TUMKUR UNIVERSITY

Undergraduate Biotechnology Syllabus (3 Major system) -2024

Syllabus- Theory and Practical

SEP-2024 Curriculum and credit frame work

UG Programme (Biotechnology)

3 subject with practical

Title of the paper	Contact hrs/week	Exam hours	IA	Marks	Total marks	Credits
Fifth Semester						
Biotechnology-V **5BTDSCT-5.1** Immunology-5.1	**4**	**3**	**20**	**80**	**100**	**3**
Biotechnology-V **5BTDSCT-5.2** Genetic Engineering -5.2	**4**	**3**	**20**	**80**	**100**	**3**
Biotechnology-V **5BTDSCP-5.1** Immunology and Genetic Engineering -5.1	**4**	**3**	**10**	**40**	**50**	**2**
Biotechnology Skill **5BTSEC-5** Fundamentals of Bioinformatics	**2**	**1.5**	**10**	**40**	**50**	**1**
Sixth Semester						
Biotechnology-VI **6BTDSCT-6. 1** Industrial and Environmental Biotechnology -6.1	**4**	**3**	**20**	**80**	**100**	**3**
Biotechnology-VI **6BTDSCT-6.2** Plant and Animal Biotechnology -6.2	**4**	**3**	**20**	**80**	**100**	**3**
Biotechnology-VI **6BTDSCP-6.1** Plant, Animal, Industrial and Environmental Biotechnology -6.1	**4**	**3**	**10**	**40**	**50**	**2**
Biotechnology Skill **-6BTSEC-6** Clinical Research and Clinical Trials/Dissertation/Field Visit** **or** Molecular Diagnostic and Forensic Techniques/Dissertation/ Field Visit**	**2**	**1.5**	**10**	**40**	**50**	**1**

****Student can choose any one (optional)**

B.Sc., Biotechnology Semester-V

Course code: 5BTDSCT-5.1

Course Title: Immunology (Theory)

COURSE TITLE	Immunology -5.1
COURSE CREDITS	03
TOTAL CONTACT HOURS	48
DURATION OF EXAM	3 Hrs
FORMATIVE ASSESSMENT MARKS	20
SUMMATIVE ASSESSMENT MARKS	80

Course Outcome: Upon successful completion of this course, students will be able to explain the fundamental concepts of immunology, including the history and scope of immunology, types of immunity, immune cells, lymphoid organs, and the structure, classification, and functions of antigens and antibodies; describe the mechanisms of immune recognition and effector responses, including antigen–antibody interactions, cytokines, chemokines, the Major Histocompatibility Complex (MHC), the complement system, and the principles and applications of immunological techniques used in disease diagnosis; and analyse the immunological basis of hypersensitivity, autoimmune diseases, transplantation, immunodeficiency, and cancer, while evaluating the principles and applications of immunization, vaccination, monoclonal antibodies, and CAR-T cell therapy in disease prevention and treatment.

UNIT 1: Fundamentals of Immunology and the Immune System 16 Hrs

History and Scope of Immunology: Introduction to immunology; historical development of immunology; contributions of Edward Jenner and Louis Pasteur; scope and applications of immunology.

Immunity and Types of Immunity: Definition of immunity; innate and adaptive immunity; active and passive immunity; humoral and cell-mediated immunity; primary and secondary immune responses; immunological memory.

Cells and Organs of the Immune System: Stem cells and hematopoiesis; leukocytes and their functions; B lymphocytes, T lymphocytes, and natural killer (NK) cells; phagocytosis; antimicrobial and cytotoxic activities; antigen-presenting cells (APCs); dendritic cells and mast cells. Primary and secondary lymphoid organs-bone marrow, thymus, lymph nodes, spleen, and mucosa-associated lymphoid tissues (MALT).

Antigens and Antibodies: Definition, types, classification, and properties of antigens; haptens; adjuvants; toxoids; immunogenicity. Structure, classes, properties, and functions of immunoglobulins; theories of antibody formation. Components of immune cells; Cluster of Differentiation (CD) molecules.

UNIT 2: Immune Recognition and Effector Mechanisms 16 Hrs

Antigen-Antibody Interactions: Principles and mechanisms of antigen-antibody interactions; affinity and avidity; precipitation and agglutination reactions; opsonization; complement fixation test; immunofluorescence; radioimmunoassay (RIA); enzyme-linked immunosorbent assay (ELISA); fluorescent antibody techniques.

Cytokines and Chemokines: Definition, classification, properties, biological functions, and role in immune regulation and inflammation.

Major Histocompatibility Complex (MHC): Structure, classification, genetics, antigen processing and presentation, and biological functions of MHC molecules.

Complement System: Components and biological functions; activation pathways (classical, alternative, and lectin pathways); regulation and significance in host defense.

UNIT 3: Clinical Immunology and Immunotherapy 16 Hrs

Hypersensitivity: Definition, mechanisms, and classification of hypersensitivity reactions (Type I, II, III, and IV); clinical examples.

Autoimmunity and Autoimmune Diseases: Mechanisms of autoimmunity; Graves' disease, Myasthenia gravis, Hashimoto's thyroiditis, Systemic Lupus Erythematosus (SLE), Rheumatoid arthritis, and Severe Combined Immunodeficiency (SCID).

Transplantation Immunology: Types of grafts; transplantation antigens; mechanisms of graft rejection; prevention of graft rejection; immunosuppressive therapy.

Cancer Immunology: Tumor antigens; immune surveillance; oncogenes and tumor suppressor genes (p53); immune evasion by tumors; hybridoma technology; production and applications of monoclonal and polyclonal antibodies; CAR-T cell therapy.

Immunization and Vaccination: Principles of immunization; active and passive immunization; adjuvants; types of vaccines; primary and secondary immune responses; schedule and importance of vaccination.

References

1. Kuby Immunology (8th Edition) - Jenni Punt, Sharon Stranford, Patricia Jones.
2. Essentials of Immunology - Dr. S.K. Gupta.
3. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
4. Janeway’s Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.

5. Roitt's Essential Immunology (13th Edition) - Seamus J. Martin and Dennis R Burton - Iran M Roitt.
6. Goldsby R.A. Kindt T.I and Osborne B.A Kuby. 2000. Immunology 4th Edition. WH Freeman &Co, NY.
7. E. Riot. 2011. Essential Immunology 12th Edition. Wiley & Blackwell.
8. Hybridoma technology in the Biosciences and Medicine – Timothy Springer (1985) Plenum Press.
9. Alberts, Bruce, et al. Molecular Biology of the Cell. 7th ed., W. W. Norton & Company, 2022.
10. Lodish, Harvey, et al. Molecular Cell Biology. 9th ed., Macmillan Learning, 2021.

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
CLASS TEST (2 CLASS TEST)	15
ASSIGNMENT/ OPEN DISCUSSION	5
TOTAL	20

Course code: 5BTDSCT-5.2

Course Title: Genetic Engineering (Theory)

COURSE TITLE	Genetic Engineering-5.2
COURSE CREDITS	03
TOTAL CONTACT HOURS	48
DURATION OF EXAM	3 Hrs
FORMATIVE ASSESSMENT MARKS	20
SUMMATIVE ASSESSMENT MARKS	80

Course Outcome: Upon successful completion of this course, students will be able to explain the principles and applications of recombinant DNA technology; describe the structure, properties, and functions of DNA-modifying enzymes, cloning vectors, expression vectors, and host systems used in genetic engineering; perform and interpret gene cloning strategies, PCR-based techniques, site-directed mutagenesis, and genomic and cDNA library construction; analyze recombinant DNA using molecular techniques such as restriction mapping, colony PCR, DNA sequencing, and blotting methods; understand recombinant protein expression, purification, and characterization using different expression systems and affinity-based approaches; evaluate the production and applications of recombinant proteins and biopharmaceuticals in medicine, agriculture, diagnostics, and industry; and demonstrate awareness of biosafety, bioethics, and regulatory considerations associated with recombinant DNA technology.

UNIT 1: Enzymes and Vectors in Recombinant DNA Technology 16 Hrs

DNA-Modifying Enzymes: Introduction to recombinant DNA technology; restriction endonucleases-types (Type I, II, III, and IV), nomenclature, recognition sequences, sticky and blunt ends, isoschizomers, neoschizomers, and applications. DNA polymerases-properties and applications of DNA Polymerase I, Klenow fragment, T4 DNA polymerase, Taq DNA polymerase, Pfu DNA polymerase, Phusion DNA polymerase, and other thermostable DNA polymerases. DNA-dependent RNA polymerases, reverse transcriptase, DNA ligases, alkaline phosphatase, polynucleotide kinase, terminal deoxynucleotidyl transferase, exonucleases, RNases, and their applications in molecular biology.

Cloning and Expression Vectors: Characteristics of ideal cloning vectors; plasmids-structure, high- and low-copy-number plasmids, plasmid replication, copy number regulation, selectable markers, multiple cloning sites (MCS), and reporter genes. Cosmids, phagemids, bacteriophage vectors (λ and M13), shuttle vectors, and expression vectors for prokaryotic and eukaryotic systems. Vector selection based on cloning requirements and applications.

UNIT 2: Gene Cloning Strategies and Host Systems 16 Hrs

Cloning Hosts: Characteristics of ideal host cells; specialized features of cloning hosts including Escherichia coli, yeast (Saccharomyces cerevisiae), animal cell lines, insect cells, and plant cells. Host-vector interactions and selection of suitable expression systems.

Artificial Chromosomes and Advanced Vectors: Yeast Artificial Chromosomes (YACs), Bacterial Artificial Chromosomes (BACs), P1-derived Artificial Chromosomes (PACs), and their construction, principles, advantages, limitations, and applications in genome mapping and large DNA fragment cloning.

Gene Cloning Techniques: DNA cloning using sticky-end and blunt-end ligation; adapter and linker strategies; construction of genomic and complementary DNA (cDNA) libraries; library screening methods. Polymerase Chain Reaction (PCR)-principle, components, thermal cycling, types of PCR (conventional, RT-PCR, multiplex PCR, nested PCR, quantitative PCR), PCR-based cloning approaches, colony PCR, and applications. Site-directed mutagenesis—principle, methods, and applications in protein engineering and functional genomics.

UNIT 3: Analysis of Recombinant DNA and Applications 16 Hrs

Analysis of Cloned Genes: Confirmation of recombinant clones using restriction digestion, colony PCR, DNA sequencing, and restriction mapping. Southern blotting-principle, probe preparation (radioactive and non-radioactive labeling), hybridization, washing, detection, and autoradiography. Introduction to Northern and Western blotting and comparative applications.

Recombinant Protein Expression and Purification: Expression of recombinant proteins in bacterial, yeast, insect, and mammalian systems. Affinity tags (His-tag, GST-tag, MBP-tag, FLAG-tag) and their applications in protein purification and detection. Affinity chromatography and basic protein purification strategies.

Applications of Recombinant DNA Technology: Production of commercially important recombinant products at laboratory scale, including recombinant insulin, human growth hormone, interferons, vaccines, industrial enzymes, and therapeutic proteins. Applications in medicine, agriculture, diagnostics, and industrial biotechnology. Introduction to biosafety, bioethics, and regulatory aspects of recombinant DNA technology.

References

1. Molecular Biology of the gene by Watson J D, Bake T A, Bell SP, Gann A, Lewine M, Losick R 2014
2. Epigenetic Gene Expression and Regulation by Huang S, Litt M D, and Blackey C A, 2015
3. Molecular Cloning - A Laboratory Manual by Michael Green and Joseph Sambrook, CSHL Press, 4th edition, 2014
4. Mechanisms of Gene Regulation: How Science Works by Carsten Carlberg, Ferdinand M
5. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008).
6. Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
7. Stanley Maloy.,(1994). Microbial genetics. (2nd Edition). Jones and Bartlett publisher.

8. Uldis N. Streips and Ronalad E. Yasbin. (2002). Modern Microbial Genetics. (2nd Edition). Wiley-Blackwell.
9. Sandy B., Primrose, Richard M., Twyman, Robert W. Old. (2008). Principles of Gene Manipulation. 6th Edition. Blackwell Science.
10. Daniel L.Hartl. (2011). Analysis of Genes and Genomes. 8th edition. Maryellen Ruvolo. Laxmi Publications.
11. Keya Chaudhuri. (2012). Recombinant DNA Technology. The Energy and Resources Institute, TERI.
12. J.F. Sambrook and D.W. Russell. (2011). Molecular Cloning: A Laboratory Manual. (3rd Edition) Volume 1, 2 and 3. Cold Spring Harbor Laboratory Press.
13. Tvan R.S. (1997). Recombinant Gene Expression Protocols. Humana Press Inc., Tokowa.

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
CLASS TEST (2 CLASS TEST)	15
ASSIGNMENT/ OPEN DISCUSSION	5
TOTAL	20

Biotechnology-V 5BTDSCP-5.1

Immunology and Genetic Engineering-5.1

COURSE TITLE	Biotechnology particals-5
COURSE CREDITS	02
CONTACT HOURS	4 HOURS/WEEK
DURATION OF EXAM	03
FORMATIVE ASSESSMENT MARKS	10
SUMMATIVE ASSESSMENT MARKS	40

Course Outcomes: Upon successful completion of this practical course, students will be able to perform and interpret fundamental immunological and molecular biology techniques, including antigen–antibody reactions, blood grouping, antibody titration, immunoelectrophoresis, Coombs' test, ELISA, haemagglutination inhibition assay, serum separation, and hemolysis testing; isolate genomic DNA from plant and animal tissues; demonstrate PCR and agarose gel electrophoresis; perform comet assay for DNA damage analysis; and develop essential laboratory skills in experimental design, data interpretation, biosafety, and troubleshooting relevant to research and diagnostic applications.

List of experiments

1. Antigen-Antibody reactions- Agglutination (Blood grouping testing).
2. Antibody titration (Ouchterlony Double Diffusion).
3. Antigen-Antibody reactions- Immuno-electrophoresis,
4. Antigen-Antibody reactions- Coomb’s test.
5. Antigen-Antibody reactions- ELISA.
6. Haemagglutination inhibition assay
7. Separation of serum from blood
8. Hemolysis testing
9. DNA isolation from cauliflower
10. PCR demonstration
11. DNA isolation from chicken liver
12. Agarose gel electrophoresis
13. Comet assay

References

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt’s Essential Immunology. 11th edition WileyBlackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby’s Immunology. 6th edition W.H. Freeman and Company, New York.

4. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
7. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN: 13: 978-0-7167-8590-3 /ISBN: 10:0-7617-8590-0.
8. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.
9. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4.
10. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology, W.H. Freeman and Co, New York.
11. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10-14641-0962- 1.
12. Weinberg, Robert. A. The Biology of Cancer (2nd ed.). W. W. Norton & Company.
13. Alberts, Bruce, et al. Molecular Biology of the Cell. 7th ed., W. W. Norton & Company, 2022.
14. Lodish, Harvey, et al. Molecular Cell Biology. 9th ed., Macmillan Learning, 2021.

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
RECORD/ VIVA VOCE	5
CONTINUOUS EVALUATION AND CLASS TEST	5
TOTAL	10

Course Code: 5BTSEC-5
Skill Enhancement Course with Practical -
Fundamentals of Bioinformatics (SEC-Theory)

COURSE TITLE	Fundamentals of Bioinformatics- 5.1
COURSE CREDITS	02
TOTAL CONTACT HOURS	15
DURATION OF EXAM	1.5 Hrs
FORMATIVE ASSESSMENT MARKS	10
SUMMATIVE ASSESSMENT MARKS	40

Course Outcome: Upon successful completion of this course, students will be able to understand the fundamentals of bioinformatics, retrieve and analyse biological data from public databases, perform sequence alignment and similarity searches using bioinformatics tools, and interpret basic protein structure and phylogenetic analyses for biological applications.

Unit I: Fundamentals of Bioinformatics **15 Hrs**

Introduction to Bioinformatics: History, scope, applications and limitations. Introduction to the National Center for Biotechnology Information and its resources. Biological databases: concepts, types and applications of GenBank, PubMed, Swiss-Prot and Protein Data Bank. Sequence analysis: concepts of homology, similarity and identity. Pairwise sequence alignment: local and global alignment. Introduction to sequence alignment tools: BLAST and FASTA. Multiple sequence alignment, phylogenetic analysis and basic protein structure prediction with their applications in biotechnology.

Computer-Based Laboratory Experiments

1. Retrieval of Biological Data from NCBI: Search and retrieve DNA, RNA and protein sequences from the National Center for Biotechnology Information database.
2. Sequence Similarity Search Using BLAST: Perform nucleotide or protein sequence similarity searches using BLAST and interpret the results.
3. Pairwise Sequence Alignment: Compare two DNA or protein sequences using pairwise sequence alignment tools and analyze sequence similarity and identity.
4. Protein Structure Visualization: Retrieve a protein structure from the Protein Data Bank and visualize its three-dimensional structure using molecular visualization software (e.g., PyMOL or Mol* Viewer).

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
CLASS TEST (1 CLASS TEST)	5
ASSIGNMENT/ OPEN DISCUSSION	5
TOTAL	10

References

1. Xiong, J., 2006. Essential bioinformatics. Cambridge University Press.
2. Bioinformatics sequence and Genome analysis by Dawid W. Mount
3. Jiang, R., Zhang, X. and Zhang, M.Q. eds., 2013. Basics of bioinformatics: Lecture notes of the graduate summer school on bioinformatics of China. Springer Science & Business Media.

B.Sc., Biotechnology Semester-VI

Course code: 6BTDSCT-6.1

Course Title: Industrial and Environmental Biotechnology (Theory)

COURSE TITLE	Industrial and Environmental Biotechnology -5.1
COURSE CREDITS	03
TOTAL CONTACT HOURS	48
DURATION OF EXAM	3 Hrs
FORMATIVE ASSESSMENT MARKS	20
SUMMATIVE ASSESSMENT MARKS	80

Course Outcome: Upon successful completion of this course, students will be able to explain the principles of industrial and environmental biotechnology, including microbial fermentation, bioprocess technology, environmental pollution and environmental monitoring; describe fermentation processes, bioreactors, downstream processing, and the microbial production of industrially important products and fermented foods; apply biotechnological approaches for bioremediation, wastewater treatment, solid waste management, and sustainable bioenergy production; and understand the concepts of intellectual property rights, biotechnology entrepreneurship, and the role of biotechnology in sustainable industrial development and environmental conservation.

Unit I: Microbial Fermentation and Bioprocess Technology 16 Hrs

Introduction to Industrial Biotechnology: scope, importance and applications. Isolation, screening and strain improvement of industrially important microorganisms. General concepts of fermentation. Fermentation media: natural and synthetic media; sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inducers and antifoam agents. Monitoring and control of fermentation parameters: temperature, pH, aeration and agitation. General design and components of a stirred-tank bioreactor. Types of fermentation: solid-state and submerged fermentation; batch and continuous fermentation. Downstream processing: microbial growth curve, cell disruption, filtration, centrifugation, extraction, precipitation, chromatography and drying techniques (lyophilization and spray drying). Immobilization of enzymes and whole cells: methods and industrial applications.

Unit II: Industrial Production of Biomolecules, Food Biotechnology and Intellectual Property Rights 16 Hrs

Microbial production of industrially important products: alcohol (ethanol), organic acids (citric acid and acetic acid), antibiotics (penicillin and streptomycin), enzymes (amylase and protease), vitamins (riboflavin and vitamin B12), recombinant products (insulin and hepatitis B vaccine), biodegradable plastics (polyhydroxyalkanoates), single-cell protein (SCP) and Spirulina. Fermented foods and

beverages: bread, yogurt, cheese, vinegar and alcoholic beverages (beer and wine). Principles of food preservation, food spoilage, sterilization, pasteurization and canning. Introduction to Intellectual Property Rights (IPR): patents, TRIPS, WTO, WIPO, Patent Cooperation Treaty (PCT), geographical indications (GI), biotechnology entrepreneurship, biotechnology industries in India and career opportunities.

Unit 1: Environmental Biotechnology **16 Hrs**

Introduction and Environmental Pollution: Scope and significance of environmental biotechnology; renewable and non-renewable energy resources; water, soil and air pollution; xenobiotic and recalcitrant compounds and their environmental impact; global warming, greenhouse effect, ozone depletion and acid rain. Environmental Monitoring: Bioindicators, biomonitoring, biosensors and biochips; biotechnological methods for pollution detection including bioassays, immunoassays and DNA-based methods. Bioremediation: Principles and applications of bioremediation; in situ and ex situ bioremediation; phytoremediation and mycoremediation; biosorption and bioaccumulation of heavy metals; bioremediation of pesticides, plastics and petroleum hydrocarbons; bioleaching and biomining. Wastewater and Solid Waste Management: Characteristics of wastewater; primary, secondary and tertiary wastewater treatment; activated sludge process and anaerobic digestion; biodegradation of DDT, BHC and malathion; biomagnification; principles of solid waste management; composting and vermicomposting; e-waste management and recycling. Bioenergy and Sustainable Technologies: Bioethanol, biodiesel, biogas and biological hydrogen production; biopolymers and biodegradable plastics.

References

1. Clerk, D.P. and Pazdernik, N.J. (2012). Biotechnology - Academic Publisher, California, 2012.
2. Gupta, P.K., (2014). Elements of Biotechnology (Second Edition), Rastogi Publication, New Delhi.
3. Odum, E.P. 1971. Fundamentals of Ecology. W.B.Saunders company, Philadelphia
4. Sharma, P.D. 1990. Ecology and environment. Rsatogi publications, Meerut.
5. Verma P.S. and V.K. Agarwal. 1996. Principles of Ecology. S.Chand. & co., New Delhi.
6. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
CLASS TEST (2 CLASS TEST)	15
ASSIGNMENT/ OPEN DISCUSSION	5
TOTAL	20

B.Sc., Biotechnology Semester-VI

Course code: 6BTDSCT-6.2

Course Title: Plant and Animal Biotechnology (Theory)

COURSE TITLE	Plant and Animal Biotechnology -5.1
COURSE CREDITS	03
TOTAL CONTACT HOURS	48
DURATION OF EXAM	3 Hrs
FORMATIVE ASSESSMENT MARKS	20
SUMMATIVE ASSESSMENT MARKS	80

Course Outcomes: Upon successful completion of this course, students will be able to understand the fundamental principles and applications of plant and animal biotechnology; perform and apply basic techniques in plant tissue culture, micropropagation, animal cell culture, and genetic engineering; explain the methods and applications of transgenic technologies, genome editing, hybridoma technology, and stem cell biology; evaluate the role of biotechnology in agriculture, medicine, and sustainable development through biofertilizers, biopesticides, recombinant products, and tissue engineering; and recognize the importance of biosafety, bioethics, intellectual property rights, and regulatory aspects associated with modern biotechnology.

Unit I: Plant Tissue Culture and Micropropagation **16 Hrs**

Introduction to Plant Biotechnology: scope, history and importance of plant tissue culture. Laboratory organization, aseptic techniques and sterilization methods. Nutrient media: composition and commonly used media (Murashige and Skoog (MS) and Gamborg's B5 media). Plant growth regulators: auxins, cytokinins, gibberellins and abscisic acid, and their role in plant tissue culture. Principles of plant tissue culture: dedifferentiation, redifferentiation and cellular totipotency. Callus culture, cell suspension culture and their applications in the production of secondary metabolites. Organogenesis and somatic embryogenesis. Micropropagation: stages, methods, advantages and applications. Meristem culture, embryo culture and embryo rescue. Production of haploid plants, protoplast culture, somatic hybridization, synthetic seeds and germplasm conservation.

Unit II: Plant Genetic Engineering and Agricultural Biotechnology **16 Hrs**

Introduction to plant genetic engineering. Agrobacterium tumefaciens-mediated gene transfer: Ti plasmid, T-DNA and binary vectors. Direct gene transfers methods: particle bombardment, electroporation and polyethylene glycol (PEG)-mediated transformation. Marker and reporter genes. Applications of transgenic plants: insect resistance (Bt crops), herbicide resistance, disease resistance

and Golden Rice. Genome editing using CRISPR-Cas9. Antisense RNA technology for delayed fruit ripening. Hairy root culture and its applications. Biofertilizers: Rhizobium, Azotobacter, mycorrhiza and cyanobacteria. Biopesticides, integrated pest management and biological nitrogen fixation. Single-cell protein (Spirulina, Chlorella and yeast). Introduction to intellectual property rights (IPR), plant breeders' rights and biosafety issues associated with genetically modified crops.

Unit III: Animal Biotechnology **16 Hrs**

Introduction to Animal Biotechnology: History, scope and applications of animal cell culture. Animal cell culture laboratory: design, aseptic techniques, sterilization and essential equipment. Cell culture media: natural and synthetic media, serum and serum-free media, chemically defined media, basal salt solutions, growth factors and culture conditions. Biology of cultured cells: cell adhesion, proliferation, differentiation, cell viability, growth kinetics and apoptosis. Animal Cell Culture Techniques: Primary and established cell lines. Tissue disaggregation methods (mechanical, enzymatic and EDTA). Monolayer, suspension and organ cultures. Hybridoma technology and production of monoclonal antibodies. Applications of Animal Biotechnology: Production of recombinant proteins and cell culture-based vaccines. Stem cells: embryonic and adult stem cells, basic properties and applications. Transgenic animals and genome editing using CRISPR-Cas9. Introduction to tissue engineering and regenerative medicine. Biosafety and ethical issues in animal biotechnology.

References

1. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology – The genetic manipulation of plants. Oxford University press, USA.
3. Kalyan Kumar De., 1997. Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
4. Mascarenhas A.F., 1991. Hand book of Plant Tissue Culture. Indian Council of Agricultural Research. New Delhi.
5. Devlin, O.P. 1974. Plant Physiology, Affiliated East West Press Pvt. Ltd.
6. Phundan Singh, 2013. Principles of Plant Biotechnology. Kalyani Publishers, India.
7. V. Kumaresan, 2015. Applied Plant Biotechnology. Saras Publication, India.
8. Singh, 2014. Plant Biotechnology, 2nd Revised Edition, Kalyani Publishers, India.
9. Ashwani Kumar, Sudhir K. Sopory. (2013). Recent Advances in Plant Biotechnology and its Applications. L.K. International Pvt. Ltd. New Delhi.
10. B.D. Singh. Plant Biotechnology (2015). Kalyani Publishers.
11. Razdan M.K. Introduction to Plant Tissue Culture. (3rd Edition). Oxford& IBH Publishing Co Pvt. Ltd.
12. Taiz, L. and Zeiger, E. Plant Physiology. Sinauer Associates. 2010 5th Eds.
13. R. Sasidhara, (2019). Animal Biotechnology; Author, R. Sasidhara ; Publisher, MJP Publisher.

14. B Singh, SK Gautam and MS Chauhan. (2013). Textbook of Animal biotechnology. The Energy and Research Institute.
15. M.K. Sateesh. (2010). Biotechnology: V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2nd Edition. New Age International.
16. Freshney, E. D. (2000). Animal Cell Culture: A practical approach. John Wiley Pub. New York.
17. Mather, J.P. and Barnes, D. (Eds.). (1998). Animal Cell Culture Methods (Methods in Cell Biology. Vol. 57). Academic Press, London.
18. Butler, M. (Ed.). (1990). Mammalian Cell Biotechnology - A Practical Approach. Oxford Univ. Press, Oxford.
19. Singer, M. and P. Berg. (Ed.). (1997). Exploring Genetic Mechanisms. University Science Books, Sausilato, CA, USA.
20. E.J. Murray (Ed). (1991). Gene Transfer and Expression Protocols – Methods in Molecular Biology Vol.7. Humana Press, Totowa, NJ.
21. Watson, J.D., M. Gilman, J. Witkouski and M. Zoller. (1992). Recombinant DNA. Scientific American Books, New York.
22. Gahlawat, S.K & Duhan, J.S. (2018). Advances in Animal Biotechnology and its applications. Springer Nature
23. Ed by Verma, A. S. & Singh, A. (2014). Animal Biotechnology: Models in Discovery and Translation. Elsevier

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
CLASS TEST (2 CLASS TEST)	15
ASSIGNMENT/ OPEN DISCUSSION	5
TOTAL	20

Course Code: 6BTDSCP-6.1
Course Title: Plant, Animal, Industrial and Environmental Biotechnology- 6.1 (Practical)

COURSE TITLE	Plant, Animal, Industrial and Environmental Biotechnology (Practical)
COURSE CREDITS	02
CONTACT HOURS	4 HOURS/WEEK
DURATION OF EXAM	03
FORMATIVE ASSESSMENT MARKS	10
SUMMATIVE ASSESSMENT MARKS	40

List of experiments

1. Preparation of Plant tissue culture media (Any one)
2. Preparation of Synthetic seeds
3. Isolation of Protoplast
4. Preparation of Explant for tissue culture
    - Anther or Pollen
    - Stem segment (Nodal)
    - Leaf
    - Shoot tip
5. Callus culture
6. VAM
7. Preparation of Animal cell culture media (Any one)
8. Cell viability assay using Trypan blue exclusion method
9. Cell count by Heamocytometer
10. Preparation of WINE
11. Estimation of Percentage of Alcohol by Specific gravity method
12. Estimation of Total acidity and Volatile acidity
13. Estimation of Citric acid by titration method
14. Estimation of Lactic acid by titration method
15. Immobilization of yeast cells
16. BOD
17. Algal culture
18. COD
19. MPN test
20. Estimation of Dissolved oxygen in water sample
21. Vermicomposting

References

1. M. S. Clark. 1997. Plant Molecular Biology: A Laboratory Manual. Springer-Verlag.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology – the genetic manipulation of plants. 2nd Edition. Oxford University press, USA.

3. H.S. Chawla, 2002. Introduction to Plant Biotechnology. Oxford and IBHP 39 Publishing Co. Pvt. Ltd. New Delhi.
4. Monica. A. Hughes. 1999. Plant Molecular Genetics. Pearson Education limited, England.
5. Harrison, M.S. and Bal, I.R. 1997. General techniques of all culture. Cambridge University press.
6. Prasash M. and Arora. C.K. 1998. Plant tissue culture, Ammol publication Pvt. Ltd.
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FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
RECORD/ VIVA VOCE	5
CONTINUOUS EVALUATION AND CLASS TEST	5
TOTAL	10

Course Code: 6BTSEC-6

Skill Enhancement Course with Practical-
Clinical Research and Clinical Trials/Dissertation/Field Visit**

(**SEC-Theory**)

COURSE TITLE	Clinical Research and Clinical Trials - 6.1
COURSE CREDITS	02
TOTAL CONTACT HOURS	15
DURATION OF EXAM	1.5 Hrs
FORMATIVE ASSESSMENT MARKS	10
SUMMATIVE ASSESSMENT MARKS	40

Course Outcome: Upon successful completion of this course, students will be able to understand the fundamentals of clinical research and clinical trial management, prepare essential clinical trial documents, perform basic laboratory procedures, and apply ethical and Good Clinical Practice (GCP) principles in clinical research.

Unit I: Fundamentals of Clinical Research and Trial Management **15 Hrs**

Introduction to clinical research: definition, history, scope and importance of clinical trials. Common terminology: clinical research, clinical practice, healthy volunteer, patient volunteer, inclusion and exclusion criteria, informed consent, placebo, protocol, principal investigator, randomization, and single- and double-blind studies. Phases and types of clinical trials: diagnostic, prevention, screening and treatment trials. Clinical trial protocol and its essential components. Basics of clinical trial management: case report forms (CRFs), investigator's brochure (IB), investigator and site selection, contract research organizations (CROs), site management organizations (SMOs), and documentation. Introduction to clinical data management, pharmacovigilance, quality assurance, and ethical principles in clinical research, including the Nuremberg Code, Declaration of Helsinki, Belmont Report, and Good Clinical Practice (ICH-GCP).

Practical

1. Preparation and Analysis of an Informed Consent Form
2. Design of a Simple Clinical Trial Protocol
3. Case Report Form (CRF) Design
4. Separation of plasma
5. Separation of serum

References

1. Richard K. Rondel, Sheila A. Varley, Colin F. Webb Clinical Data Management: 2nd Edition.
2. Susanne Prokscha Practical Guide to Clinical Data Management by - Taylor & Francis.
3. Basic Principles of Clinical Research and Methodology by S.K.Gupta
4. Clinician's Guide to Medical Writing: Robert B. Taylor. 1st ed. 2004. Springer Publications.
5. Lawrence M. Friedman (2010). Fundamentals of Clinical Trials, Springer Science & Business Media.
6. David Machin, Simon Day, Sylvan Green (2007). Textbook of Clinical Trials, John Wiley & Sons.
7. Stuart J. Pocock (2013) Clinical Trials: A Practical Approach, John Wiley & Sons.
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9. R K Rondels, S A Varley, C F Webbs (2000). Clinical Data Management edited Second Edition, Wiley Publications

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
CLASS TEST (1 CLASS TEST)	5
ASSIGNMENT/ OPEN DISCUSSION	5
TOTAL	10

Course Code: 6BTSEC-6

Skill Enhancement Course with Practical-

Molecular Diagnostic and Forensic Techniques/Dissertation/ Field Visit**

(SEC-Theory)

Course Outcome: Upon successful completion of this course, students will be able to understand the principles of molecular diagnostics and forensic science, perform basic molecular diagnostic techniques, interpret molecular and immunological test results, and apply DNA profiling and forensic documentation in biological investigations.

Unit I: Molecular Diagnostic and Forensic Techniques **15 Hrs**

Introduction to molecular diagnostics: principles and applications in clinical microbiology. Molecular diagnostic techniques: Polymerase Chain Reaction (PCR), Restriction Fragment Length Polymorphism (RFLP), nucleic acid hybridization, immunofluorescence, enzyme immunoassays (ELISA), and the use of monoclonal and polyclonal antibodies in disease diagnosis. Introduction to forensic science: scope, principles, organization and services of forensic science laboratories. Basic forensic techniques: forensic entomology, injury types, methods of determining cause of death, and the role of criminology in criminal investigations. Principles of DNA fingerprinting: satellite DNA, repetitive DNA sequences, DNA profiling methods, and applications in forensic identification, paternity testing and crime investigation.

Practical

1. Micropipetting and Preparation of PCR Reaction Mixture (Demonstration)
2. Interpretation of PCR and Gel Electrophoresis Results
3. Demonstration of ELISA
4. Virtual PCR primer design using freely available online tools.
5. Documentation and chain of custody for forensic biological evidence.

References

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

FORMATIVE ASSESSMENT	
ASSESSMENT	WEIGHTAGE IN MARKS
CLASS TEST (1 CLASS TEST)	5
ASSIGNMENT/ OPEN DISCUSSION	5
TOTAL	10

Question Paper pattern for Skill Enhancement Course with Practical (SEC)

Duration of exam: 1.5 hours	**The question shall consist of two parts: part a and part b**	**Maximum marks: 40**
Part A (Theory)	Answer any 4 out of 5 questions (Q1 to Q5)	4 × 2 = 08
	Answer any 4 out of 6 questions (Q5 to Q9)	4 × 3 = 12
Part B (Practical)	Answer any 4 out of 5 questions (Q10 to Q13)	4 × 2 = 08
	Answer any 1 out of 2 questions (Q14 to Q15)*	1 × 12 = 12
*Q14 and Q15 question shall have only two sub-divisions (a) and (b) with (4+5)/ (3+6) marks respectively. **In part B,** questions from the experiments related to practical (principle, reactions, reaction mechanisms, structures, formulas, calculations and procedure shall be given).		
In case of Dissertation**	Students opting for the Dissertation component shall submit a dissertation report and make an oral presentation of their work before the examiner(s). The dissertation will be evaluated based on the quality of the report, understanding of the subject, presentation skills, and performance during the viva voce examination. Marks shall be awarded accordingly as per the prescribed evaluation scheme.	
In case of field visit**	Students opting for the field visit component shall participate in an approved visit to a research institution, industry, diagnostic laboratory, food processing unit, or other relevant facility. Each student shall submit a field visit report documenting the observations, learning outcomes, and relevance of the visit to the discipline. Students may also be required to make a presentation before the examiner(s). Evaluation shall be based on participation, quality of the report, presentation, and understanding of the concepts and practices observed during the visit.	

Fifth and Sixth Semester B.Sc Degree Examination, July 2026
(UGSEP 2024)
BIOTECHNOLOGY
Title of the Paper:

Time: 3 Hrs **Max. Marks: 80**

Note to candidates: All sections are compulsory.

SECTION-A

I. Answer any 10 of the following. **(2X10= 20)**

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)
11)

SECTION -B

II. Answer any SIX of the following. **(6X5= 30}**

13)
14)
15)
16)
17)
18)
19)
20)

SECTION -C

III. Answer any THREE of the following. **(3X10=30)**

21)
22)
23)
24)
25)

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