B.Sc. Biotechnology 5th Semester

Program Name	**B.Sc. Biotechnology**		Semester	**5th Semester**
Course Title	**Genetic Engineering (Theory + Practical)**			
Course Code:	**DSC-5T BTC 105**	No. of Theory Credits		**04**
Contact hours	**60hrs**	Duration of ESA/Exam		**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks		**60**

Course Objectives

1. Understand the fundamental principles and techniques of genetic engineering.
2. Explore the applications of genetic engineering in agriculture, medicine, biotechnology, and environmental science.
3. Develop practical skills in genetic engineering techniques and laboratory procedures.
4. Gain knowledge of gene expression regulation and genetic modification methods.
5. Analyze and interpret genetic data using bioinformatics tools.
6. Enhance critical thinking and problem-solving skills through discussions and case studies.
7. Stay updated on emerging trends and advancements in genetic engineering.

Course Outcomes:

1. Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.
2. Apply the knowledge of genetic engineering to diverse applications in agriculture, medicine, biotechnology, and environmental science.
3. Perform laboratory procedures and develop practical skills in genetic engineering techniques. CO4: Explain gene expression regulation mechanisms and apply genetic modification methods effectively.
4. Analyse and interpret genetic data using bioinformatics tools for a comprehensive understanding of gene function and evolutionary relationships.
5. Evaluate genetic engineering's ethical, social, and legal implications and propose responsible solutions.
6. Stay updated with recent advancements in genetic engineering, critically evaluate emerging trends, and assess their potential impact on various fields.

Content of Theory	60 hrs
Unit I- Tools of Genetic Engineering	**15 hrs.**
Definition, scope, and historical overview of genetic engineering. Importance and applications in various fields. **Isolation techniques of DNA and RNA**- Techniques for DNA isolation and purification methods (Plants, animals, microorganisms and plasmids) and RNA. Methods for quantification and characterization. **Recombinant DNA technology** – Introduction to molecular cloning. Prokaryotic and eukaryotic host cell. Overview of cloning vectors. Plasmids, phage, cosmid, BAC, and YAC. Features and applications of cloning vectors in genetic engineering. Enzymes used in recombinant DNA technology: Restriction endonucleases, Polymerases, Ligase, kinases, and phosphatases. Expression vectors.	
Unit II- Techniques in Genetic Engineering	**15 Hrs.**
Gene introduction Techniques - Methods of gene delivery. Physical, chemical, and biological methods. Transformation, transfection, electroporation and micro-injection. **Gene Manipulation Techniques** - Gene knockout techniques in bacterial and eukaryotic organisms. **Screenings of recombinants**: Replica plating, Blue-White selection, colony hybridization, FISH. Protein Expression and Purification. Techniques for expressing recombinant proteins using bacterial, animal, and plant expression systems.	
Unit III- Genome Editing and Applications of Genetic Engineering	**15 Hrs.**
Gene library: Types and applications. **Genome Editing** - Introduction to genome editing techniques- Principles and applications of genome editing techniques- CRISPR-Cas9 and Site-directed mutagenesis. Overview of the diverse applications of genetic engineering. DNA fingerprinting and its applications in forensics. Production of biopharmaceuticals using recombinant DNA technology. The role of biotechnology in sustainable crops and livestock improvement. Industrial applications of genetic engineering, such as enzyme production, biofuel production, and bioremediation.	
Unit IV- Bioinformatics, Biosafety and Bioethics	**15 Hrs.**
Bioinformatics and Computational Tools: Introduction to bioinformatics. Genome sequencing techniques, Genome projects: A brief account on Human Genome Project, biological databases. Tools for biological sequence analysis – Sequence comparison and phylogenetic analysis. Role of Bioinformatics in genetic engineering. **Biosafety assessment of transgenic plants**: Biosafety guidelines, Potential risks and benefits of transgenic plants, International regulatory frameworks for releasing and commercializing genetically modified organisms (GMOs). **Bioethics**: Public perception and consumer acceptance of transgenic plants. Ethical considerations of GMOs. Socio-economic impacts of GMO **IPR and Patents:** A brief account.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Genetic Engineering**	Practical Credits	**02**
Course No./ **Course Code:**	DSC-5P BTC 105	Contact hours	**60 hrs**

Practical

1. **Introduction to Laboratory Techniques -** Safety guidelines and laboratory protocols
   Aseptic techniques and proper handling of materials. Basic equipment and instrument operation
   Preparation of reagents and media
2. **Nucleic Acid Extraction and Quantification-** DNA extraction from different sources (e.g., bacteria, plant, animal). RNA extraction and purification methods. Quality assessment and quantification of nucleic acids (spectrophotometry, gel electrophoresis).
3. **Polymerase Chain Reaction (PCR)**
   Primer design and optimization
   PCR setup and cycling conditions
   Agarose gel electrophoresis for PCR product analysis
4. **Gel Electrophoresis and DNA Analysis**
   Agarose gel electrophoresis for DNA fragment separation and analysis
   DNA size determination using molecular weight markers
   DNA band visualization techniques (e.g., ethidium bromide staining, DNA intercalating dyes)
5. **Bioinformatics for Genetic Engineering**
   Introduction to bioinformatics databases and tools, Sequence analysis (e.g., BLAST, multiple sequence alignment). Prediction of protein secondary structure and function

Practical Assessment

Assessment

Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	50
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

References

1. Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1405156660.
2. Gene Cloning and DNA Analysis: An Introduction (2019) 7th ed., Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
3. Genome 4 (2017) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
4. Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford University Press India, ISBN: 978-0198745891.
5. Genomics and Personalized Medicine: What Everyone Needs to Know (2016) 1st ed., Snyder, M, OUP-USA, ISBN: 978-0190234768.
6. Molecular Biology of the Gene (2014) 7th ed., Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M, and Losick, R, Pearson, ISBN: 978-0321762436.
7. Principles of Gene Manipulation and Genomics (2019) 9th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1119163774.
8. Genomes (2018) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
9. Introduction to Genomics and Proteomics (2015) 2nd ed., Burrell, MM, Wiley, ISBN: 978-0470850075.
10. Genomics: The Science and Technology Behind the Human Genome Project (2019) 2nd ed., Gibson, G, and Muse, SV, Oxford University Press, ISBN: 978-0198786207.
11. Genomics and Evolution of Microbial Eukaryotes (2019) 1st ed., Katz, LA, and Bhattacharya, D, Oxford University Press, ISBN: 978-0198830202.
12. Essentials of Genomic and Personalized Medicine (2016) 2nd ed., Ginsburg, GS, and Willard, HF, Academic Press, ISBN: 978-0124078652.
13. Genomic Medicine: Principles and Practice (2014) 2nd ed., Ginsburg, GS, and Willard, HF, Oxford University Press, ISBN: 978-0199334468.
14. Genomic Medicine in Resource-limited Countries: Genomics for Every Nation (2019) 1st ed., Wonkam, A, Puck, JM, and Marshall, CR, Academic Press, ISBN: 978-0128133003.
15. Molecular Genetics and Genomics (2020) 1st ed., Krebs, JE, and Goldstein, ES, Jones & Bartlett Learning, ISBN: 978-1284154544.
16. Bioinformatics and Functional Genomics (2015) 3rd ed., Pevsner, J, Wiley-Blackwell, ISBN: 978-1118581780.
17. Genomic Approaches for Cross-Species Extrapolation in Toxicology (2019) 1st ed., Wichard, J, and Maertens, A, CRC Press, ISBN: 978-0815348023.
18. Introduction to Genetic Analysis (2020) 12th ed., Griffiths, AJF, Wessler, SR, Carroll, SB, and Doebley, J, W.H. Freeman, ISBN: 978-1319149609.
19. Genetic Engineering: Principles and Methods (2019) 3rd ed., Fowler, MR, CABI, ISBN: 978-1789240605.

B.Sc. Biotechnology 5th Semester

Program Name	**B.Sc. Biotechnology**		Semester	**5th Semester**
Course Title	**Plant and Animal Biotechnology (Theory + Practical)**			
Course Code:	**DSC-6T BTC 106**		No. of Theory Credits	**04**
Contact hours	**60hrs**		Duration of ESA/Exam	**3 Hours**
Formative Assessment Marks		**40**	Summative Assessment Marks	**60**

Course Objectives

1. To understand the fundamental aspects of plant tissue culture.
2. Learn about biotechnological tools and techniques used in plant research and agriculture.
3. Explore methods of introducing foreign genes into plants through transformation techniques.
4. Gain practical skills in plant tissue culture for plant improvement and propagation.
5. To understand the concepts of modern technology pertaining to large-scale production of agricultural products and evaluate several methods for stable and transient plant transformation.
6. Design strategies for plant genetic manipulation against biotic and abiotic stressors.
7. Hypothesize strategies to increase plant yield and fruit/seed quality.

Course Outcomes:

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

1. Demonstrate a comprehensive understanding of plant biology, physiology, genetics, and molecular biology.
2. Apply biotechnological tools and techniques used in plant research and agriculture, such as plant tissue culture, genetic engineering and transgenics.
3. Execute plant tissue culture techniques for callus induction, somatic embryogenesis, and micropropagation, and apply them in plant breeding and propagation.
4. Perform plant transformation methods and demonstrate the ability to introduce foreign genes into plants using different techniques.
5. Utilize molecular markers and genomic approaches for genetic mapping, marker-assisted selection, and plant breeding programs.
6. Apply molecular biology techniques, including PCR, DNA sequencing, and gene expression analysis, to investigate and analyze plant genetic information.
7. Utilize bioinformatics tools and databases to analyze and interpret plant genomic and transcriptomic data.
8. Apply knowledge about ethical considerations and regulatory frameworks associated with plant biotechnology and genetically modified crops.
9. Apply acquired knowledge and problem-solving skills to address real-world challenges in agriculture, food security, and environmental sustainability using plant biotechnology approaches.

Content of Theory	60 hrs
Unit–I – Plant Tissue culture	**15 hrs.**
Introduction, history, definition, and concept of totipotency. Principles of plant tissue culture-cytodifferentiation and morphogenesis, Media and laboratory organization. Techniques – Organ culture (meristem and embryo), callus culture, Somatic embryogenesis and synthetic seeds. **Haploid culture** – Anther, Pollen and Ovule culture, A brief account on protoplast culture and somatic hybridization. Somaclonal variation. **Secondary metabolites-** *In vitro* secondary metabolite production, Suspension cultures, cell cultures, growth vs secondary metabolite production, bioreactors and scaling up of secondary metabolite production, limitations, and applications. Production of (Shikonin and Ginseng).	
Unit -II Unit -II Transgenic Plants and Biofertilizers.	**15 hrs.**
Overview of transgenic plants and their significance in agriculture. - Techniques for introducing foreign genes into plants: Agrobacterium-mediated transformation, biolistic, microinjection, electroporation and chemical mediated transformation. Role of reporter genes in screening and selection. Plant Molecular markers. **Applications of Transgenic Plants** - Improved crop traits through genetic engineering: pest resistance, herbicide tolerance, disease resistance, and abiotic stress tolerance. **Biofertilizers-** Rhizobium, Micorrhiza, Azolla	
Unit–III Animal Cell culture methods	**15 Hrs.**
History and laboratory organization, Media. Cell types and culture characterstics. Pluripotency, Multipotency, Differentiation, Trans differentiation and Reprogramming. **Biology and characterization of cultured cells**- cell adhesion, proliferation, differentiation, morphology of cells, and identification. The basic technique of mammalian cell culture in vitro, Measuring parameters of growth in cultured cells, cell viability, and cytotoxicity. Large-scale culture of cell lines- monolayer, suspension, and immobilized cultures. **Organ and histotypic culture-** Technique, advantages, limitations, applications. Stem cells: types (embryonic, adult, induced pluripotent), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues.	
Unit IV –Transgenic animals and cloning.	**15 hrs.**
Gene constructs, promoter/ enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase and CAT. **Transfection of animal cells**- calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, Retrovirus, microinjection. Transgene identification methods. **Transgenic and genome-edited animals-** Ethical issues in transgenesis. Manipulation of animal reproduction and characterization of animal genes, Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development. Group discussion and critical analysis of scientific papers related to transgenic plants.

Summative Assessment = 60 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Plant and Animal Biotechnology**	Practical Credits	**2**
Course No./ **Course Code:**	**DSC- 6P BTC 106**	Contact hours	**60 hrs**

Content of Practical

1. Laboratory organization of basic and commercial plant tissue culture
2. Media preparation (MS, B5), solid media preparation, and Liquid media preparation
3. Explant preparation – Leaf, bud, rhizome, and meristem
4. Synthetic seed production
5. Callus culture- Initiation and establishment of different types of callus cultures
6. Micropropagation with a suitable example – Stage 0. 1, 2, 3, and 4
7. Staining, cell viability, and cell count of cell cultures
8. Preparation of cell culture media: Preparation of basic cell culture media, such as Dulbecco's Modified Eagle Medium (DMEM), antibiotics, and other required additives.
9. Extraction of serum.
10. Aseptic techniques and sterile handling: Practicing aseptic techniques, including properly handling tools and equipment, working in a laminar flow hood, and maintaining sterility throughout the cell culture process.
11. Filter sterilization: Practice filter sterilization for sensitive media ingredients.
12. Cell counting and viability assessment: Count cells using a hemocytometer or automated cell counter, and perform viability assays (e.g., trypan blue exclusion) to determine the percentage of viable cells.
13. Cell staining and microscopy: Staining the cultured cells using dyes such as hematoxylin and eosin (H&E), and observe them under a light microscope to study cell morphology and structure.
14. Contamination identification and troubleshooting: Learn to identify and troubleshoot common issues in cell culture, such as contamination by bacteria, fungi, or mycoplasma, and implement appropriate corrective measures.
15. Experimental design and data analysis: Students can design and execute simple experiments, record and analyze data, and interpret the results based on their observations and measurements.

Practical Assessment			
Assessment			
Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	50
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

References

6. Bhojwani, S.S., and Razdan, M.K. (2004). Plant Tissue Culture: Theory and Practice. Amsterdam: Elsevier Science.
7. Brown, T.A. (2010). Gene Cloning and DNA Analysis: An Introduction. 7th edition. Oxford: Wiley-Blackwell.
8. Gardner, E.J., Simmons, M.J., and Snustad, D.P. (2008). Principles of Genetics. 10th edition. Hoboken, NJ: John Wiley & Sons.
9. Glick, B.R., and Pasternak, J.J. (2018). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th edition. Washington, DC: ASM Press.
10. Raven, P.H., Johnson, G.B., Losos, J.B., and Singer, S.R. (2013). Biology. 10th edition. New York, NY: McGraw-Hill Education.
11. Reinert, J., and Bajaj, Y.P.S. (1997). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Berlin: Springer.
12. Russell, P.J. (2013). iGenetics: A Molecular Approach. 3rd edition. Boston, MA: Benjamin Cummings.
13. Sambrook, J., Fritsch, E.F., and Maniatis, T. (1989). Molecular Cloning: A Laboratory Manual. 2nd edition. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
14. Slater, A., Scott, N.W., and Fowler, M.R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
15. Smith, R. (2012). Plant Tissue Culture: Techniques and Experiments. 3rd edition. San Diego, CA: Academic Press.
16. Taiz, L., and Zeiger, E. (2014). Plant Physiology. 5th edition. Sunderland, MA: Sinauer Associates.
17. Vasil, I.K., and Vasil, V. (2007). Molecular Improvement of Cereal Crops. Dordrecht: Springer
18. Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press. ISBN: 978-1316614761.
19. Gahlawat, S.K., Duhan, J.S., Salar, R.K., Siwach, P., Kumar, S., & Kaur, P. (2018). Advancesin Animal Biotechnology and its Applications. Springer. ISBN: 978-981-10-4701-5.
20. Primrose, S.B., & Twyman, R.M. (2016). Principles of Gene Manipulation (8th ed.).Blackwell Science. ISBN: 978-1405135442.
21. Verma, A., & Singh, A. (2013). Animal Biotechnology. Elsevier. ISBN: 978-0124160026.Glick, B.R., & Pasternak, J.J. (2009). Molecular Biotechnology (4th ed.). ASM Press. ISBN:978-1555814984.
22. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
23. Watson, J.D., Meyers, R.M., AC, A., & AW, J. (2006). Recombinant DNA (3rd ed.). ColdSpring Harbor Laboratory Press. ISBN: 978-0716728665.

24. Clynes, M. (Ed.). (1998). Animal Cell Culture Techniques. Springer.
25. Masters, J.R.W. (Ed.). (2000). Animal Cell Culture - Practical Approach. Oxford University Press.
26. Freshney, I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (8th ed.). Wiley-Blackwell.
27. Pörtner, R. (Ed.). (2007). Animal Cell Biotechnology: Methods and Protocols. Humana Press.
28. Singh, B., & Gautam, S.K. (2013). Textbook of Animal Biotechnology. The Energy and Resources Institute (TERI).
29. Gupta, P.K. (2018). Animal Biotechnology. Rastogi Publications.
30. Mather, J.P., & Barnes, D. (Eds.). (Year N/A). Animal Cell Culture Methods. In Methods inCell Biology, Vol. 57. Academic Press.
31. Singh, B.D. (2006). Biotechnology: Expanding Horizons (3rd ed.). Kalyani Publishers.
32. Srivastava A.K. Animal Biotechnology. (2018). Oxford & IBH Publishing Co Pvt.Ltd,458pp.

B.Sc. Biotechnology 6th Semester

Program Name	**B.Sc. Biotechnology**	Semester	**6th Semester**
Course Title	**Immunology and Medical Biotechnology (Theory + Practical)**		
Course Code:	**DSC -7T BTC 107**	No. of Theory Credits	**04**
Contact hours	**60hrs**	Duration of ESA/Exam	**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Objectives

1. To understand the basic aspects of medical biotechnology, pathogenesis of human diseases, disease diagnosis, management, drug discovery, development and Clinical research.
2. To provide an overview of genetic diseases and the diagnostic techniques used in the medical field.
3. This course focuses on the relationship between microbes and human health. Students will study important diseases emphasizing on etiology, pathogenesis, diagnosis, treatment, and prevention.

Course Outcomes:

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

1. Understanding the basics of genetic information responsible for disease development
2. Understanding the classical and advanced methods used for the diagnosis of various diseases
3. Students will have a clear understanding of microbial diseases, host pathogen interactions, and the issues associated with drug-resistant microorganisms.
4. Students also comprehend the significance of normal flora associated with human health.
5. They will also learn about drug- Receptor interactions, drug toxicology and its pharmacological significance, conducting clinical trials, ethical issues in clinical research and a preliminary idea about artificial intelligence and personalized medicine as highly emerging areas in medical science.

Content of Theory	60 hrs.
Unit I: Cells and Organs of the Immune System	**15hrs**
Introduction to the Immune System: History of Immunology, Types of Immunity: first and second line of defense, innate and acquired/adaptive immunity, specificity, diversity. Cells of the immune system: Antigen-presenting cells (APCs), Role of B and T-lymphocytes in Humoral immunity and cell-mediated immunity, primary and secondary immune response, Immunization, memory. Organs of the Immune system: Thymus, bone marrow, spleen, Lymph Node, peripheral lymphoid organs	
Unit -II Molecules of the Immune System	**15 hrs.**
Antigens and haptens: Properties (foreignness, molecular size, heterogeneity). Adjuvants. Antigenicity and Immunogenicity. Affinity and Avidity. B and T cell epitopes, superantigens Immunoglobulins: Classification, structure, and function. Antibody diversity, Monoclonal and polyclonal antibodies. Major histocompatibility complexes: Classification, structure, and function. Cytokines: Classification and function, Hypersensitivity: Reactions – Types I, II, and III. Delayed Type Hypersensitive Response.	
Unit -III Immunotechniques and vaccines	**15 hrs.**
Structure and properties of antigens- iso- and allo-antigens, antigen specificity, Cross-reactivity, Precipitation, Immunodiffusion reactions: Radial immunodiffusion, Ouchterlony double diffusion, Immunoelectrophoresis. Agglutination: Agglutination reactions. ELISA, RIA. Immunocytochemistry, Fluorescent Techniques. Vaccines: Conventional vaccines (Live attenuated, heat killed and toxoid), Recombinant vaccines-subunit (Peptide, Protein and DNA) Attenuated recombinant vaccine, vector recombinant vaccine. CoVID19 vaccines. edible vaccines, plantibodies, and Cancer vaccines.	
Unit IV: Microbial disease of human and therapy	**15 hrs.**
Microbial diseases in humans**:** Mode of infection, symptoms, epidemiology and control measures of diseases caused by Viruses (Hepatitis-B), Bacteria (Typhoid), Fungi (Aspergillosis), Protozoa (Malaria) Autoimmune disorders with examples. Immunodeficiencies: Primary and secondary, immunodeficiencies; acquired immunodeficiency syndrome. cancer immunotherapy. Role of biotechnology in diagnosis and therapy. Gene therapy.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Immunology and Medical Biotechnology**	Practical Credits	**02**
Course No.	**DSC-7P BTC 107**	Contact hours	**60 hrs**

Content of Practical

1. Hemagglutination of ABO Blood groups
2. Determination of Rh factor
3. Whole Count of WBC using Hemocytometer
4. Cells of the Immune System (differential
5. Radial immunodiffusion
6. Ouchterlony double diffusion
7. ELISA – Demonstrate
8. Serum Immunoelectrophoresis
9. Western Blotting
10. Determination of blood clotting time
11. Haemoglobin estimation using a haemometer
12. Estimation of serum cholesterol
13. Demonstration using Diagnostic kits
14. SGOT
15. SGPT and
16. Blood Urea
17. Widal test
18. VDRL test

Practical Assessment

Assessment

Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	50
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

References

1. Textbook of Immunology, Paul Ajoy, Books and Allied (P) Ltd., 2016
2. Kuby Immunology. Kindt T.J. et at., W.H. Freeman & Co. 2018
3. Cellular and Molecular Immunology. Abbas, A.K. et al., Elsevier Saunders Co., 2015
4. Essential Immunology. Riott, I.M., Blackwell Scientific Publications, 1994
5. Handbook of Experimental Immunology, Vol. 1 & 2, Weir D.M., Wiley, 1997
6. Immunology. Riott, I.M., Brostoff J., Male, D. Mosby Pub., 2017
7. Immunobiology. Janeway C.A. and Travers, P. Churchill Livingstone Pub., 2016
8. Practical Immunology. Hudson L. and Hay F.C., Blackwell Scientific Pub., 1989
9. Robbins S.L. (1974) Pathological basis of Disease. W B Saunders Company
10. Guyton A.C. and Hall J.E. (2006) Textbook of Medical Physiology 11th edn. Saunders
11. Hage D S and Carr J D, (2010) Analytical Chemistry & Quantitative Analysis, Prentice Hall
12. Brant W.E. and Helms C.A. (2007) Fundamentals of Diagnostic Radiology, 3rdedn. Lippincott Williams &Wilkins.
13. Glick B. R. and Pasternak J. J. 1994 "Molecular Biotechnology Principles"
14. Jogd and S N. Medical Biotechnology 2nd Edition Himalaya publishers 2008
15. Strayer L. Biochemistry 4th Ed. (1995) W.H. Freeman Co., San Francisco, U.S.A.
16. Vishal Bansal Parar, Clinical Research Fundamental and Practice, Medical Publisher, 2010.
17. Jaypee brothers. Basic Principles of Clinical Research and Methodology, Medical Publishers (P) Ltd., 2009.
18. Gupta, S.K. Basic Principles of Clinical Research and Methodology, 1st edition,2009.
    Richard B Silverman, Organic Chemistry of Drug Design and Drug action Elsevier Science, Academic Press.2014.
19. Friedman LM, Furberg CD, DeMets DL, Reboussin DM, Granger CB. Fundamentals of Clinical trials,Springer Nature, Switzerland AG, 2015.
20. Instant Notes in Immunology. Lydyard PM et al. Viva Books Pvt. Ltd., 2011
21. Abbas AK, Lichtman AH, and Pillai S. (2019). Basic Immunology- Functions and Disorders of the Immune System. Elsevier,
22. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. W.B. Saunders Publisher. Philadelphia.
23. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4th edition- Wiley-Liss. New York.
24. Borrebacc, C.A.K. (1995). Antibody Engineering, 2nd edition. Oxford University Press, Oxford.
25. Dimmock, N.J., Primrose, S.B. (1994). Introduction to Modern Virology, Blackwell Science Ltd. Oxford.
26. Hyde, R.M. (1992). Immunology, 2nd edition, Williams and Wilkins, Baltimore.
27. Kuby, J. (2003). Immunology 5th Edition. WH. Freeman and Company, NY.
28. Klaus D. Elgert (1996). Immunology. ELBS, Blackwell Scientific Publishers, London.
29. Roitt, I.M. (2017). Essential Immunology, Thirteenth edition, ELBS, Wiley Blackwell Scientific Publishers, London.
30. Goldsby, R.A, Kindt TJ and Osborne A (2000). Kuby Immunology, 4th edition, W.H. Freeman and Company, New York
31. Tizard I.R. (1995). Immunology, 4thedition, W.B. Saunders Publisher. Philadelphia.
32. Paul W.E (1989). Fundamentals in Immunology, Raven Press. NY

B.Sc. Biotechnology Sixth Semester

Program Name	**B.Sc. Biotechnology**		Semester	**6th Semester**
Course Title	**Bioprocess Technology and Environmental Biotechnology (Theory)**			
Course Code:	**DSC-8T**	**BTC 108**	No. of Theory Credits	**04**
Contact hours	**60hrs**		Duration of ESA/Exam	**3 Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Objectives:

1. The objective of this paper is to introduce students to the fundamentals of bioprocess engineering and technology, and its industrial applications, thus enabling the students to understand the requirements of bioprocess technology in advanced and emerging areas of biological science.
2. The field of biotechnology is developing very rapidly and needs skilled engineers with a bioprocess engineering background to design, build, control, and operate bioreactors and fermenters.
3. Design bioreactors for the production of various products.
4. Analyze and formulate mechanisms for enzymatic reactions.
5. Understand soluble and immobilized enzyme technologies for the production of industrial and medical products.
6. Predict important yield coefficients using the principles of stoichiometry and energetics of microbial growth.
7. Perform simulations of microbial growth and metabolism.
8. Present knowledge about major metabolic pathways and those related to biofuel production from microbes.
9. Analyze metabolic network and metabolic flux.
10. Estimate kinetic parameters from raw fermentation data.
11. Specify required technologies to effectively utilize genetically engineered microorganisms for bioprocessing.

Course outcome:

At the end of the course, the student should be able to:

1. Students can understand the exploitation of microorganisms for industrial use and their improvement, stoichiometric analysis, and formulation of media for efficient growth and production of microbial or cell-based products.
2. Students will also have an idea about the design, operation, and specific applications of various bioreactors.
3. Graduates acquire professional leadership roles in bioprocess engineering and related fields leading to successful career.
4. Graduates establish commitment and contribute toward sustainable and bio-based economic development for a better society.
5. Graduates engage in lifelong learning by conducting practical engineering tasks.
6. Able to acquire a sound knowledge in mathematics and natural science and apply engineering principles in determining and solving contemporary and complex problems related to bioprocessing. Able to formulate and operate conversion processes of biological resources into bio-based value-added materials related to food, feed, fuels,

pharmaceutical, nutraceutical, biomaterials, or biochemicals.

7. Able to design biological reactions and reactors including their materials, instrumentation, control, and modeling.
8. Able to communicate a creative idea and works effectively within the professional community and larger society.
9. Able to demonstrate an ability to work in multidisciplinary and multicultural teams in developing innovative engineering solutions using complex problem-solving skills.
10. Able to conduct practice-based tasks related to bioprocessing in a responsible, safe, voluntary, self-motivated, and ethical manner.
11. Able to appraise bioprocessing and bioproducts manufacturing and valorization using entrepreneurship principles

Content of Theory	**60 hrs.**
UNIT- I – Introduction to bioprocess technology	**10hrs**
Basic 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-Bioreactors and downstream processing	
Bioreactors- Design and components - Impeller, Baffles, Sparger; **Specialized bioreactors**- design and their functions: airlift bioreactor, tubular bioreactors, membrane bioreactors, tower 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, biosensors-construction and applications, Microbial production of ethanol, amylase, Penicillin, Vinegar and Single Cell Proteins.	**20hrs**
Unit III- Fundamentals of Environmental Biotechnology	**15hrs**
Introduction to Environmental Biotechnology- Principles of Environmental Science. Role of Biotechnology in Environmental Conservation. Microbial Processes in Environmental Biotechnology. Pollution and Biotechnology – Major issues in environmental pollution and the role of biotechnology in addressing them. Use of biosensors in pollution monitoring. Biotechnological Methods in Pollution Abatement-Reduction of CO2 emission. Addressing eutrophication through biotechnological interventions. Application of cell immobilization techniques in pollution abatement.	
Unit IV- Bioremediation and Waste Management	**15hrs**
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. Bio metallurgy and bio-mining. Waste water Management. Waste water Characterization and Composition. Biological Processes in Waste water Treatment. Activated Sludge Process and Biological Nutrient Removal, Anaerobic Digestion and Biogas Production. Solid Waste Management. Xenobiotics – Characterstics, types and their bidegradation.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

ourse Title	**Bioprocess Technology**	Practical Credits	**02**
Course No.	**DSC- 8P BTC 108**	Contact hours	**60 hrs**

Content of Practical

1. Bacterial growth curve.
2. Calculation of the thermal death point (TDP) of a microbial sample.
3. Study of fermentor- Demonstration.
4. Production of wine–estimation of the percentage of alcohol, total acidity & volatile acidity in wine.
5. Production and analysis of ethanol.
6. Production and analysis of amylase.
7. Production and analysis of lactic acid.
8. Isolation of industrially important microorganisms from natural resources.
9. Estimation of Biological Oxygen Demand
10. Estimation of Chemical Oxygen Demand
11. Visit to Vermicompost/Biofertilizer/Biogas facility.

Practical Assessment			
Assessment			
Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	50
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

References

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (3rd Edn.).2022
6. Cambridge University Press. 2002.

7. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
8. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor &Francis Ltd, UK, 2007.
9. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001.
10. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003.
11. Prentice Hall, Engelwood Cliffs, 2002.
12. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984.
13. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition
14. Handbook of Medicinal and Aromatic Plants by S.K. Bhattacharjee (2004).
15. Recent Progress in Medicinal Plants Vol.12, Globalization of Herbal Health by A.K.Sharma (2006).
16. Handbook of Ayurvedic Medicinal Plants by L.D. Kapoor (2005).
17. Indian Medicinal Plants (Vol 1- 4) by K.R. Kirtikar and B.D. Basu (2006). Medicinal Plants Cultivation: A Scientific Approach by S.S. Purohit (2004)
18. Direct uses of medicinal plants and their identification by Vardhana, Sarup and Sons, AnsariRoad, Dariyaganj, New Delhi (2008).
19. Medicinal Plant Biotechnology. Beauchamp J. W., 2011 CBS HB; First Edition
20. Medicinal Plant Biotechnology. Ciddi Veeresham. CBS Publishers & Distributors, 2008
21. Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry.
22. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
23. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
24. Ram P Rastogi, Compendium of Indian Medicinal Plants Vol. I-V, CSIR, Lucknow &NISCOM, New Delhi, 1998.