ಡಾ. ಮನಮೋಹನ ಸಿಂಗ್
ಬೆಂಗಳೂರು ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

Dr. MANMOHAN SINGH
BENGALURU CITY UNIVERSITY

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No.MSBCU/BoS/Syllabus/Science/ 109 /2026-27 Date: 29.06.2026

NOTIFICATION

Sub: Syllabus for the V & VI Semester Under Graduate Courses in the Faculty of Science -reg

Ref: 1. Government Order No. ED 166 UNE 2023 Bengaluru dated. 08.05.2024
2. Recommendations of the Boards of Studies in the Faculty of Science
3. Approval of the Academic Council in its meeting held on 08.06.2026
4. Orders of Vice-Chancellor dated.29.06.2026

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The Syllabus prepared by the Boards of Studies for the different Subjects of V & VI semester Under Graduate Courses, in the faculty of Science based on the Guidelines and Curriculum Structure issued by the Government under ref(1) have been approved by Academic Council meeting held on 08.06.2026.

Accordingly, the CBCS Syllabus for the V & VI Semester UG Courses of Science Faculty in respect of following subjects are hereby notified for implementation from the academic year 2026-27.

Sl. No.	Subjects
1.	Botany– V & VI Semester
2.	Chemistry– V & VI Semester
3.	Zoology and Genetics– V & VI Semester
4.	BoS in Fashion and Apparel Design i. FAD – V & VI Semester ii. IDD– V & VI Semester
5.	Geography– V & VI Semester
6.	Mathematics– V & VI Semester
7.	Physics – V & VI
8.	BoS in Home Science i) Home Science – V & VI ii)Nutrition & Dietetics – V & VI iii)Clinical Nutrition & Dietetics – V & VI iv)Food Technology – I & II Sem

p.t.o

9.	Criminology and Forensic Science– V & VI
10.	Psychology– V & VI Semester
11.	Electronics – V & VI
12.	Statistics – V & VI
13.	Microbiology– V & VI
14.	Biotechnology– V & VI
15.	Environmental Science– V & VI

The detailed Syllabi for above subjects are notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

Copy to;

1. The Registrar(Evaluation), Dr. Manmohan Singh Bengaluru City University
2. The Dean, Faculty of Science, MSBCU.
3. The Principals of the concerned affiliated Colleges of MSBCU- through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), MSBCU.
5. Office copy / Guard file / University Website: www.bcu.ac.in

Dr. MANMOHAN SINGH BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(SEP 2024)

Syllabus for B.Sc. Biotechnology (V & VI Semester) 2026-27 onwards

CURRICULUM FOR B. Sc. (UG) BIOTECHNOLOGY 2024-25 Onwards

Dr. MANMOHAN SINGH BENGALURU CITY UNIVERSITY

	Course Code	Course Title	T/P/L Hrs/ week	Duration of Exam (Hrs)	CIA Marks	ESE Marks	Total Marks	Credits
I	**BTT -101 (Theory)**	**Cell Biology & Genetics**	**04**	**03**	**20**	**80**	**100**	**3**
	BTP-102 (Practical)	Cell Biology & Genetics	03	03	10	40	50	2
II	**BTT -201 (Theory)**	**Microbiological Methods**	**04**	**03**	**20**	**80**	**100**	**3**
	BTP-202 (Practical)	Microbiological Methods	03	03	10	40	50	2
III	**BTT -301 (Theory)**	**Biomolecules**	**04**	**03**	**20**	**80**	**100**	**3**
	BTP-302 (Practical)	Biomolecules	03	03	10	40	50	2
	DSEBT 1 (Elective-1)	Applications of Biotechnology in Agriculture	02	1.5	10	40	50	2
IV	**BTT -401 (Theory)**	**Molecular biology**	**04**	**03**	**20**	**80**	**100**	**3**
	BTP-402 (Practical)	Molecular biology	03	03	10	40	50	2
	DSEBT 2 (Elective-2)	Bioinformatics and Bioresearch	02	1.5	10	40	50	2
	Skill-1 Compulsory Skill Development Practical	**Biochemical Analysis**	03	03	10	40	50	2

Semester	Course Code	Course Title	T/P/L Hrs/ week	Duration of Exam (Hrs)	CIA Marks	ESE Marks	Total Marks	Credits
V	BTT -501 (Theory)	Genetic engineering	04	03	20	80	100	3
	BTT -502 (Theory)	Immunotechnology	04	03	20	80	100	3
	BTP -503 (Practical)	Genetic engineering and Immunotechnology	03	03	10	40	50	2
	BTSkill-2 Compulsory Practical Knowledge	Advanced Analytical Techniques	03	03	10	40	50	2
VI	BTT -601 (Theory)	Plant and Animal Biotechnology	04	03	20	80	100	3
	BTT -602 (Theory)	Bioprocess and Environmental Biotechnology	04	03	20	80	100	3
	BTP -603 (Practical)	Plant and Animal Biotechnology Bioprocess and Environmental Biotechnology	03	03	10	40	50	2

Skill-3: Internship/Project

Semester	Course Code	Course Title	Total Hrs.	Total Marks	Credits
VI	BTSkill-3*	Internship/ Project	90-120	50	2

***Compulsory skill may involve practical experience in an industrial set up/ Laboratory/ Dissertation/ Minor Project providing hands on experience other than the regular practical of the course.**
Report to be submitted (Manuscript) -40 Marks and Viva Voce -10 Marks)

B. Sc. Semester Scheme

Biotechnology

Scheme of Examination

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

I	Answer any 10 of the following: (Out of 12) Questions 1 to 12	10 x 2 = 20 Marks
II	Answer any 6 of the following: (Out of 8) Questions 13 to 20	6 x 5 = 30 Marks
III	Answer any 3 of the following: (Out of 5) Questions 21 to 25	3 x 10 = 30 Marks

B.Sc. Biotechnology 5th Semester (SEP 2026-27 onwards)

BTT-501 Genetic Engineering (Theory)

Course Title : Genetic Engineering	
Course Code : BTT-501	**L-T-P per week: 4-0-0**
Total Hours: 56	**Course Credits: 03**
Formative Assessment(IA) Marks: 20	**Duration of ESA/ Exam: 3 Hrs.**
Summative Assessment Marks: 80	

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. Enhance critical thinking and problem-solving skills through discussions and case studies.
6. 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.
4. Explain gene expression regulation mechanisms and apply genetic modification methods effectively.
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.

BTT-501: Genetic Engineering - Content of Theory	56 hrs
Unit I- Fundamentals of Genetic Engineering	**14**
Scope and Importance: Definition, historical overview of genetic engineering and applications. **DNA Structure and Manipulation** - Techniques for DNA isolation and purification. Methods for quantification and characterization of DNA samples. **RNA Analysis** - Methods for RNA isolation and purification. **Tools of Recombinant DNA technology:** Introduction to molecular cloning. **Vectors**: 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.	
Unit II- Techniques in Genetic Engineering	**14**
Hybridization techniques: Introduction to molecular probes and label ling, Southern, Northern, Western, FISH. **Polymerase Chain Reaction (PCR):** Principle, types and Applications. **DNA sequencing**- Sanger's, Next Generation Sequencing **Gene Transformation Techniques** - Methods of gene delivery. Physical, chemical, and biological methods. electroporation and micro-injection. **Genome Editing** - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis.	
Unit III- Construction and Applications of Genetic Engineering	**14**
Gene libraries: c-DNA and Genomic DNA. **Gene Cloning Strategies** - Gene therapy and its potential in treating genetic disorders, gene delivery in therapeutic applications. DNA fingerprinting and its applications in forensics. **Molecular diagnostic techniques** - Role in disease diagnosis, development of vaccines. Production of biopharmaceuticals using recombinant DNA technology. **Applications of Gene knockout techniques**: Bacterial and Eukaryotic organisms.	
Unit IV- Advances, Ethical and Regulatory Considerations	**14**
Industrial Applications: Scale up techniques of genetic engineering and synthetic biology: Chemical synthesis of gene, Design and construction of artificial biological systems. **Ethical and Regulatory Considerations** - Ethical implications associated with genetic engineering. Introduction to regulatory guidelines and safety considerations for genetic engineering research and applications	

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

Summative Assessment = 80 Marks	
Formative Assessment / type	**Weightage in Marks**
Attendance	5
Seminar Assignment	5
Debates and Quiz	5
Test	5
Total FA	**20**
Total (FA + SA)	**100 marks**

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.

BTT-502: Immunotechnology (Theory)

Course Title : Immunotechnology	
Course Code : BTT-502	**L-T-P per week: 4-0-0**
Total Hours: 56	**Course Credits: 03**
Formative Assessment(IA) Marks: 20	**Duration of ESA/ Exam: 3 Hrs.**
Summative Assessment Marks: 80	

Course Objectives:

1. To understand the various aspects of immunity, elicitation of immune responses, factors determining the outcome of immune responses and major players of immunity, relevance between nutritional support and immunity, and immunological techniques.
2. To provide knowledge on essential features of antigens and antibodies and their types and different theories of Antibody formation.
3. To acquire knowledge on types of immunity, phagocytosis, interferons, and the complement system.
4. To explain the concept of hypersensitivity, autoimmunity, and transplantation.
5. To provide knowledge on immune deficiencies and several immunological techniques

Course Outcomes:

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

1. Demonstrate comprehension of the underlying structure and function of the immune system and related disorders.
2. Demonstrate an understanding of the role of cells and molecules in immune reactions and responses
3. Demonstrate technical skills in immunological tools and techniques
4. Apply the domain-specific knowledge and skills acquired in immunology for innovative therapies and immunotechnologies
5. Understand the fundamental concepts of immunity, and the contributions of the organs and cells in immune responses.
6. Realize how the MHC molecule's function and host encounters an immune insult.
7. Understand the antibodies and complement system
8. Understand the mechanisms involved in the initiation of specific immune responses
9. Differentiate the humoral and cell-mediated immune mechanisms
10. Comprehend the overreaction by our immune system leading to hypersensitive conditions and its consequences
11. Understand unique properties of cancer cells, immune recognition of tumors, immune evasion of cancers

BTT502: Immunotechnology - Content of Theory	56 Hrs.
Unit–I Cells and Organs of the Immune System	**14**
Introduction to the Immune System: History of Immunology, Cells of Immune system, Organs of the Immune system: Central/Primary lymphoid organs -Thymus, Bone marrow, Peripheral/Secondary lymphoid organs: Spleen, Lymph Node. **Types of Immunity**: First and Second line of defense, Innate immunity, Acquired/adaptive immunity, Humoral immunity and Cell-mediated immunity. primary and secondary immune response.	
Unit -II Molecules of the Immune System	**14**
Antigens and Haptens: Properties (foreignness, molecular size, heterogeneity).Iso- and Allo-antigens, antigen specificity Adjuvants. Antigenicity and Immunogenicity. B and T cell epitopes, Super-antigens **Immunoglobulins:** Classification, Structure, and Functions. Monoclonal and Polyclonal antibodies. **Major Histocompatibility Complexes:** Classification, structure, and function. Antigen processing and Presentation pathways – Cytosolic and Endocytic. **Cytokines:** Classification and functions.	
Unit -III Immune Reactions and Microbial diseases in Humans	**14**
Complement Pathways: Classical and Alternative. **Hypersensitivity Reactions** – Type I, II, III and IV. **Antigen antibody reactions:** Affinity, Avidity and Cross-reactivity, Zone phenomenon. Precipitation: Single Radial immunodiffusion, Ouchterlonys' double diffusion, Immuno-electrophoresis: Rocket Immuno Electrophoresis. Agglutination: Haemagglutination reactions. Immunoassays: ELISA, RIA. Immunocytochemistry. **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.	
Unit - IV Transplantation immunology and Vaccines	**14**
Graft rejection: Definition, Phases and immuno-suppressors. **Autoimmune Disorders:** Systemic and Organ-specific Autoimmune disorders with examples. **Immunodeficiencies:** Primary (congenital) and secondary immunodeficiency (Acquired Immuno Deficiency Syndrome). **Cancer and the immune system** – immune surveillance, immunological escape, cancer antigens, cancer immunotherapy **Vaccines:** Conventional, peptide vaccines, subunit, DNA and RNA vaccines. Toxoids, edible vaccines, plantibodies.	

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

Summative Assessment = 80 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks (20)**
House Examination/ Test	10
Written Assignment/ Presentation/ Project/ Term/Seminar	05
Class performance and Participation	05
Total	**80 marks + 20 marks = 100 marks**

References

1. Textbook of Immunology, Paul Ajoy, Books and Allied (P) Ltd., 2016
2. Cellular and Molecular Immunology. Abbas, A.K. et al., Elsevier Saunders Co., 2015
3. Essential Immunology. Riott, I.M., Blackwell Scientific Publications, 1994
4. Handbook of Experimental Immunology, Vol. 1 & 2, Weir D.M., Wiley, 1997
5. Immunology. Riott, I.M., Brostoff J., Male, D. Mosby Pub., 2017
6. Immunobiology. Janeway C.A. and Travers, P. Churchill Livingstone Pub., 2016
7. Practical Immunology. Hudson L. and Hay F.C., Blackwell Scientific Pub., 1989
9. Instant Notes in Immunology. Lydyard PM et al. Viva Books Pvt. Ltd., 2011
10. Abbas AK, Lichtman AH, and Pillai S. (2019). Basic Immunology- Functions and Disorders of the Immune System. Elsevier,
11. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. W.B. Saunders Publisher. Philadelphia.
12. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4th edition- Wiley-Liss. New York.
13. Borrebacc, C.A.K. (1995). Antibody Engineering, 2nd edition. Oxford University Press, Oxford.
14. Tizard I.R. (1995). Immunology, 4thedition, W.B. Saunders Publisher. Philadelphia.
15. Paul W.E (1989). Fundamentals in Immunology, Raven Press. NY.

Course BTP:503 Genetic Engineering & Immunotechnology (Practical)

Course Title: **Genetic Engineering & Immunotechnology (Practical)**	
Course Code : BTP-503	**L-T-P per week: 0-0-3**
Total Hours: 42Hrs.	**Course Credits: 02**
Formative Assessment(IA) Marks: 10	**Duration of ESA/ Exam: 3 Hrs.**
Summative Assessment Marks: 40	

Sl. No.	**Experiments**	**Units**
1.	Isolation of genomic DNA from plant tissue (Cauliflower).	1
2.	Isolation of genomic DNA from animal tissue (Liver).	1
3.	Separation of DNA by Agarose Gel Electrophoresis.	2
4.	Analysis of Restriction enzyme digestion	2
5.	Study of Ligation reactions/ DNA fingerprinting	2
6	Hemagglutination in ABO Blood groups	1
7	Perform Widal & VDRL tests	1
8	Determination of the WBC using Haemocytometer	1
9	Demonstration of SRID	1
10	Demonstration of ELISA	2
11	Demonstration Ouchterlonys' Double Diffusion	1

Formative Assessment/ Internal	**Total Marks-10**	**Summative Assessment Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exam**
House Examination/Test	05	40 Marks
Practical Performance/Attendance	05	

B.Sc Biotechnology, V Semester :Practical Exam Question Paper
Practical: BTP-503 Genetic Engineering & Immunotechnology

Time: 3hours **Marks: 40M**

Q. No.	Experiments	Marks
1	Isolate the genomic DNA from sample 'A' (Plant / Animal tissue). (Principle – 2M, Performance – 3M, Result – 1M)	6 marks
2	Perform the Blood Grouping / Differential count of WBC from the given sample 'B'. Comment on the results (Principle – 2M, Performance – 3M, Result – 1M)	6 marks
3	Write the Principle and Procedure for 'C' Restriction Digestion, Ouchterlony double diffusion/ ELISA/ DNA fingerprinting (Principle – 2M, Procedure – 2M)	4 marks
4	Perform RPR / Widal test with the given sample 'D'/ Electrophoresis- Agarose Gel loading. (Principle – 2M, Performance – 2M, Result – 1M)	5marks
5	Identify and Comment on 'E' & 'F'	2x3=6 marks
6	Class Records and Industrial Visit	8 marks (4+4)
7	Viva- voce	5 marks

Fifth Semester BTSkill- 2: Advanced Analytical Techniques

Course Title : Advanced Biotechnological Techniques	
Course Code : BTSkill-2	**L-T-P per week: 0-0-3**
Total Hours: 30Hrs.	**Course Credits: 02**
Formative Assessment(IA) Marks: 10	**Duration of ESA/ Exam: 3 Hrs.**
Summative Assessment Marks: 40	

Course Outcomes (COs)	At the end of the course the student should be able to
CO1	Apply good laboratory and experimental practices (GLP & GMP) to perform molecular, biochemical, and analytical techniques accurately and safely.
CO2	Demonstrate practical skills in phytochemical screening, nutritional analysis, and simulation-based experiments.
CO3	Evaluate biochemical properties and develop problem-solving skills through enzyme assays.

Fifth Semester BTSkill- 2: Advanced Analytical Techniques

Sl. No.	**Experiments**	**Units**
1	Implementing Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP) in experimental design.	1
2	Nutritional Analysis of Vitamin C and Protein content in Microgreens	3
3	Quantification of glucose in probiotic sample by Benedicts' method	1
4	Assessment of catalase activity in the potato extract	1
5	Study of Single Cell Protein(Spirulina spp.)and their production	2
6	Qualitative phytochemical screening of medicinal plant extracts.	1
7	Detection and Analysis of Enzyme Activity in Milk (Peroxidase Test).	2
8	Separation of amino acids by TLC method	1
9	Study of plant growth parameters in the hydroponics system.	2
10	Case study on prevalence of antibiotic resistance bacteria in Local area	1

Formative Assessment/ Internal Assessment:	**Total-10 Marks**
Assessment Components	**Weightage**
House Examination/Test	05
Practical performance/Participation/ Attendance	05

B.Sc Biotechnology: V Semester
BTSkill-2 Advanced Analytical Techniques
Exam Question Paper/ Practical Scheme

Q 1.	Analyze the activity of enzyme in the given Milk sample/Analyze the Catalase activity in the potato extract ‘‘A”	10M (2.5M+2.5M+5M)
Q 2.	Estimation of Vitamin C/ Protein from the given sample “B” (Principle, Procedure, Result and Observation).	10M (2.5M+2.5M+5M)
Q 3.	Write the principle and procedure for separation of amino acids by TLC.	4M
Q 4.	Identify the spotter’s “C” and “D” Probiotics / SCP /Hydroponics /Microgreens	6M (3M+3M)
Q 5	Lab record	5M
Q 6.	Viva voce	5M

Summative Assessment - 40 Marks	
Formative Assessment Occasion/type	**Weightage in Marks**
Submission of a Case study	**05**
Test	**05**
Total	**40 + 10 Marks= 50 Marks**

B.Sc. Biotechnology Sixth Semester

BTT-601 : Plant and Animal Biotechnology (Theory)

Course Title : Plant and Animal Biotechnology	
Course Code : BTT-601	**L-T-P per week: 4-0-0**
Total Hours: 56	**Course Credits: 03**
Formative Assessment(IA) Marks: 20	**Duration of ESA/ Exam: 3 Hrs.**
Summative Assessment Marks: 80	

Course Objectives

1. To understand the fundamental aspects of plant and animal biotechnology.
2. Learn about biotechnological tools and techniques used in plant and animal research.
3. Explore methods of introducing foreign genes into plants and animals through transformation techniques.
4. Gain practical skills in plant tissue culture and animal cell culture for improvement.
5. Design strategies for plant genetic manipulation against biotic and abiotic stressors.
6. Hypothesize strategies to increase plant yield and fruit/seed quality.
7. Apply knowledge to real-world challenges in agriculture, veterinary medicine, conservation, and biomedical research
8. Understand the need for animal biotechnology for human welfare.

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. Apply knowledge about ethical considerations and regulatory frameworks associated with plant biotechnology and genetically modified crops.
6. Understand the biology and characterization of cultured cells, including their adhesion, proliferation, differentiation, morphology, and identification.
7. Gain practical skills in basic mammalian cell culture techniques, measuring growth parameters, assessing cell viability, and understanding cytotoxicity.
8. Learn about germplasm conservation techniques and the establishment of gene banks, along with large-scale culture methods for cell lines.
9. Explore organ and histotypic culture techniques, biotransformation, 3D cultures, whole embryo culture, somatic cell cloning, and the ethical considerations surrounding stem cells and their applications.

BTT-601:Plant and Animal Biotechnology - Content of Theory	56 hrs.
Unit–I – Plant Tissue culture methods	**14**
Plant tissue culture: Introduction, history, definition, hypothesis, and concept of totipotency, Principle, media and laboratory organization, morphogenesis, differentiation, callus, direct, indirect organogenesis, somatic embryogenesis, synthetic seeds. micropropagation, **Types of culture**: Seed culture, embryo culture, Meristem culture, Bud culture, limitations and applications. **Secondary metabolites:** *In vitro* secondary metabolite production, Suspension cell cultures, growth vs secondary metabolite production, bioreactors and scaling up of secondary metabolite production, limitations, and applications.	
Unit -II Transgenic Plants and biosafety	**14**
Transgenic plants and its significance in agriculture: Techniques for introducing foreign genes into plants: Agrobacterium-mediated transformation, biolistic and other methods. Selection and screening of transformed plants. **Applications of Transgenic Plants**: Improved crop traits through genetic engineering: pest resistance, herbicide tolerance, disease resistance, and abiotic stress tolerance. **Biosafety assessment of transgenic plants:** Potential risks and benefits. International regulatory frameworks for releasing and commercializing genetically modified organisms (GMOs). Ethical and socio-economic impacts of transgenic crops. Intellectual property rights and access to transgenic technologies.	
Unit–III Animal Cell culture methods	**14**
Animal Cell Culture: History and laboratory organization, media. **Cell types and culture characters**: Pluripotency, Multipotency, Differentiation, Trans differentiation 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.	
Unit -IV Transgenic animals and Cloning	**14**
Gene constructs promoter/ enhancer sequences for transgene expression in animals: Selectable markers for animal cells- thymidine kinase. **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. Recent advances and applications in the field. Manipulation of animal reproduction and characterization of animal genes, Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. **Biosafety and Ethical issues**	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development.

Summative Assessment = 80 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks (20)**
House Examination/ Test	**10**
Written Assignment/ Presentation/ Project/ Term/Seminar	**05**
Class performance and Participation/ Attendance	**05**
Total	**80 marks + 20 marks = 100 marks**

References

1. Hojwani, S.S., and Razdan, M.K. (2004). Plant Tissue Culture: Theory and Practice. Amsterdam: Elsevier Science.
2. Gardner, E.J., Simmons, M.J., and Snustad, D.P. (2008). Principles of Genetics. 10th edition. Hoboken, NJ: John Wiley & Sons.
3. Glick, B.R., and Pasternak, J.J. (2018). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th edition. Washington, DC: ASM Press.
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5. Reinert, J., and Bajaj, Y.P.S. (1997). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Berlin: Springer.
6. Smith, R. (2012). Plant Tissue Culture: Techniques and Experiments. 3rd edition. San Diego, CA: Academic Press.
7. MA: Sinauer Associates.
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B.Sc. Biotechnology Sixth Semester

BTT-602 Bioprocess and Environmental Biotechnology (Theory)

Course Title : Bioprocess and Environmental Biotechnology	
Course Code : BTT-602	**L-T-P per week: 4-0-0**
Total Hours: 56 Hrs.	**Course Credits: 03**
Formative Assessment(IA) Marks: 20	**Duration of ESA/ Exam: 3 Hrs.**
Summative Assessment Marks: 80	

Course Objectives:

1. Perform simulations of microbial growth and metabolism
2. Design bioreactors for the production of various products.
3. Present knowledge about major metabolic pathways and those related to biofuel production from microbes.
4. Understand the fundamental concepts and principles of environmental biotechnology and Explore the interrelationship between biotechnology and the environment.
5. Gain knowledge of the various applications of biotechnology in environmental conservation, pollution control, and sustainability.
6. Learn about microbial processes and their role in environmental biotechnology.
7. Understand the principles of bioremediation and its application in the clean-up of environmental pollutants.
8. Explore the potential of bioenergy production and waste management through biotechnological approaches.
9. Identify and characterize the most important contaminants in the Bioprocess and other industrial wastes.
10. Reuse/recycle the biological waste to clean technology such as energy, biofuel, bio fertilizer through bioremediation

Course out comes:

1. Exploitation of microorganisms for industrial use and their improvement, and formulation of media for efficient growth and production of microbial or cell-based products.
2. The design, operation, and specific applications of various bioreactors.
3. Demonstrate a comprehensive understanding of the fundamental concepts and principles of environmental biotechnology.
4. Apply knowledge of biotechnological techniques to address environmental challenges, such as pollution control and waste management.
5. Analyze and evaluate environmental biotechnology case studies, research findings, and real-world applications.
6. Design and implement biotechnological approaches for environmental remediation, utilizing microbial processes and biodegradation principles.
7. Evaluate the ethical and sustainable aspects of environmental biotechnology practices and make informed decisions regarding their application in environmental conservation.
8. Communicate scientific concepts and research findings related to environmental biotechnology effectively, both in written and oral forms, to diverse audiences.

BTT-602:Bioprocess and Environmental Biotechnology	56 hrs.
UNIT- I : **Introduction to bioprocess technology and Bioreactors**	**14**
Bioprocess: Basic principle components of fermentation technology. Screening and selection of industrially important microbes. **Bioreactors:** Design and basic structure of bioreactor, significance of Impeller, Baffles, Sparger. Specialized bioreactors- design and their functions: airlift bioreactor, tubular bioreactors, membrane bioreactors, tower bioreactors, fluidized bed reactor, packed bed reactors, Biosensors-construction and applications, **Strain improvement:** Introduction, Types of microbial culture and its growth kinetics– Batch, Fed-batch, and Continuous cultures.	
UNIT- II: Scale up process and Production	**14**
Principles of upstream processing – Media preparation, Inoculum development, and sterilization. **Downstream processing-** cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization. **Microbial production: Antibiotics**: Penicillin, **Brewing**: Beer, **Dairy**: Cheese. Tempeh and Single Cell Proteins.	
Unit -III: Environment and Monitoring	**14**
Environmental Biotechnology: Introduction, Role of Biotechnology in Environmental Conservation. Microbial Processes in Environmental Biotechnology. **Biotechnological Methods of Pollution Detection**: General bioassay methods for pollution detection. Use of biosensors in pollution monitoring. **Pollution Abatement:** Reduction of CO_2 emission using biotechnological approaches. Addressing eutrophication through biotechnological interventions. Application of cell immobilization techniques in pollution abatement.	
Unit –IV :Bioremediation and Waste Management	**14**
Bioremediation: Introduction, Role in environmental cleanup. Xenobiotics, Types of contaminants suitable for bioremediation. Microorganisms used in bioremediation and its methods: *In-situ* – Bioaugmentation. Biostimulation. Bioventing. Phytoremediation. *Ex-situ* - Bioremediation Methods – Composting, Land farming, Biopile and Bioslurry, slurry phase Bioreactors systems. **Bio mining**: Iron, Gold and Uranium. **Waste water Management**: Waste water Characterization and Composition. Biological Processes in Waste Water Treatment. Activated Sludge Process, Anaerobic Digestion : Biogas Production .Solid Waste Management	

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

Summative Assessment = 80 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks (20)**
House Examination/ Test	10
Written Assignment/ Presentation/ Project/ Term/Seminar	05
Class performance and Participation/ Attendance	05
Total	**80 marks + 20 marks = 100 marks**

Practical BTP- 603: Plant and Animal Biotechnology, Bioprocess and Environmental Biotechnology (Practical)

Course Title : Plant and Animal Biotechnology, Bioprocess and Environmental Biotechnology (Practical)	
Course Code : BTP-603	**L-T-P per week: 0-0-3**
Total Hours: 42 Hrs.	**Course Credits: 02**
Formative Assessment(IA) Marks: 10	**Duration of ESA/ Exam: 3Hrs.**
Summative Assessment Marks: 40	

Sl. No.	**Experiments**	**Units**
1	Laboratory organization and Media preparation (MS, B5)	2
2	Explant sterilization and preparation – Leaf, bud, rhizome, and meristem	2
3	Synthetic seed production	1
4	Cell counting and percent viability assessment by trypan blue exclusion method.	1
5	Isolation and staining of hepatocytes (liver parenchyma cells) from goat/ chicken liver.	1
6	Study of fermenter- Demonstration.	1
7.	Production of wine	2
8.	Estimation of percentage of alcohol by specific gravity method.	1
9.	Production and analysis of amylase	1
10.	Production and analysis of citric acid.	1
11	Production and analysis of lactic acid	1
12	Water quality analysis by MPN method.	1

Practical Assessment

Formative Assessment/ Internal	**Total Marks- 10**	**Summative Assessment Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exam**
House Examination/Test	05	40 Marks
Class Performance/Attendance	05	

References

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B Sc Biotechnology, VI Semester :
Practical Exam Question Paper
BTP 603: Plant and Animal Biotechnology, Bioprocess and Environmental Biotechnology (Practical)

Duration: 3 Hrs **Max. Marks: 40**

Q.no	Experiment	Marks
1	Preparation of synthetic seed / Isolation of liver parenchyma cells. (Principle – 2M, Performance – 3M, Result – 1M)	6 marks
2	Estimation of Citric acid/ Lactic acid (Principle – 2M, Performance – 3M, Result – 1M)	6 marks
3	Demonstrate the surface sterilization of an explant/ Comment on trypan blue exclusion method	4 marks
4	Estimation of percentage of alcohol by specific gravity method / Draw a neat diagram of a fermenter, label its parts, and explain its uses. (Principle – 2M, Procedure – 2M,Result:01M)	5marks
5	Identify and Comment on 'C' & 'D' Identification -1M, Key points – 2M	2x3=6 marks
6	Class Records and Industrial Visit Report	8 marks (4+4)
7	Viva- voce	5 marks

BTSkill-3: Compulsory Practical Knowledge

Course title **Internship /Project**
No of contact hours **90 – 120 Hrs.**
No credits **2**
Method of evaluation **Report Preparation and submission//Viva- voce**

Formative Assessment		**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	
Report Preparation and Submission	40	**50**
Viva voce	10	
Total	**50**	