicable).

Paper code &nomenclature in Biotechnology (as one of the subject in UG programme)

BSBT 111:	Principles of Biochemistry
BSBT 112:	Cell Biology and Genetics
BSBT 121:	Practical
BSBT 211:	Microbiology
BSBT 212:	Molecular Biology
BSBT 221:	Practical
BSBT 311:	Biophysics and Instrumentation
BSBT 312:	Biology of the Immune system
BSBT 321:	Practical
BSBT 411:	Biostatistics and Computational Biology
BSBT 412:	Environment and Biotechnology
BSBT 421:	Practical
BSBT 511:	Genetic Engineering
BSBT 512:	Plant Biotechnology
BSBT 521:	Practical
BSBT 611:	Industrial Biotechnology
BSBT 612:	Animal Biotechnology
BSBT 621:	Practical

SEMESTER – I
BSBT 111- PRINCIPLES OF BIOCHEMISTRY

Unit I

General composition of the living matter: A brief account.

Bioenergetics: Principles of Bioenergetics, concept of free energy, compounds with free energy of hydrolysis (energy rich compounds).

Water: Importance of water for living organisms, structure and properties of water molecule, hydrophilic and hydrophobic groups in biomolecules.

Carbohydrates: classification and general structure; properties of monosaccharides; biological functions of carbohydrates.

Unit II

Amino acids: classification, general structure and properties.

Proteins: classification, three dimensional structure – primary, secondary (α - helix and β - pleated sheet), tertiary (myoglobin) and quaternary (haemoglobin), various types of bonds (covalent and non covalent) in protein structure.

Unit III

Lipids: classification and general structure of simple and compound lipids, properties of fats and oils, biological functions of lipids.

Nucleotides: composition, general structure and properties. Nucleic acids: DNA – types and general structure.

Non-canonical DNA structures (bent DNA, cruciform, triple stranded, G quartet, slipped DNA). RNA: types and functions; structure of t- RNA.

Unit IV

Enzymes: brief history, classification, general properties, concept of active site, mechanism of action, kinetics, regulation of enzyme activity: allosteric enzymes, ATCase as an example, reversible covalent modification- glycogen phosphorylase and glutamine synthase. Zymogen activation.

Unit V

Plant photosynthetic pigments: types, structure and biological functions.

Vitamins: classification, structure and biological functions.

Metabolism: Gluconeogenesis, Glycogenolysis, Glycolysis, Glycolytic pathway, TCA cycle and its products, Oxidative phosphorylation.

Suggested readings:

1. Gupta, SN 2015, *A Text Book of Biochemistry*, 2nd edn, Rastogi Publications, Meerut.
2. Hames, D 2007, *Instant Notes- Biochemistry*, Viva Publications, New Delhi.
3. Jain, JL 2014, *Fundamentals of Biochemistry*, S. Chand and Co. New Delhi, India.
4. Nelson, DL & Cox, MM 2017, *Lehninger Principles of Biochemistry*, 7th edn, W.H. Freeman, New York, USA
5. Palmer, T 2001, *Enzymes- Biochemistry, Biotechnology and Clinical Chemistry*, Horwood publishing house, UK.
6. Satyanarayan, U & Chakrapani, U 2007, *Essentials of Biochemistry*, Books & Allied (P) Ltd. Kolkata, India.
7. Zubay, G 2010, *Biochemistry*, Mac Millan Publishing Co. Basingstoke, UK.

BSBT 112- CELL BIOLOGY AND GENETICS

Unit I

Cell as basic unit of living system: Origin of Cell and Cell theory; Diversity of cell: Bacterial, Fungal, Plant and Animal Cell; Cell wall; Nucleus: Nature of genetic material, Chromatin, Nucleolus, Nuclear membrane and Nuclear Pore complex.

Unit II

Plasma membrane: Structural Model and Transport; Structure and Functions of Endoplasmic reticulum, Golgi complex, Lysosome, Peroxisome and Ribosome; Mitochondria and Chloroplast, Cytoskeleton (Microfilament, Microtubule and Intermediate Filaments).

Unit III

Mendelian laws of Inheritance; Linkage and mapping of genes, Interference and coefficient of coincidence; Sex Linked Inheritance; Quantitative inheritance: Polygene and environment. Epigenetics; Genome imprinting.

Unit IV

Microbial Genetics: Transformation, Conjugation and Transduction; Replica plating: Analysis of mutation in biochemical pathway and one gene-one enzyme hypothesis; Cytoplasmic inheritance; Chondriome and Plastome; RNA editing; Mutation: Spontaneous and Induced.

Unit V

Cell cycle, Mitosis and Meiosis; Sex determination in plants and animals; Chromosome organization (Nucleosome, 30 nm Fiber, Scaffold and Chromatids); Special type of chromosomes: Polytene, Lampbrush and B chromosomes.

Suggested readings:

1. De Robertis, EDP & De Robertis, EMF Jr. 2001, *Cell and Molecular Biology*, 8th edn, Blaze Publishers & Distributors Pvt. Ltd., New Delhi. Lippincott Williams & Wilkins.
2. Gupta, PK 2013, *Cell and Molecular Biology*, 3rd edn, Rastogi Publications, Meerut, India.
3. Klug, WS & Cummings, MR 2011, *Concept of Genetics*, 10th edn, Pearson Education.
4. Lodish, H, Berk, A, Kaiser, CA, Kreiger, M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016 *Molecular Cell Biology*, 8th edn, W.H. Freeman and Company, New York.
5. Maloy SR, Cronan, JE Jr. & Freifelder, D 1994, *Microbial Genetics*, 2nd edn, Jones and Bartlett Publishers.
6. Powar, CB 2010, *Cell Biology*, Himalaya Publishing House.
7. Singh, BD 2014, *Fundamentals of Genetics*, Kalyani Publishers, Delhi.
8. Turner, PC, McLennan, AG, Bates, AD & White, MRH 2002, *Instant Notes in Molecular Biology*, 2ndedn, Viva Books, New Delhi.
9. Verma, PS & Agrawal, VK 2015, *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. 14th edn, S. Chand Publications.
10. Winter, PC, Hickey, GI, & Fletcher, HL 2002, *Genetics*, Viva Books, New Delhi.

PRACTICAL: BSBT121

SUGGESTED LABORATORY EXERCISES:

1. Qualitative estimation of protein and amino acid by Biuret, Ninhydrin and Xanthoproteic method.
2. Qualitative estimation of carbohydrates by Molisch, Benedict, Fehling, Iodine & Barfoed method.
3. Quantitative estimation of the protein by Bradford's method.
4. Quantitative estimation of the total soluble sugars by Anthrone method.
5. Extraction of lipids from peanut seeds.
6. Separation of amino acids by paper chromatography.
7. Separation of sugars by paper chromatography.
8. Micrometric measurements of Microbial, Animal and Plant cells.
9. Study of various stages of Mitosis from onion root tips.
10. Microscopy and calibrations.
11. Qualitative estimation of alpha-amylase activity in germinating seeds.

SPOTS: (Three from each theory paper)

1. DNA Structure
2. Conjugation
3. Transduction
4. Clover leaf model of t-RNA
5. Lock and key model of enzyme-substrate interaction
6. Law of dominance
7. Photosynthetic pigments
8. β -pleated sheet
9. α -helix of protein
10. Polytene chromosome
11. Lampbrush chromosome
12. Mitochondria
13. Nucleosome model
14. Cell cycle
15. Substrate-level phosphorylation

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
UG PRACTICAL EXAMINATION
Biotechnology (BSBT 121)
SEMESTER- I

Time: 3 hours

Max. Marks: 80

- | | |
|--|-----------|
| 1. Perform the given Biochemistry experiment. | 23 |
| 2. Perform the given Cell Biology experiment | 23 |
| 3. Identify and comment upon the spots from '1' to '6' : | 6x 4 = 24 |
| 1. _____ | |
| 2. _____ | |
| 3. _____ | |
| 4. _____ | |
| 5. _____ | |
| 6. _____ | |
| 4. Viva-voce | 10 |

SEMESTER – II
BSBT 211- MICROBIOLOGY

Unit I

General history of microbiology with special reference to the contributions of Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Iwanovsky, Beijerinck, Stanley and Adolf Mayer.

Development of Microscopy – Principle, construction, operation and application of Light (phase contrast, dark/bright-field microscope) and Electron microscope (TEM and SEM).

The concept of asepsis and methods of sterilization: Physical methods (dry heat, wet heat, radiations, filtration, ultra-sonication) and Chemical methods.

Unit II

Prokaryotic and eukaryotic microbial cells - overview. Bacterial classification based on morphology, cell wall structure and flagella types. Bergey's classification of Systematic Bacteriology (2nd edition). General account of important groups of fungi, classification (Alexopoulos and Mims, 1979) and economic importance.

Unit III

Nutritional classification of Bacteria. Symbiosis and N₂-fixing microbes in agriculture; antibiosis among microbial populations, Extremophiles, Polyextremophiles. Host- Pathogen interactions, Defense Mechanism against micro-organisms. Basics of serology- serological reactions: precipitation reaction, agglutination reaction, complement fixation test (CFT).

Unit IV

Viruses: General account, classification (LHT System), structure, replication and transmission. General account of L- forms, Mycoplasma, Spiroplasma and Phytoplasma.

Unit V

Microbial metabolism – Photosynthesis: Light Reaction (oxygenic and anoxygenic), CO₂ Fixation reaction (Calvin cycle); Respiration: Definition, Types: aerobic and anaerobic; Breakdown of glucose to pyruvate (EMP, PPP, EDP), TCA cycle, Electron transport and oxidative phosphorylation..

Suggested readings:

1. Banerjee, AK & Banerjee, N 2006, *Fundamentals of Microbiology and Immunology*, New Central Book Agency (P) Ltd, India.
2. Aneja, KR (ed.) 2017, *Crueger's Biotechnology: A Text Book of Industrial Biotechnology*, Medtech India.
3. Dubey, RC & Maheshwari, DK 2013, *A Text Book of Microbiology*, S. Chand & Company LTD., New Delhi.
4. Madigan, MT & Martinko, JM 2006, *Biology of Microorganisms*, 11th edn, Pearson Prentice Hall, USA.
5. Maloy, SR, Cronan, JE Jr., & Freifelder, D 2006, *Microbial Genetics*, Jones Bartlett Publishers, Sudbury, Massachusetts.
6. Pelczar, MJR, Chan, ECS & Kreig, NR 1998, *Microbiology*, 5th edn, Tata McGraw Hill.
7. Powar, CB & Dagainawala, HF 2008, *General Microbiology*, Vol II, Himalaya Publishing House, Mumbai, India.
8. Reed, G (Ed.) 1987, *Prescott & Dunn's Industrial Microbiology*, 4th edn, CBS Publishers & Distributors, New Delhi.
9. Sharma, PD 2005, *Microbiology*, Rastogi Publications, Meerut.
10. Willey, JM, Sherwood, LM & Woolverton, CJ 2008, *Prescott, Harley and Klein's Microbiology*, 7thedn, McGraw Hill, New York.

BSBT 212- MOLECULAR BIOLOGY

Unit I

Concept of gene: DNA as a genetic material, different types of DNA; RNA as a genetic material, different types of RNA.

DNA damage & repair pathway – Direct reversal, NER, BER, mismatch repair, SOS repair.

Unit II

DNA replication - prokaryotic and eukaryotic DNA replication - mechanisms of DNA replication - enzymes and accessory proteins involved in DNA replication – fidelity of DNA replication and proof reading.

Unit III

Structure of prokaryotic and eukaryotic gene. Transcription in prokaryotes and eukaryotes: mechanism, promoters and RNA polymerases, transcription factors, post transcriptional modifications of eukaryotic mRNA.

Unit IV

Genetic code, properties and Wobble hypothesis. Mechanism of translation in prokaryotes and eukaryotes; post translational modifications.

Unit V

Regulation of gene expression in prokaryotes - operon concept (*lac* and *trp*), regulation of gene expression in eukaryotes – transcriptional activation, galactose metabolism in yeast. Developmental and environmental regulation of gene expression.

Suggested readings:

1. Alberts, B, Johnson, A, Lewis, J, Raff, M, Roberts, K & Walter, P 2007, *Molecular Biology of the Cell*, 5th edn, Garland Science, New York.
2. Cooper, GM & Hausman, RE 2016, *The Cell: A Molecular Approach*, 7th edn, ASM Press and Sinauer Associates Inc, USA.
3. Das, HK 2010, *Textbook of Biotechnology*, 4th edn, Wiley India Pvt. Limited.
4. Gupta, PK 2014, *A Textbook of Cell and Molecular Biology*, 4th edn, Rastogi Publications, Meerut
5. Karp G, Iwasa, I & Marshall, W 2016, *Cell and Molecular Biology: Concepts and Experiments*, 4thedn, John Wiley & Sons Inc, USA.
6. Jocelyn, EK, Stephen, TK, Elliott, SG & Lewin, B 2014, *Genes XI*, Jones & Bartlett Learning. Publishers, Boston, Massachusetts.
7. Lodish, H, Berk, A, Kaiser, CA, Kreiger, M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016 *Molecular Cell Biology*, 8th edn, W.H. Freeman and Company, New York.
8. Pierce, BA 2016, *Genetics: A Conceptual Approach*, 6th edn, W.H. Freeman and Company, NY.
9. Powar, CB 2010, *Cell Biology*, Himalaya Publishing House.
10. Snustad, DP & Simmons, MJ 2012, *Principles of Genetics*, 6th edn, John Wiley & Sons Inc., USA.
11. Verma, PS, & Agarwal, VK 2015, *Cell Biology, Genetics, Molecular Biology, Evolution & Ecology*, S. Chand & Company Ltd.
12. Watson, JD, Hopkins, NH, Roberts, JW, Steitz, JA & Weiner, AM 1987, *Molecular Biology of the Gene*, 4th edn, The Benjamin-Cummings Publ. Co. Inc, California.

PRACTICAL: BSBT 221

SUGGESTED LABORATORY EXERCISES:

1. Practices of asepsis: Sterilization, disinfection, safety in microbiology laboratory.
2. Preparation of media for growth of various microorganisms (nutrient agar, LB agar, EMB agar, MacConkey agar and PDA).
3. Isolation of pure culture of bacteria by streak plate method and pour plate method.
4. Staining of microorganisms (Gram's staining and cotton blue staining).
5. Study of Growth kinetics of bacterial population by turbidimetry method.
6. Demonstration of antibiotic resistance.
7. Isolation and screening of microorganisms by serial dilution method from soil sample.
8. Isolation of plasmid DNA from bacteria.
9. Analysis of isolated DNA by agarose gel electrophoresis.

SPOTS: (Three from each theory paper)

1. Autoclave
2. DNA replication
3. Eukaryotic gene structure
4. Prokaryotic RNA polymerase
5. Ribosome
6. Laminar air flow bench
7. TEM
8. SEM
9. Antibody
10. Mycoplasma
11. Rhizobia
12. Antony von Leeuwenhoek
13. Louis Pasteur
14. F. Crick
15. *lac* operon

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
UG PRACTICAL EXAMINATION
Biotechnology (BSBT 221)
SEMESTER- II

Time: 3 hours

Max. Marks: 80

- | | |
|---|------------|
| 1. Perform the given Molecular Biology experiment. | 23 |
| 2. Perform the given Microbiology experiment | 23 |
| 3. Identify and comment upon the spots from '1' to '6': | 6 x 4 = 24 |
| 1. _____ | |
| 2. _____ | |
| 3. _____ | |
| 4. _____ | |
| 5. _____ | |
| 6. _____ | |
| 4. Viva-voce | 10 |

SEMESTER-III
BSBT 311- BIOPHYSICS AND INSTRUMENTATION

Unit I

Acids and Bases - pH, Ka, pKa; Buffers, Henderson-Hasselbalch equation; Redox reactions and redox potential; Nernst Equation. Potential across neural membrane: Resting Potential and Action Potential.

Unit II

Concept of Thermodynamics: Laws; Enthalpy, Free Energy & Entropy. Strategies of light reception in microbes, plants and animals.

Unit III

Physical Methods applied to determine structure: X-ray crystallography, Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR), Circular Dichroism (CD).

Unit IV

Concept of Chromatography: Paper chromatography, TLC, Ion-Exchange Chromatography, Gel Filtration Chromatography, Affinity Chromatography.
Electrophoresis: SDS-PAGE, AGE, Isoelectric focusing.

Unit V

Centrifugation: Basic principle of centrifugation, Velocity gradient and buoyant density centrifugation-differential and density gradient centrifugation.
Spectroscopy: Lambert-Beer Law, UV-Visible Spectroscopy, IR Spectroscopy, Emission Spectroscopy.

Suggested readings:

1. Berg JM, Tymoczko, JL & Stryer, L 2002, *Biochemistry*, W. H. Freeman and Company, San Francisco, USA.
2. Bialek, W 2013, *Biophysics: Searching for Principle*, Princeton University Press, NJ, USA.
3. Freifelder D 1982, *Physical Biochemistry: Application to Biochemistry and Molecular Biology*, 2nd edn, W. H. Freeman & Company, San Francisco, USA.
4. Hofmann, A & Clokie, S 2018, *Wilson & Walker's Principles and Techniques of Biochemistry and Molecular Biology*, 8th edn, Cambridge University Press.
5. Holme, D & Peck, H 1998, *Analytical Biochemistry*, 3rd edn, Longman, New York, USA.
6. Nelson, DL & Cox, MM 2008, *Lehninger Principles of Biochemistry*, 5th edn, W. H. Freeman and Company, San Francisco, USA.
7. Nelson, P 2013, *Biological Physics: With New Art*, W. H Freeman, San Francisco, USA.
8. Kumar, P 2014, *Fundamentals and Techniques of Biophysics and Molecular Biology*, 2nd edn, Pathfinder Publication.
9. Rao, CNR 2001, *Understanding Chemistry*, Universities Press, Hyderabad. India.

BSBT 312: BIOLOGY OF THE IMMUNE SYSTEM

Unit I

Immunology: History and scope. Cells involved in the immune system and their functions: Granulocytes, Non-granulocytes and lymphocytes. Organs of the immune system and their functions: Primary and Secondary organs. Concept of Acquired/Adaptive and Innate immunity.

Unit II

Antigen: Epitopes, Haptens, Adjuvants. Structure and function of various classes of immunoglobulins. Antigen-antibody interactions: Precipitation, Immunoelectrophoresis, Haemagglutination, RIA, ELISA and Immunofluorescent techniques.

Unit III

Major Histocompatibility Complex - structure and its role in immunity. Antigen processing and presentation: self restriction of cells, role of antigen presenting cells. Maturation, activation and proliferation of B- and T-cell.

Unit IV

Cytokines and their role in immune regulation, The Complement system: Structure and Components. Hypersensitivity and its types. Autoimmune disorders: Types- Organ specific (Insulin- dependent Diabetes Mellitus) and Systemic disease (Rheumatoid Arthritis).

Unit V

Vaccines: Dead, live attenuated, recombinant, edible, DNA and multi sub-unit vaccines. Immunodeficiencies: acquired and congenital. Gene therapy: types and process. *In vivo* antibody production: plantibody and Camelid antibody. Hybridoma technology and Monoclonal antibody.

SUGGESTED READINGS:

1. Abbas, AK, Lichtman, AH & Pillai, S 2015, *Basic Immunology: Functions and Disorders of the Immune System*, 5th edn, Elsevier – Health Sciences Division, Philadelphia, US.
2. Chapel, H, Haeney, M, Misbah, S & Snowden, N 2013, *Essentials of Clinical Immunology*, 6th edn, Wiley – Blackwell, NJ, USA.
3. Decker, J & Reischl, U 2004, *Molecular Diagnosis of Infectious Diseases*, Humana Press, USA.
4. Delves, PJ, Martin, SJ, Burton, DR & Roitt, IM 2017 *Essential Immunology*, 13thedn, Wiley – Blackwell, NJ, USA.
5. Goldsby, RA, Kindt, TJ, Osborne, BA & Kubly, J 2002, *Immunology*, 6th edn W. H. Freeman & Co. NY.
6. Lal, SS & Kumar, S 2017, *Immunology*, 2nd edn. Rastogi Publications, Meerut.
7. Lydyard, P M, Whelan, A & Fanger MW 2002, *Instant Notes in Immunology*, Viva Books New Delhi
8. Paul, NC 2013, *Fundamental of Immunology*, 7th edn, Lippencott Williams & Wilkins.
9. Rao, CV 2011, *Immunology-A Text Book*, 5th edn, Narosa Publication House, New Delhi.
10. Sinha, JK & Bhattacharya, SA 2006, *Text Book of Immunology*, Academic Publishers, Kolkata.

PRACTICAL: BSBT 321

SUGGESTED LABORATORY EXERCISES:

1. Preparation of stationary phase of silica gel for TLC.
2. Separation and identification of amino acids and plant pigments by TLC.
3. Separation of alkaloids by TLC (e.g. *Curcuma*, *Arnebia*).
4. Separation of molecules in cellular extract using Gel Filtration.
5. Separation of molecules in cellular extract using Ion exchange Chromatography.
6. Gel casting, sample loading and visualization of DNA through Gel Electrophoresis.
7. Blood film preparation and identification of cells.
8. Diagnosis of infectious disease by an immunoassay (demonstration using commercial kits): dot-ELISA, Malaria and typhoid testing.
9. Double diffusion and immunoelectrophoresis.
10. Validation of Beer – Lambert Law using colorimeter / spectrophotometer & determination of the unknown concentration of carbohydrates and amino acids in the given sample.
11. Determination of absorption maxima of the plant pigments in the given sample.
12. Demonstration of fluorescence in isolated plant pigments.

SPOTS: (Three from each theory paper)

1. Superantigen
2. Monoclonal antibody
3. MHC structure
4. Immunoprecipitation
5. Receptor mediated endocytosis
6. Camelid antibody
7. Autoimmune disorder- rheumatoid arthritis
8. FACS
9. Charles Arntzen
10. Marie Curie
11. NMR spectroscopy
12. X-ray crystallography
13. UV- VIS spectroscopy
14. Density gradient centrifugation
15. Isoelectric focusing

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
UG PRACTICAL EXAMINATION
Biotechnology (BSBT 321)
SEMESTER- III

Time: 3 hours

Max. Marks: 80

- | | |
|--|------------|
| 1. Perform the given Biophysics experiment. | 23 |
| 2. Perform the given Immunology experiment | 23 |
| 3. Identify and comment upon the spots from '1' to '6' : | 6 x 4 = 24 |
| 1. _____ | |
| 2. _____ | |
| 3. _____ | |
| 4. _____ | |
| 5. _____ | |
| 6. _____ | |
| 4. Viva-voce | 10 |

SEMESTER IV

BSBT411: BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

Unit I

Collection of data: Primary and secondary data. Attributes and variables. Qualitative and quantitative data. Graphical and diagrammatic representation: Histogram, bar diagrams, pie chart, and frequency polygon. Classification: types of classification. Tabulation. Measures of central tendency: mean, median and mode.

Unit II

Measures of dispersion: Range, Standard deviation and variance, Coefficient of variation. Correlation: Introduction, definition and types of correlation between two variables. Scatter diagram, Karl Pearson's coefficient of correlation and Spearman's rank correlation coefficient.

Unit III

Hypothesis: null and alternate hypothesis. Test for significance: chi-square test, student t-test (single sample mean and two sample mean), F-test.

Designing and methodology of an experiment: Introduction, Definition of the problem, Aims and Objectives, Review of Literature, Hypothesis, Plan of Action, Analysis of Data, Conclusion.

Unit IV

Computer: General introduction to computers, Generations of computer. Organization of computer, Input and output devices of computer. Types of computers: Digital, Analog and Hybrid.

An introduction to Bioinformatics: Introduction, Historical overview and its applications.

Unit V

Biological databases: Definition, type of biological databases, Information retrieval from databases, Primary, secondary and composite databases; Big data and Cloud computing.

Introduction to different tools & databases such as – BLAST, FASTA, Entrez, PubMed, OMIM, PIR, Swiss-Prot, Cn3D, PROSITE, GenBank, EMBL, DDBJ, PDB, MMDB.

Suggested readings:

1. Baxevanis, AD & Ouellette, BFF 2001, *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, 3rd edn, John Wiley & Sons Inc, UK.
2. Campbell, RC 1989, *Statistics for Biologists*, 3rd edn, Cambridge University Press, USA.
3. Daniel, W 1999, *Biostatistics*, 3rd edn, Panima Publishing Corporation, New Delhi.
4. Gupta, SC & Kapoor, VK 2007, *Fundamentals of Mathematical Statistics*, 11th edn, S. Chand & Sons, New Delhi.
5. Jean-Michel, C 2003, *Bioinformatics- A Beginner's Guide*, John Wiley & Sons, UK.
6. Jin, X 2006, *Essential Bioinformatics*, Cambridge University Press, USA.
7. Khan, IA & Khanum, A 2004, *Fundamentals of Biostatistics*, 2nd revised edn, New Age Publishing corporation, New Delhi.
8. Mount, DW 2001, *Bioinformatics – Sequence and Genome analysis*, Cold Spring Harbor Laboratory Press, NY.
9. Philip, EB & Helge, W 2003, *Structural Bioinformatics*, John Wiley & Sons, UK.
10. Rashidi, HH & Buehler, LK 2005, *Bioinformatics Basics: Applications in Biological Science and Medicine*, CRC Press, Florida.
11. Rastogi, SC, Mendiratta, N & Rastogi, P 2013, *Bioinformatics-Methods and Applications*, 4th edn, Prentice-Hall of India Pvt. Ltd, New Delhi.
12. Rastogi, VB 2009, *Fundamentals of Biostatistics*, 2nd edn, Ane Books Pvt. Ltd, New Delhi.
13. Sharma, V, Munjal, A & Shankar, A 2008, *A Text Book of Bioinformatics*, Rastogi Publications, Meerut.

BSBT412: ENVIRONMENT AND BIOTECHNOLOGY

Unit I

Environment - basic concepts and issues. Environmental pollution - types of pollution, sources of pollution, methods of measurement of pollution, fate of pollutants in the environment.

Unit II

Global environmental problems and their impact: Ozone depletion, greenhouse effect, salinization, desertification, acid rain, El Nino and radiation hazards.

Unit III

Environmental Protection Act – Environmental Laws, national movements, sustainable development, environmental policies, environmental economics, environmental ethics – holistic approach of environmental protection and conservation, IUCN – role in environmental protection. Environmental Protection Agency (EPA).

Unit IV

Microbiology of waste water treatment by: Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums & oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors. Waste waters Treatment schemes.

Unit V

Xenobiotic compounds - organic and inorganic. Bioremediation of xenobiotics in environment - ecological consideration, decay behavior and degradative plasmids; molecular techniques in bioremediation. Biodeterioration: Introduction, biodeterioration of natural materials, plastics, rubbers and fuels, methods of control. bioconcentration & biomagnification, biofertilizers and biopesticides.

Suggested readings:

1. Ahmed, N, Qureshi, FM & Khan, OY 2001, *Industrial and Environmental Biotechnology*, Horizon Scientific Press, Norfolk, U.K.
2. Allsopp, D, Seal KJ & Gaylarde, C 2004, *Introduction to Biodeterioration: Applications*, Caister Academic Press, Norfolk UK.
3. Baaker, KH & Herson DS 1994, *Bioremediation*, McGraw Hill Inc, New York.
4. Burton, F, Tchobanoglous, G & Stensel, HD 2002, *Waste Water Engineering - Treatment, Disposal and Reuse*, 4th edn, Tata McGraw Hill Inc., New Delhi.
5. De, AK 1996, *Environmental Chemistry*, New Age International, New Delhi.
6. Dubey, RC 2014, *A Text Book of Biotechnology*, S. Chand and Company, New Delhi.
7. Sharma, PD 2014, *Ecology and Environment*, Rastogi Publications, Meerut, UP.
8. Singh, BD 2005, *Plant Biotechnology*, Kalyani Publishers, Delhi.

PRACTICAL: BSBT 421

SUGGESTED LABORATORY EXERCISES:

1. Measurement of central tendency (mean, mode and median) of the given biological data.
2. Measurement of standard deviation of the given data.
3. Planning and design of an experiment.
4. Determination of the region of local similarity between sequences with the help of various tools - BLAST, FASTA, ENTREZ, etc.
5. Phylogenetic study of biological samples through PHYLIP/ CLUSTAL-W
6. Isolation of microorganisms from polluted soil and water.
7. Effect of heavy metals/pesticides on bacterial growth.
8. Water quality assessment for polluted water bodies:
 - a. Physical - pH and conductivity.
 - b. Chemical - Dissolved oxygen and Chemical oxygen demand.

SPOTS: (Three from each theory paper)

1. Histogram
2. Correlation
3. Chi-square test
4. Bioinformatics
5. SWISS PROT
6. EMBL
7. BLAST
8. Smog
9. Eutrophication
10. Global warming
11. Acid rain
12. Trickling filter
13. Superbug
14. Bioremediation
15. Biomagnification

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JODHPUR, RAJASTHAN
UG PRACTICAL EXAMINATION
Biotechnology (BSBT 421)
SEMESTER- IV

Time: 3 hours

Max. Marks: 80

1. Perform the given Environmental Biotechnology experiment. 23

2. Perform the given Bioinformatics and/or Statistics exercise 23

3. Identify and comment upon the spots from '1' to '6' : 6 x 4 = 24
 1. _____
 2. _____
 3. _____
 4. _____
 5. _____
 6. _____

4. Viva-voce 10

SEMESTER V

BSBT511: GENETIC ENGINEERING

Unit I

Genetic engineering – history and principles. Enzymes for molecular cloning: exo-, endo nucleases/ meganucleases, Restriction endonucleases - classes of restriction enzymes and mode of action. DNA ligase, Alkaline Phosphatase, Terminal transferase, S1 nuclease, DNase, RNase, DNA polymerase and Reverse transcriptase.

Vector: Characteristics of an ideal vector, Vector types - plasmids, phages, phagemids, cosmids, viruses, BAC and YAC.

Unit II

General techniques in genetic engineering: Amplification of nucleic acid (PCR), Electrophoresis, Southern Blotting, Northern Blotting. Gene sequencing - Sanger method, Automated DNA sequencing and Ultra-throughput sequencing.

Isolation and purification of genomic DNA from bacterial, plant and animal cells. Isolation of RNA. Quantification of purified DNA/RNA.

Unit III

DNA cloning strategies - steps involved. Preparation and screening of genomic and cDNA libraries. Screening of recombinants - insertion inactivation, blue-white screening, Immunological screening and colony hybridization.

Unit IV

Methods of gene transfer into living cells: Direct - Electroporation, Gene gun method, liposome- mediated gene transfer and Microinjection. Indirect – *Agrobacterium*- based method, *in planta* gene transfer.

Application of cloning in gene analysis: Expression of foreign genes in prokaryotic and eukaryotic cells, production of proteins from cloned genes.

Unit V

Application of r-DNA technique in human health - production of insulin. Production of recombinant vaccine - Hepatitis-B. Production of human growth hormone - somatotropin. Forensic applications - DNA fingerprinting. Social and ethical issues and safety measures of genetic engineering.

Suggested readings:

1. Brown, TA 2010, *Gene Cloning and DNA Analysis: An Introduction*, 6th edn, Wiley-Blackwell Publishing, UK.
2. Dale, JW, Schantz, M & Plant, N 2011, *From Genes to Genomes: Concepts and Applications of DNA Technology*, 3rd edn, Wiley-Blackwell publishing, UK.
3. Gupta, PK 2012, *Biotechnology and Genomics*, 1st edn, Rastogi Publications, Meerut.
4. Joshi, P 2007, *Genetic Engineering and its Applications*, 2nd edn, Agrobios- India, Jodhpur.
5. Primrose, S & Twyman R, 2001, *Principles of Gene Manipulation and Genomics*, 6th edn, Blackwell Science, UK.
6. Sambrook, J, Fritsch, EF & Maniatis, T 1989, *Molecular Cloning-A Lab Manual*, 2nd edn, Cold Spring Harbor Laboratory Press, NY.
7. Mitra, S 2000, *Genetic Engineering-Principles and Practice*, Macmillan India Limited, Delhi.
8. Satyanarayana, U 2005, *Biotechnology*, 1st edn, Books and Allied Publishers, Kolkata
9. Singh, BD 2012, *Biotechnology- Expanding Horizons*, 4th edn, Kalyani Publishers, New Delhi.
10. Watson, JD, Hopkins, NH, Roberts, JW, Steitz, JA & Weiner, AM 1987, *Molecular Biology of the gene*, 4th edn, The Benjamin/Cummings Publishing Company, Inc, California.

BSBT512: PLANT BIOTECHNOLOGY

Unit I

Plant Tissue Culture: History; Concept of totipotency and asepsis; Nutrient media; Plantlet regeneration through axillary bud proliferation, organogenesis and somatic embryogenesis and their applications.

Unit II

Somaclonal variations - causes and epigenetics, *in vitro* selection and their applications; Endosperm culture and production of triploid plants; Production of haploid plants – Androgenic and gynogenic, Identification of haploid plants, Diploidization of haploid plants, Applications of haploids.

Unit III

Principal classes of secondary metabolites (alkaloids, terpenoids, phenolics); Suspension culture- types, synchronization, culture of isolated single cells (single cell clones); Types of bioreactors (air-lift, stirred tank); biotransformation, elicitation, hairy root culture, immobilization; Commercial production of secondary metabolites (taxol, ginseng, vinblastine and vincristine,) in bioreactors using cell culture.

Unit IV

Protoplast Isolation, Culture and Fusion: Various steps in isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization—Introduction, Various methods of fusion of protoplast (chemical and electrical); Use of markers for selection of hybrid cells.

Unit V

Genetic Transformation: Practical applications of somatic hybridization (hybrids/cybrids); Molecular biology of crown gall disease; Root formation using *Agrobacterium rhizogenes*; Basics of RNA editing, gene/genomic imprinting and genome editing.

Suggested readings:

1. Bhojwani, SS & Razdan, MK 1996, *Plant Tissue Culture: Theory and Practice (revised edition)*, Elsevier Science, Netherlands.
2. Chawla, HS 2009, *Introduction to Plant Biotechnology*, Oxford & IBH Publications Ltd., New Delhi.
3. Davey, MR & Anthony, P 2010, *Plant Cell Culture: Essential Methods*, Wiley-Blackwell Ltd.
4. De, KK 1992, *An Introduction to Plant Tissue Culture*, New Central Book Agency, Kolkata.
5. Purohit, SD 2013, *Introduction to Plant Cell, Tissue and Organ Culture*, PHI Learning Private Limited, Delhi.
6. Razdan, MK 2003, *An Introduction to Plant Tissue Culture*, Oxford & IBH Publ. Ltd., New Delhi.
7. Singh, BD 2012, *Biotechnology: Expanding Horizons*, Kalyani Publishers, Ludhiana.
8. Slater, A, Scott, N & Fowler, M 2003, *Plant Biotechnology: The Genetic Manipulation of Plants*, Oxford University Press, UK.
9. Vasil, IK & Thorpe, TA (eds.) 2005, *Plant Cell and Tissue Culture*, Springer India Pvt. Limited, New Delhi.

BSBT 521 PRACTICAL:

SUGGESTED LABORATORY EXERCISES:

1. Isolation of genomic DNA from bacteria, plant and animal tissue.
2. Separation of isolated DNA from bacteria, animal and plant tissue by agarose gel electrophoresis.
3. Quantification of isolated DNA using spectrophotometer.
4. Restriction digestion of DNA.
5. Construction of restriction map of DNA.
6. Preparation of competent bacterial cell.
7. Planning / Organization of plant tissue culture laboratory
8. Preparation and sterilization of culture media.
9. Explant preparation and surface sterilization for *in vitro* culture of plant tissue(s).
10. Study of the growth of plant cells in callus culture.
11. Establishment of suspension culture(s).
12. Study of the effect of PGR's on organogenesis.
13. Preparation of synthetic seeds.
14. Demonstration of *in vitro* and *ex vitro* rooting.
15. Demonstration of anther culture.

SPOTS: (Three from each theory paper)

1. Restriction endonuclease
2. Reverse transcriptase
3. Southern blotting
4. Polymerase chain reaction
5. Plasmid
6. α - complementation
7. Microinjection
8. DNA fingerprinting
9. Micropropagation
10. Somatic embryogenesis
11. Suspension Culture
12. Protoplast fusion
13. RNA editing
14. Guha and Maheshwari
15. Gottlieb Haberlandt

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
UG PRACTICAL EXAMINATION
Biotechnology (BSBT 521)
SEMESTER- V

Time: 3 hours

Max. Marks: 80

1. Perform the given Plant Biotechnology experiment allotted by lots.
 - a. Preparation of nutrient medium and reporting the constituents in mg/l. 07
 - b. Pretreatment, surface sterilization and inoculation of the explants 16
2. Perform the given Genetic Engineering experiment 23
3. Identify and comment upon the spots from '1' to '6': 6 x 4 = 24
 1. _____
 2. _____
 3. _____
 4. _____
 5. _____
 6. _____
4. Viva-voce 10

SEMESTER VI
BSBT611: INDUSTRIAL BIOTECHNOLOGY

Unit I

Principles of microbial cell growth and animal cell culture – introduction, the principles of growing of cells, ways to increase yield , kinetics of cell culture, physical and chemical factors influencing the cell growth, Culture methods to optimize the cell growth, cell cytotoxicity. Batch, fed-batch and continuous cultures (definition and kinetics).

Unit II

Bioreactor / Fermenter – types & operation of Bioreactors, physico-chemical standards used in bioreactors, limitations of bioreactors, stages of fermentation processes, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static, Submerged and agitated fermentation), advantages & disadvantages of solid substrate & liquid fermentations.

Unit III

Technology of Microbial cell maintenance – steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain), Strain preservation, maintenance and strain improvement by mutation of gene transfer processes, Downstream processing – extraction, separation, concentration, recovery & purification.

Unit IV

Enzyme technology – nature of enzymes, various sources of enzyme, production, extraction, purification, limitations of microbial cells used as catalysts in fermentation, genetic engineering & protein engineering of enzymes . Enzyme immobilization techniques, biosensors. Enzyme applications – therapeutic, manipulative, industrial and analytical.

Unit V

Biotechnology in specific medical & industrial applications – Microbial process for immunization (Production of monoclonal antibodies), Biofilms, microbial biopolymers, biosurfactants, Single-cell Protein, Biomining and bioleaching of ores, Bio-diesel. Production of herbal drugs, Industrial production of Insulin, Ethyl alcohol, α -amylase/tannase/protease; penicillin, tetracycline and vitamin B12.

Suggested readings:

1. Demain AL & Davies J 2010, *Manual of Industrial Microbiology and Biotechnology*, ASM press, Washington DC, USA.
2. El-Mansi M & Bryce C 2002, *Fermentation Microbiology and Biotechnology*. Taylor and Francis Ltd., London.
3. Paul, JK 1983, *Genetic Engineering Applications for Industry*, Noyer Corporation, New Jersey, US.
4. Prescott, and Reed DG 1983, *Industrial Microbiology*, AVI Publishing Company Inc. Connecticut USA.
5. Rehm, HJ & Reed, G 1983, *Biotechnology*, VI-VIII, Verlag Chemie, Weinheim, Germany.
6. Stanbury, PF & Whitaker, A 1984, *Principles of Fermentation Technology*, Pergamon Press, Oxford, UK.

BSBT612: ANIMAL BIOTECHNOLOGY

Unit I

Animal cell culture: History and development. Biology of cultured cells: Culture environment, cell adhesion, cell proliferation, differentiation.

Culture vessels: Substrate-Glass, Plastic; Treated surfaces- Matrix coating, Feeder layer; factors governing the basis of choices of culture vessels.

Biohazards: levels of containment, Human biopsy material, genetic manipulation and disposal.

Unit II

Culture media: Physicochemical properties, balanced salt solution, Complete media, Serum. Serum-free media: Advantages and disadvantages of serum-free media, development of serum-free media, commonly used serum-free media. Importance of growth factors in culture media. Growth kinetics of cells in culture.

Unit III

Primary cultures: Techniques for primary cell culture- mechanical disaggregation, enzymatic disaggregation, and primary explant technique.

Cell lines: Finite and Continuous Cell Lines, Nomenclature, Subculture and Propagation, Selection of cell lines, Maintenance of cell lines. Commonly used animal cell lines — their origin and characteristics.

Bioreactors for large scale culture of cells- Air lift fermentor, Rotating chambers, Roller culture and Microcarrier.

Unit IV

Cell separation: Cell density and isopycnic sedimentation, antibody based techniques, FACS.

Cell characterization: morphology of cells, species of origin of cells, identification of tissue of origin, and identification of specific cell line.

Cell transformation: Genetic instability, immortalization, aberrant growth control, tumorigenicity.

Unit V

Application of animal cell culture: Introduction to organ culture, organoid culture and 3-D culture. Production of special secondary metabolites/ products (somatotropin, interferon, tPA, factor VIII etc.). Growth factors for promoting proliferation of animal cell (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin). Transgenic animals: importance and applications.

Suggested Readings:

1. Butler, M 2004, *Animal Cell Culture and Technology*, 2nd edn, Taylor & Francis, UK
2. Freshney, R I 2010, *Culture of Animal Cells- A Manual of Basic Techniques*, 6th edn Wiley-Blackwell, USA.
3. Jennie, P & David, B 1998, *Methods in Cell Biology*, Volume 57, *Animal Cell Culture Methods*, Academic Press, Netherland.
4. Masters, JRW 2000, *Animal Cell Culture*, 3rd edn, Oxford University Press, USA.
5. Ranga, MM 2007, *Animal Biotechnology*, 3rd edn, Agrobios - India, Jodhpur.
6. Satyanarayana, U 2005, *Biotechnology*, 1st edn, Books and Allied (P) Ltd, Kolkata.

BSBT 621: PRACTICAL

SUGGESTED LABORATORY EXERCISES:

1. Isolation and Culture of industrially important bacteria on solid medium and liquid medium (broth culture).
2. Determination of bacterial growth by turbidimetric method.
3. Demonstration of formation of alcohol from fruit juice(s).
4. Differentiate the viable and nonviable cells by staining methods.
5. Study of pure and mixed cell cultures of microbes by simple and differential staining.
6. Introduction to culture vessels for animal cells.
7. Designing a prototype of Bioreactor (Group Exercise).
8. Demonstration of establishment of primary cell culture by trypsinization.
9. Separation and identification of various cell types of animal by staining.
10. Preparation of culture media for animal cell culture.
11. Quantitative estimation of alpha-amylase activity in germinating seeds by DNS method.

SPOTS: (Three from each theory paper)

1. Batch culture
2. Continuous culture
3. Fermenter
4. Lyophilization
5. Downstream processing
6. Cell immobilization
7. Single cell protein
8. Bio-diesel
9. Cell adhesion
10. Biohazard
11. Continuous cell lines
12. Immune panning
13. Transgenic animals
14. Cell transformation
15. Ian Wilmut

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
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UG PRACTICAL EXAMINATION
Biotechnology (BSBT 621)
SEMESTER- VI

Time: 3 hours

Max. Marks: 80

1. Perform the given Industrial Biotechnology experiment. 23

2. Perform/Demonstrate/Comment on the given Animal Biotechnology experiment 23

3. Identify and comment upon the spots from '1' to '6': 6 x 4 = 24
 1. _____
 2. _____
 3. _____
 4. _____
 5. _____
 6. _____

4. Viva-voce 10