DAVANGERE UNIVERSITY
DAVANGERE-577007

CURRICULUM CONTENTS

IN

BIOTECHNOLOGY

NEW SYLLABUS-SEP (2024-25)

Undergraduate Course B.Sc.

5th and 6th Semester

DAVANGERE UNIVERSITY

SHIVAGANGOTRI

DAVANGERE-577007

18/02/26
Chairman
Board of Studies
Department of Studies in Biotechnology
Davangere University
Shivagangotri, Davangere - 577 007.

18/02/2026.

18/02/2026

18/02/2026

18/2/26

Prof. M. Govindappa
Dean Science & Technology
Davangere University
Shivagangotri, Davangere-577007

Registrar
Davangere University
Shivagangotri, Davangere.

Continuous Assessment Programme/Internal Assessment/Formative Assessment

Semester-V								
5	**24-MCBT-VA - RECOMBINANT DNA TECHNOLOGY**	**MCBT-T**	04	80	20	**100**	03	3 Hrs.
	24-MCBT-VB - IMMUNOLOGY	**MCBT-T**	04	80	20	**100**	03	3 Hrs.
	Practical – V RECOMBINANT DNA TECHNOLOGY AND IMMUNOLOGY	**MCBT-P**	04	40	10	**50**	02	3 Hrs.
	24-MCBT-VC- ELEMENTARY RESEARCH METHODOLOGY	**MCBT-T**	2	40	10	**50**	02	2 Hrs
	Total		**12**	**160**	**40**	**200**	**10**	---
Semester-VI								
6	**24-MCBT-VIA PLANT AND ANIMAL BIOTECHNOLOGY**	**MCBT-T**	04	80	20	**100**	03	3 Hrs.
	24-MCBT-VIB INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY	**MCBT-T**	04	80	20	**100**	03	3 Hrs.
	Practical – VI PLANT AND ANIMAL BIOTECHNOLOGY INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY	**MCBT-P**	04	40	10	**50**	02	3 Hrs.
	Dissertation/Project	**AEDP**	02	40	10	**50**	02	2 Hrs.
	Total		**14**	**160**	**40**	**200**	**10**	---

MC: *Major Course*; **MC-T:** *Major Course Theory*; **MC-P:** *Major Course Practical*;
El/Op: *Elective/Optional*; **AEDP:** *Apprenticeship Embedded Degree Programme.*

Major Courses

Sl. No.	Continuous Assessment Programme/Internal Assessment	
(1)	(2)	
01	Two Session Tests with proper record for assessment (5+5 = 10)	
02	Assessment of Skill Development activities/Seminars/Group Discussion/ Assignment etc., with proper record	
03	• Attendance with proper record	
TOTAL MARKS		

- **Attendance Marks-breakup**

<75%	-	00 Marks
75-80%	-	01 Mark
80-85%	-	02 Marks
85-90%	-	03 Marks
90-95%	-	04 Marks
>95%	-	05 Marks

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Continuous Assessment Programme/Internal Assessment/Formative Assessment
Elective/Optional Papers

Sl. No.	Continuous Assessment Programme/Internal Assessment	Maximum Marks
(1)	(2)	(3)
01	Two Session Tests with proper record for assessment (2+2 = 4)	**04**
02	Assessment of Skill Development activities/Seminars/Group Discussion/ Assignment etc., with proper record	**03**
03	• Attendance with proper record	**03**
TOTAL MARKS		**10**

- **Attendance Marks-breakup**

<75%	-	00 Marks
75-80%	-	01 Mark
85-90%	-	02 Marks
90-100%	-	03 Marks

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THEORY EXAMINATION QUESTION PAPER PATTERN FOR MAJOR SUBJECTS

(Semesters I –VI)

B.Sc. Semester-I Degree Examination; 2024-25

(Semester Scheme; New Syllabus: 2024-25)

SUBJECT: Biotechnology

Paper –_____: _____

Paper Code: _____

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

Instructions to candidates:

1) All sections are compulsory
2) Draw neat and labelled diagrams wherever necessary.

SECTION-A

1. Answer **all** the following questions: **(2×10=20)**

a)

b)

c)

d)

e)

f)

g)

h)

i)

j)

SECTION-B

Answer any **SIX** of the following: **(5×6=30)**

2. From Unit I

3. From Unit I

4. From Unit II

5. From Unit II

6. From Unit III

7. From Unit III

8. From Unit IV

9. From Unit IV

SECTION -C

Answer **Any Three** of the following: **(10×3=30)**

10. From Unit I

11. From Unit II

12. From Unit III

13. From Unit IV

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THEORY EXAMINATION QUESTION PAPER PATTERN FOR ELECTIVE/OPTIONAL PAPERS

(Semesters III & IV)

B.Sc. Semester-I/II/III/IV/V Degree Examination; 2024-25

(Semester Scheme; New Syllabus: 2024-25)

SUBJECT: Biotechnology

Paper – _____: _____

Paper Code: _____

Time: 2 Hours **Max. Marks: 40**

Instructions to candidates:

1) All sections are compulsory
2) Draw neat and labelled diagrams wherever necessary.

SECTION-A

Answer **all** the following questions: **(2×5=10)**

1.
2.
3.
4.
5.

SECTION-B

Answer any **SIX** of the following: **(5×6=30)**

6.
7.
8.
9.
10.
11.
12.
13.

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SEMESTER-V

24-MCBT-VA- RECOMBINANT DNA TECHNOLOGY

TOTAL HOURS- 56

Course Learning Objective:

a) To understand the basics of Recombinant DNA technology.
b) To study the tools of Genetic engineering
c) To study applications of Recombinant DNA technology
d) To learn the importance of Recombinant DNA technology in Diagnostics and Therapeutics
e) To study the importance of genetic engineering on human health

Course Outcome: On successful completion of the course, students are able to
a) Understand the molecular aspects of Recombinant DNA technology
b) Understand the importance of Recombinant DNA technology in production of Biopharmaceuticals.
c) Understand the role of Recombinant DNA technology in molecular diagnostics and therapeutics
d) Understand the regulatory aspects of Recombinant DNA technology.

Unit-I: Tools of Recombinant DNA technology **14hrs**

Introduction: Historical perspectives and scope. Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Handling, quantification and storage of nucleic acid.
r-DNA Enzymes: Restriction Enzymes: Types, nomenclature, Type II restriction endonucleases, recognition of sequences, cleavage patterns and modifications of cut ends. DNA Modifying Enzymes: DNA ligase, DNA polymerase, Polynucleotide kinase, Reverse transcriptase and their applications.
Cloning vectors: Host cell types-Prokaryotic hosts, Eukaryotic hosts, Uses of promoters, Types and Properties of good vectors: Plasmids-pBR322 and pUC18; Hybrid plasmid/phage vectors- Cosmids, Animal viruses-SV40, retroviruses; Bacteriophage vectors- Lambda phage as natural vector, Plant vectors-Ti-plasmid, Artificial chromosomes-BAC, YAC and HAC.

Unit-II: Techniques of Recombinant DNA technology **14hrs**

Gene cloning: Preparation of DNA fragments for cloning; Ligation, packaging, and amplification; Expression of cloned DNA molecules; Cloning large DNA fragments in BAC and YAC vector. Screening of recombinant DNA: Insertional inactivation, colony hybridization, replica plating technique.**Screening techniques:** Nucleic acid hybridization: RNA and DNA probes, cDNA probes Restriction mapping, DNA Sequencing, Fluorescent *in situ* Hybridization. Blotting techniques-Southern, Northern and Western blotting. **DNA amplification:** Polymerase Chain Reaction (PCR), essential features of the PCR, The design of primers for PCR, DNA polymerases for PCR. And applications of the PCR. RFLP and RAPD.

Unit –III: Applications of Recombinant DNA technology **14hrs**

Construction of DNA libraries: Generating a genomic library. Types of Genomic Libraries- Nuclear Genomic Library, Organelle Genomic Library. Applications of Genomic Library. **Genome Editing** - Introduction to genome editing techniques- Principles and applications of genome editing techniques- CRISPR-Cas9 and Site-directed mutagenesis. **DNA fingerprinting and forensic applications-** Molecular Markers VNTRs (minisatellites) and STRs (microsatellites). Steps in DNA fingerprinting. Applications.

Unit-IV: Regulatory aspects of Recombinant DNA technology **14hrs**

Bioethics: Ethical issues related to genetic engineering, transgenic organisms, and biomedical applications. Social and environmental impacts of biotechnology. Overview of ethical and regulatory frameworks guiding Recombinant DNA technology research and applications. **Biosafety:** Basic concepts of biological risk assessment and containment levels. Safe handling of genetically modified organisms (GMOs). Overview of national and international biosafety guidelines. Laboratory safety measures and proper waste disposal practices. **Intellectual Property Rights (IPR):** Types - patents, copyrights, trademarks, trade secrets and geographical indications. Fundamentals of patents — basic requirements, filing process and protection of biotechnology inventions. IPR issues related to recombinant DNA products.

TEXT AND REFERENCE BOOKS:

1. Jocelyn E Krebs, Elliott S Goldstein Jones and Bartlett. 2014. Lewin's Genes XI, Student Edition. Jones and Bartlett India Pvt Ltd, New Delhi.
2. Parihar and Parihar. 2010. Advances in Biotechnology. Agrobios, India.
3. Michael M Cox and David L Nelson. 2008. Lehniger Principles of Biochemistry, 5th Edition. Freeman and Company, California.
4. Thomas G M Schalkhammer. 2008. Analytical Biotechnology. Springer Private Limited, New Delhi.
5. R M Taryman. 2008. Gene Transfer to Animal Cells. Bios Scientific Publishers, England.
6. L Veera Kumari. 2006. Bioinstrumentation. MJP Publishers, Chennai.
7. S Hughes and R Leskan. 2005. Whole Genome Amplification. Scion Publishing Limited, England.
8. Kammermeyer, K. and Clark, V.L. 1989. Genetic engineering Fundamentals: An Introduction to principles and Application. Marcel Dekker, Inc., New York.
9. Chirikjian, J.G.(Ed). 1995. Biotechnology: Theory and Techniques, 2 Vols. Jones and artlett Publishers, Boston.
10. Old, R.N and B. Primrose, 1990. Principles of Gene Manipulation. Blackwell Scientific Publication, New York.
11. Rehm.R.H. and G. Reed. 1993. Fundamentals of Genetic Engineering Vol.12. Verlar Press, New York.
12. Wu,R.L. Grossman, and K.Moldane (Ed.) 1989. Recombinant DNA Methodology. Academic Press, San Diego.
13. Walden, R. 1988. Genetic Transformation of Plants. Open University Press, Bachingham.
14. Sambrook,J.E.F.,Fritsch and T. Maniatis.1989.Molecular Cloning.Coldpring Harbor, New York.
15. Lewin, B.1997. Gene VI. John Wiley & Co., New York.

SEMESTER-V

24-MCBT-VB- IMMUNOLOGY

TOTAL HOURS-56

Course Learning Objective:

a) To understand the concepts of Immunology and Immunotechnology.
b) To study the basics of Immunology.
c) To study components of Immune system
d) To learn the applications of immunology in diagnostics and therapeutics
e) To study the importance of immunology on human health

Course Outcome: On successful completion of the course, students are able to

a) Understand the molecular basis of immunology.
b) Understand the importance of immunology in maintaining overall health.
c) Understand the role of immune techniques in molecular diagnostics.
d) Understand to translate the immunological aspects into therapeutics

Unit-I: An overview of Immunology 14hrs

Immunity: Introduction: history and scope of Immunology. Types of immunity: Innate and acquired Immunity. Active Immunity – Natural and artificial; Passive immunity – Natural and artificial. **Organs of immune system:** primary lymphoid organs – Thymus, Bursa of Fabricus, bone marrow. Secondary lymphoid organs – lymph node, spleen, (Mucosa associated lymphoid tissue: MALT), Payer's patches. **Cells of the Immune system:** T-cells, B-cells, macrophage, helper cells, Natural killer cells, stem cells, lymphoid lineage – lymphocytes, myeloid lineage – monocytes, polymorphonuclear cells, mast cells, antigen presenting cells. Antigen processing and presentation.

Unit-II: Antigen and Antibody 14hrs

Antigens: epitopes and paratopes: Chemical nature of antigens and antigenic determinants, factors influencing antigenicity – size, chemical nature, solubility, foreignness, Haptens, Adjuvants-complete and incomplete adjuvants. **Antibodies:** Immunoglobulins and antibodies – an analysis, basic structure of the immunoglobulins, immunoglobulins; classification, structure, biological properties and functions. Regulation of immunoglobulin gene expression – Clonal selection theory, antibody diversity.**Antigen–antibody interactions**– Precipitation reaction- Principle, lattice hypothesis, Radial immunodiffusion, Ouchterlony technique, Immunoelectrophoresis. Agglutination reactions – bacterial and hemagglutination. RIA and ELISA – principle, methodology and application. Immunofluorescence.

UNIT-III: Molecular basis of Immunology **14hrs**

Cytokines: Production and properties of cytokine, biological functions of cytokines; different families of cytokines and their salient features, Cytokine-related disease- Bacterial septic shock, COVID 19, role of cytokines in lymphoid and myeloid cancers, therapeutic uses of cytokines. **Complement systems:** Salient features, origin, activation; Types: Classical pathway and alternate pathway, biological functions and fixation, regulation of complement pathway, complement deficiencies and its consequences. **Cell mediated effector response:** General Properties of Effector T Cells, Mechanism of activation of T cells, activation of Cytotoxic T Lymphocytes. Natural killer cells: properties and their mechanism of action, mechanism of antibody dependent cell mediated Cytotoxicity (ADCC).

UNIT IV: Immune dysfunction **14hrs**

Hypersensitivity: Factors causing hypersensitivity, common reactions, classification, Types of Hypersensitivity, type-I (anaphylactic), type-II (antibody dependent cytotoxic) type-III (immune complex mediated), type-IV (cell mediated) and type-V (Stimulatory); hyper sensitivity. Allergy and Contact dermatitis. **Tumor Immunology:** Introduction, properties of tumor cells, causes of tumors, tumor antigens, immune response and Immunodiagnosis of tumors, Immunotherapy. Immune surveillances of tumor cells. **Autoimmune diseases:** Definition, causes and pathogenesis of autoimmune diseases, Classification of autoimmune diseases. Examples - Systemic Lupus Erythematosus, Myasthenia gravis, RA, Type 2 diabetes, psoriasis.

TEXT AND REFERENCE BOOKS:

1. Arvind Kumar. 2013. Text Book of Immunology. TERI Press, India.
2. Meyers. 2007. Immunology. Wiley–VCH, USA.
3. Abbas, A.K., A.H. Lichtman, J.S.Pober, 1994. Cellular and Molecular immunology. W.B.Saunders Co., Philadelphia.
4. Kubey. I.M. 1990. Essential Immunology. 6thed. Blackwell Scientific Publication, New York.
5. Roitt, I. *et al.*, 1993. Immunology 3rd ed. Mosby Year Book Europe Ltd., London.
6. Janewny, *et al.* 1994. Immunobiology, The Immune System in Health and Disease. CBS, New Delhi.
7. Rotti, I. 1994. Essential Immunology. Blackwell, London.
8. Benjamin,E.G. Sunshine and S. Leskowity, 1996. Immunology-A short course, 3rd ed., Wiley-Liss., New York.
9. Tizard, I.R. 1995. Immunology, An Introduction. Saunders College Publishing, New York.
10. Borrebacek, C.A.K. 1995. Antibody, Engineering 2nded. Oxford University Press, Oxford.
11. Stites, D.P. and Terr, A.I. 1991. Basic Clinical Immunology, 7th ed. Appleton & Lange, California.
12. Talwar G. P., and Gupta S.K., A Hand book of Practical and Clinical Immunology, Vol. 1 & 2, CBS Publications, 2004.
13. Chakravarthy AK. Immunology &Immunotechnology. Oxford University Publishers. 2nd Ed. 2009
14. Gosling J P, Reen D J. Immunotechnology. Portland Press Ltd. UK. 6th Ed. 2009
15. Pandian. Immunology and Immunotechnology. Panima Publishers. 2nd Ed. 2009.

24-MCBT-P-V: PRACTICAL PAPER-V RECOMBINANT DNA TECHNOLOGY AND IMMUNOLOGY

1. Study of morphology of blood cells through human blood smear and staining
2. Differential counting of WBC in the given blood sample.
3. Determination of cross matching of given blood sample with blood group.
4. Study of Outchterlony double immunodiffusion technique
5. Determination of Hemoglobin content by Sahli-hellige method.
6. Determination of Erythrocyte sedimentation rate (ESR) from blood sample.
7. Isolation of DNA/RNA/Plasmid from bacterial sources
8. Isolation of DNA/RNA from animal and plant sources
9. Quantification of DNA/RNA
10. Agarose/Polyacrylamide Gel electrophoresis
11. Demonstration of techniques through charts – CRISPR CAS9, Hybridization techniques, Ag-Ab interactions (RIA, ELISA).

SEMESTER-V

24-MCBT-VC-ELEMENTARY RESEARCH METHODOLOGY

Total hours-32

Course Learning Objective: To introduce students to the fundamentals of research, making them to conduct ethical biological research by formulating hypothesis, ensuring biosafety compliance, reviewing literature effectively, and producing well-structured scientific reports.

Course Outcomes: On successful completion of the course, the student will able to

a) Understand the basics of research

b) Understand the biosafety guidelines and bioethics

c) Understand the need for literature reviews and sources for reviews

d) Develop the research report writing skills

Unit I: Research and Research hypothesis: **8hr**

Definition, objectives types and importance, research in biological sciences, research process and research design; ffeatures of a good research study. Identification of problem; research problem ccomponents; fformulating hypothesis- types of hypothesis.

Unit II: Biosafety and Bioethics: **8hr**

Guidelines for biosafety and bioethics;Institutional biosafety committee – handling of genetically modified organisms, institutional human and animal ethics committee -compliance, concerns and approval; safety practices and disposal of bio-waste in the laboratory;radioactivity and safety precautions; handling and disposal of flammable and hazardous chemicals.

Unit III: Review of Literature and Statistical methods for data analysis **8hr**

Need for reviewing literature, sources of literature, conventional sources (Indexes and abstracts, journals) computer based sources (Pub med, Science Direct, Search engines, Google Scholar, Research gate). Statistical methods for data analysis (descriptive and inferential methods).

Unit IV: Scientific Report Writing and Presentations: **8hr**

Principles of writing, steps in report writing. Format of the research report, research Paper, dissertation/ thesis, project proposal. Organization of the research document in to different sections (Introduction,Methodology,Results,Discussion&Summary,Conclusions,Bibliography); Use of electronic tools for bibliographic formatting and checking Plagiarism.

TEXT AND REFERENCE BOOKS:

1. Gurumani, N. (2006). Research methodology for biological sciences. MJP Publishers.
2. Holmes, D., Moody, P., & Dine, D. (2010). Research methods for the biosciences (2nd ed.). Oxford University Press.
3. Pechenik, J. A. (2016). A short guide to writing about biology (9th ed.). Pearson.
4. Shashwat Publication. (2025). A text book for research methodology and bio-statistics. Shashwat Publication.
5. Saras Publication. (2024). Research methodology for life sciences. Saras Publication.
6. Thomson, A. J., Meek, J. R., & Szmyr, J. (2014). Successful scientific writing: A step-by-step guide for the biological and medical sciences (4th ed.). Cambridge University Press.

SEMESTER-VI

24-MCBT-VIA-PLANT AND ANIMAL BIOTECHNOLOGY

TOTAL HOURS-56

Course Learning Objective:

a)To understand the basics of plant and animal cell culture and its applications
b) To study the concept of plant tissue culture principles, culture methods and secondary metabolites production by *In vitro* methods.
c) To study the transgenic plant production steps and its applications.
d) To learn the basics of animal cell culture requirements and methods.
e) To study the significance of animal biotechnology.

Course Outcome: On successful completion of the course, students are able to

a) Understand the basics of plant tissue culture requirements and culture techniques.
b) Understand the applications of plant biotechnology
c) Understand the fundamentals of animal cell culture and its requirements
d) Understand the applications of animal biotechnology in various field.

Unit- I: Principles of Plant tissue culture **14 hrs**

Introduction to plant tissue culture: History, definition and concept of cellular totipotency and differentiation, laboratory organization and methods of sterilization. Culture media, Culture technique-explant preparation, callus culture, organ culture, somatic embryogenesis and synthetic seeds.**Haploid and Protoplast culture:** Anther, pollen and ovule culture, a brief account on protoplast isolation and culture, somatic hybridization, cybrids. Somaclonal variation. ***In-vitro*** **secondary metabolite production:** suspension cultures, cell cultures, root culture, hairy root cultures, growth vs secondary metabolite production, yield enhancement, elicitation, bioreactors and scaling up of secondary metabolite production, limitations, and applications. Production of (Shikonin and Ginseng).

Unit-II: Plant transgenic technology **14 hrs**

Transgenic plants: Introduction, techniques for introducing foreign genes into plants: Agrobacterium-mediated transformation, biolistic, microinjection, electroporation and chemical mediated transformation. **Transgene integration and selection of transformed plants:** Mechanism of transgene integration into plant genome, factors influencing transgene expression (promoters, enhancers, regulatory elements) methods for analysing and verifying transgene expression; 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. Molecular pharming for therapeutic protein (Plantibodies, Plant as Edible Vaccines),

Unit-III: Fundamentals of Animal Cell Culture: **14 hrs**

Scope and development of animal cell culture; Basic requirements: - Laboratory design, culture vessels, equipment's, aseptic handling and safety regulations.**Culture medium:** - Physico-chemical factors, Natural and Synthetic media- Balanced Salt solutions, Minimal Essential Medium. Primary culture- Animal selection, isolation of tissue and disaggregation-mechanical and enzymatic disaggregation. **Cell lines and organ culture:** Sub culturing and designation of cell lines, types, cell selection- finite/continuous cell line and maintenance. Organ culture: Tissue engineering and its application, artificial skin, spheroids.

Unit-IV: Applications of Animal Cell Culture: **14 hrs**

Transgenic animals: -Gene constructs, promoter/enhancer sequences for transgene expression in animals. Selectable markers for animal cells. Methods of gene transfection into animal cells**:** Physical, chemical and biological methods. Transgenic and genome-edited animals- Ethical issues in transgenesis. **Scale up of animal cell culture**-Production of biopharmaceuticals-plasminogen activator, erythropoietin, blood clotting factors and cell culture based vaccines.Production of monoclonal antibodies by hybridoma technology **Artificial Animal Breeding**: Artificial Insemination and Germ cell storage, *In vitro* Fertilization (IVF) and Embryo transfer; Superovulation: Physiological basis, Influencing factors, Freezing of embryos, Embryo sexing, Micromanipulation of Embryos - Embryo splitting, Nuclear transplantation and advantages of cell manipulation

TEXT AND REFERENCE BOOKS :

1. Bhojwani, S.S., and Razdan, M.K. (2004). Plant Tissue Culture: Theory and Practice. Amsterdam: Elsevier Science.
2. Brown, T.A. (2010). Gene Cloning and DNA Analysis: An Introduction. 7th edition. Oxford: Wiley-Blackwell.
3. Glick, B.R., and Pasternak, J.J. (2018). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th edition. Washington, DC: ASM Press.
4. Reinert, J., and Bajaj, Y.P.S. (1997). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Berlin: Springer.
5. 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.
6. Slater, A., Scott, N.W., and Fowler, M.R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
7. Smith, R. (2012). Plant Tissue Culture: Techniques and Experiments. 3rd edition. San Diego, CA: Academic Press.
8. Taiz, L., and Zeiger, E. (2014). Plant Physiology. 5th edition. Sunderland, MA: Sinauer Associates.
9. Vasil, I.K., and Vasil, V. (2007). Molecular Improvement of Cereal Crops. Dordrecht: Springer
10. Gahlawat, S.K., Duhan, J.S., Salar, R.K., Siwach, P., Kumar, S., & Kaur, P. (2018). Advances in Animal Biotechnology and its Applications. Springer. ISBN: 978-981-10-4701-5.
11. Primrose, S.B., & Twyman, R.M. (2016). Principles of Gene Manipulation (8th ed.). Blackwell Science. ISBN: 978-1405135442.
12. 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.
13. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002

14. Clynes, M. (Ed.). (1998). Animal Cell Culture Techniques. Springer.
15. Masters, J.R.W. (Ed.). (2000). Animal Cell Culture - Practical Approach. Oxford UniversityPress.
16. Freshney, I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (8th ed.). Wiley-Blackwell.
17. Pörtner, R. (Ed.). (2007). Animal Cell Biotechnology: Methods and Protocols. Humana Press.
18. Singh, B., & Gautam, S.K. (2013). Textbook of Animal Biotechnology. The Energy andResources Institute (TERI).
19. Gupta, P.K. (2018). Animal Biotechnology. Rastogi Publications.

Mather, J.P., & Barnes, D. (Eds.). (Year N/A). Animal Cell Culture Methods. In Methods inCell Biology, Vol. 57. Academic Press.

SEMESTER-VI
25-MCBT-VIB- INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY

TOTAL HOURS-56

Course Learning Objective:

a) To understand the basics of industrial and environmental biotechnology and its significance.
b) To study the concept of industrial biotechnology steps.
c) To study the bioreactors and its applications.
d) To learn the basics of environmental pollution and its management.
e) To study the solid waste management, bioremediation and bioenergy.

Course Outcome: On successful completion of the course, students are able to

a) Understand the basics of industrial fermentation methods.
b) Understand the bioreactor design and its application in metabolites production.
c) Understand the environmental pollution and its types and control steps.
d) Understand how to manage solid wastes and bioremediation, bioenergy.

Unit-I: Basic concept of Industrial Biotechnology **14hrs**

Introduction:

Scope and applications, exploitation of microorganisms and their products, Isolation and screening of microorganisms for industrial products. **Strain improvement:** Techniques for strain improvement (Random mutation, Auxotrophic mutation, rDNA technology and protoplasmic fusion). Preservation of industrial microorganisms. Inoculum development. **Fermentation process**: Definition, substrate for fermentation, types of fermentation-aerobic and anaerobic fermentation, solid state fermentation. Downstream processing.

Unit-II: Bioreactors and metabolites production **14hrs**

Bioreactors: Typical bioreactor design, principle, parts of bioreactor and their function. Types of bioreactors-continuous stirred tank, airlift, bubble column, fluidize bed, photo bioreactor, membrane bioreactor, fermentors. Application and limitations of bioreactors. **Production of primary metabolites**: A brief outline of processes for the production of some commercially important organic acids (e.g. citric acid, acetic acid); Amino acids (lysine, aspartic acid etc.,) and alcohols (ethanol, butanol). **Production of secondary metabolites:** Study of production processes for various classes of secondary metabolites: Antibiotics: Beta-lactams (Penicillin, Cephalosporin etc.), Aminoglycosides (Streptomycin).

UNIT-III: Fundamentals of Environmental Biotechnology **14hrs**

Introduction: General bioassays in pollution monitoring. Types of pollution**:** air pollution & its control through Biotechnology, Biofilters, Bioscrubbers, Biotrickling filter. **Water pollution and its management:** Measurement of water, pollution, sources of water pollution. Microbiology of waste water treatment, aerobic processes, activated sludge, oxidation ponds, trickling filters and rotating biological contactors. Anaerobic processes: Anaerobic digesters, upward flow anaerobic sludge blanket reactors. **Treatment of industrial effluents:** distillery effluent, paper and pulp mill effluent, tannery, effluent, textile dye effluent, removal of heavy metals from waste waters.

UNIT- IV: Solid waste management, Bioremediation and Bioenergy **14hrs**

Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermicomposting, Incineration, energy recovery from organic waste. Hazardous waste management, sources & classification, physicochemical properties, Hazardous waste control & treatment. Hospital waste management, Hazardous waste management & handling rules. **Biodegradation and Bioremediation** – Concepts & principles of Bioremediation, Bioremediation of hydrocarbons and its applications. Degradation of pesticides and other toxic chemicals by microorganisms, phytoremediation. Role of genetically engineered microbes in bioremediation. **Bioenergy:** Bio fuels, Bio plastics, Bio preservatives, Biopolymers, Biodiesel. Biogas, microbial groups involved in biogas production & interactions, factors affecting biogas production. Basic economics of biofuels conversion – socio-economic impacts of bioenergy.

TEXT AND REFERENCE BOOKS:

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

24-MCBT-P-VI: PRACTICAL PAPER-VI
PLANT AND ANIMAL BIOTECHNOLOGY &
INDUSTRIAL AND ENVIRONMENTALBIOTECHNOLOGY

1. Laboratory organization of basic and commercial plant and animal cell culture
2. Media preparation (MS, B5), solid media preparation, and liquid media preparation
3. Synthetic seed production
4. Callus culture- Initiation and establishment of different types of callus cultures
5. Preparation of Hanks and Earle's Balanced Salt Solution
6. Cell segregation and viability testing
7. Extraction of plasma and serum.
8. Estimation of Biological Oxygen Demand
9. Estimation of Chemical Oxygen Demand
10. Demonstration of Vermicompost/Biofertilizer/Biogas facility.
11. Isolation of industrially important microorganisms from natural resources.
12. Production of wine–estimation of the percentage of alcohol, total acidity & volatile acidity in wine.
13. Citric acid production by submerged fermentation and estimation by titrimetry.