ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ.

ಜ್ಞಾನ ಗಂಗಾ, ಕಲಬುರಗಿ–585 106, ಕರ್ನಾಟಕ, ಭಾರತ

(ಕರ್ನಾಟಕ ರಾಜ್ಯ ವಿಶ್ವವಿದ್ಯಾಲಯಗಳ ಅಧಿನಿಯಮ 1976ರ್ನಾಯ 30–09–1980 ರಂದು ಸ್ಥಾಪನೆಯಾದ ವಿಶ್ವವಿದ್ಯಾಲಯ ಮತ್ತು 2000ರ ಅಧಿನಿಯಮದ ಅಡಿಯಲ್ಲಿ ಬದಲಾಯಿಸಿದಂತೆ)

ದೂರವಾಣಿ ಸಂ. 08472-263202 ಫ್ಯಾಕ್ಸ್: 08472-263206, ಇ–ಮೇಲ್: registrargug@rediffmail.com

ವಿದ್ಯಾಮಂಡಲ

ಕ್ರ.ಸಂ.ಗುವಿಕ/ವಿಮವಿ/ಬಿಓಎಸ್/2023–24/ 427 ದಿನಾಂಕ: 09.11.23

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ಸ್ನಾತಕ ಪದವಿ ಕೋರ್ಸಿನ **ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಅಧ್ಯಯನ** ವಿಷಯದ ಐದನೇ ಹಾಗೂ ಆರನೇ ಸೆಮೇಸ್ಟರ್ ಪಠ್ಯಕ್ರಮ ಅನುಮೋದಿಸಿ 2023–24ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಜಾರಿಗೊಳಿಸಿದ ಬಗ್ಗೆ.

ಉಲ್ಲೇಖ:1. ಸರ್ಕಾರದ ಆದೇಶ ಸಂಖ್ಯೆ. ಇಡಿ 104 ಯುಎನ್ಇ 2023 ಬೆಂಗಳೂರು, ದಿನಾಂಕ:20.07.2023

2. ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ವಿಷಯದ ಸ್ನಾತಕ ಅಧ್ಯಯನ ಮಂಡಳಿಯ ನಿರ್ಣಯ ದಿನಾಂಕ: 21.09.2023.

3. ವಿಜ್ಞಾನ ನಿಕಾಯಗಳ ಸಮಿತಿ ಸಭೆಯ ನಿರ್ಣಯ ದಿನಾಂಕ: 06.11.2023

4. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 08.11.2023

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ಸರ್ಕಾರದ ನಿರ್ದೇಶನದಂತೆ, 2023–24ನೇ ಶೈಕ್ಷಣಿಕ ಪ್ರಸಕ್ತ ಸಾಲಿನಿಂದ ಜಾರಿಗೊಳಿಸಿರುವ ಸ್ನಾತಕ ಪದವಿ ಐದನೇ ಮತ್ತು ಆರನೇ ಸೆಮಿಸ್ಟರ್ ಪಠ್ಯಕ್ರಮವನ್ನು ಜಾರಿಗೊಳಿಸಬೇಕಾಗಿರುವ ಪ್ರಯುಕ್ತ **ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಅಧ್ಯಯನ** ವಿಷಯದ ಅಧ್ಯಯನ ಮಂಡಳಿಯು ಪಠ್ಯಕ್ರಮವನ್ನು ಪರಿಷ್ಕರಿಸಿ ಶಿಫಾರಸ್ಸು ಮಾಡಿರುವುದರಿಂದ ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ವಿಜ್ಞಾನ ನಿಕಾಯದ ಸಭೆಯಲ್ಲಿ ಒಪ್ಪಗೆ ಪಡೆದಿರುವಂತೆ, ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಘಟನೋತ್ತರ ಅನುಮೋದನೆಯನ್ನು ನಿರೀಕ್ಷಿಸಿ ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಸ್ತುತ ಸ್ನಾತಕ ಪದವಿ ಕೋರ್ಸಿನ **ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಅಧ್ಯಯನ** ವಿಷಯದ ಐದನೇ ಮತ್ತು ಆರನೇ ಸೆಮೆಸ್ಟರ್ 2023–24ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ ಜಾರಿಗೊಳೀಸಲಾಗಿದೆ.

ಈ ಮಾಹಿತಿಯನ್ನು ಸಂಬಂಧಪಟ್ಟ ಶಿಕ್ಷಕರ ಹಾಗೂ ವಿದ್ಯಾರ್ಥಿಗಳ ಗಮನಕ್ಕೆ ತರಲು ಸೂಚಿಸಲಾಗಿದೆ. ಪಠ್ಯಕ್ರಮದ ವಿವರಗಳನ್ನು ಗುಲಬರ್ಗ ವಿಶ್ವವಿದ್ಯಾಲಯದ ವೆಬ್‌ಸೈಟ್ www.gug.ac.in ದಿಂದ ಪಡೆಯಬಹುದಾಗಿದೆ.

08.11.23

ಕುಲಸಚಿವರು

ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ.

ಗೆ,

1. ಮುಖ್ಯಸ್ಥರು, **ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಅಧ್ಯಯನ** ವಿಭಾಗ, ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ.
2. ಎಲ್ಲಾ ಪದವಿ ಕಾಲೇಜುಗಳ ಪ್ರಾಂಶುಪಾಲರುಗಳಿಗೆ.

ಪ್ರತಿಗಳು:

1. ಡೀನ್‌ರು, ವಿಜ್ಞಾನ ನಿಕಾಯ, ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ ರವರ ಮಾಹಿತಿಗಾಗಿ.
2. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ
3. ನಿರ್ದೇಶಕರು, ಪಿಎಂಇಬಿ ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ ರವರ ಮಾಹಿತಿಗಾಗಿ.
4. ಗ್ರಂಥಪಾಲಕರು, ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ ರವರ ಮಾಹಿತಿಗಾಗಿ.
5. ವಿಜ್ಞಾನ ನಿಕಾಯದ ಎಲ್ಲಾ ಅಧ್ಯಯನ ವಿಭಾಗಗಳ ಮುಖ್ಯಸ್ಥರಿಗೆ ಗು.ವಿ. ಕಲಬುರಗಿ
6. ಸಂಯೋಜಕರು, ಟಾಸ್ಕ್‌ಫೋರ್ಸ್ ಸಮಿತಿ, ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ ರವರ ಮಾಹಿತಿಗಾಗಿ.
7. ವಿಶೇಷಾಧಿಕಾರಿಗಳು, ಆಡಳಿತ, ವಿದ್ಯಾಮಂಡಲ, ಪರೀಕ್ಷಾ, ಅಭಿವೃದ್ಧಿ ಗು.ವಿ. ಕಲಬುರಗಿ ರವರ ಮಾಹಿತಿಗಾಗಿ.
8. ಮುಖ್ಯಸ್ಥರು, ಗಣಕ ಕೇಂದ್ರ, ಗು.ವಿ. ಕಲಬುರಗಿ ರವರಿಗೆ ವೆಬ್‌ಸೈಟ್‌ನಲ್ಲಿ ಪ್ರತ್ಯೇಕ ಪೋರ್ಟಲ್‌ನಲ್ಲಿ ಪ್ರಕಟಿಸಲು ಸೂಚಿಸಲಾಗಿದೆ.
9. ನೋಡಲ್ ಅಧಿಕಾರಿಗಳು, UUCMS, ಗು.ವಿ.ಕಲಬುರಗಿ ಇವರ ಮಾಹಿತಿಗಾಗಿ
10. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿ/ಕುಲಸಚಿವರ ಆಪ್ತ ಸಹಾಯಕರ ಗು.ವಿ. ಕಲಬುರಗಿ ರವರ ಮಾಹಿತಿಗಾಗಿ.

B.Sc. Biotechnology 5th Semester

Program Name	B.Sc. Biotechnology		Semester	5th Semester
Course Title	Plant Biotechnology (Theory + Practical)			
Course Code:	BTC5		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**
Introduction, history, definition, hypothesis, and concept of totipotency. Principles of plant tissue culture, types of culture, morphogenesis, differentiation, callus, direct and indirect organogenesis. In vitro propagation and micropropagation, Seed culture, embryo culture, bud culture, limitations, applications in horticulture, agriculture, and forestry. Meristem culture, Somaclonal variation. Commercial micropropagation of Banana and Sugarcane. Haploid Production, Anther culture, Pollen culture, Ovary culture, Ovule culture - technique, limitations, and applications. Protoplast culture, Somatic hybridization, cybrids.	
Unit -II *In vitro* secondary metabolite production	**20**
Introduction to secondary metabolites, major secondary metabolites, and applications. *In vitro* secondary metabolite production, Suspension cultures, cell cultures, root cultures, hairy root cultures, growth Vs secondary metabolite production, yield enhancement, elicitation, biotransformation, bioreactors and scaling up of secondary metabolite production, limitations, and applications. Case studies of Shikonin and root cultures of *Panax ginseng*.	
Unit -III Transgenic Plants	**15**
Introduction to Transgenic Plants. Overview of transgenic plants and their significance in agriculture. Historical background and development of plant genetic engineering. Benefits and controversies associated with transgenic plants. Transgenic Plant Technology - Techniques for introducing foreign genes into plants: Agrobacterium-mediated transformation, biolistics, and other methods. Selection and screening of transformed plants. Molecular markers and reporter genes used in transgenic plant research. Transgene Integration and Expression. Mechanisms of transgene integration into plant genomes. Factors influencing transgene expression: promoters, enhancers, and regulatory elements. Methods for analyzing and verifying transgene expression. Applications of Transgenic Plants - Improved crop traits through genetic engineering: pest resistance, herbicide tolerance, disease resistance, and abiotic stress tolerance. Case studies of commercially important transgenic crops.	
Unit -IV Biosafety and Regulatory Considerations	**10**
Safety assessment of transgenic plants: potential risks and benefits. International regulatory frameworks for releasing and commercializing genetically modified organisms (GMOs). Public perception and consumer acceptance of transgenic plants. Ethical considerations of genetic engineering in plants. Socio-economic impacts of transgenic crops on farmers and agricultural systems. Intellectual property rights and access to transgenic technologies. Emerging trends and technologies in plant biotechnology - genome editing (CRISPR-Cas9) and RNA interference (RNAi)	

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 Biotechnology**	Practical Credits	2
Course No./ **Course Code:**	BTC5–P	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. Callus culture- Initiation and establishment of different types of callus cultures
5. Micropropagation – Stage 0. 1, 2, 3, and 4
6. Acclimatization and hardening techniques
7. Anther culture and pollen culture
8. Ovary and Ovule culture
9. Isolation and culture of Protoplast
10. Staining, cell viability, and cell count of cell cultures
11. Hairy root culture by Agrobacterium rhizogenic transformation

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**	

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11. Taiz, L., and Zeiger, E. (2014). Plant Physiology. 5th edition. Sunderland, MA: Sinauer Associates.
12. Vasil, I.K., and Vasil, V. (2007). Molecular Improvement of Cereal Crops. Dordrecht: Springer

B.Sc. Biotechnology 5th Semester

Program Name	B.Sc. Biotechnology		Semester	5th Semester
Course Title	Animal Biotechnology (Theory + Practical)			
Course Code:	BTC5–T		No. of Theory Credits	04
Contact hours	60 hrs		Duration of ESA/Exam	03 Hours
Formative Assessment Marks		40	Summative Assessment Marks	60

Course Objectives:

- Understand principles of animal biology and genetics
- Explore biotechnological techniques in animal research and applications
- Study applications of animal biotechnology in breeding, production, and disease management
- Examine ethical and regulatory considerations
- Apply knowledge to real-world challenges in agriculture, veterinary medicine, conservation, and biomedical research
- Understand the need for animal biotechnology for human welfare.

Course Outcomes:

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

1. Understand the biology and characterization of cultured cells, including their adhesion, proliferation, differentiation, morphology, and identification.
2. Gain practical skills in basic mammalian cell culture techniques, measuring growth parameters, assessing cell viability, and understanding cytotoxicity.
3. Learn about germplasm conservation techniques and the establishment of gene banks, along with large-scale culture methods for cell lines.
4. 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.
5. Develop knowledge of the manipulation of animal reproduction, including artificial insemination, embryo transfer, in vitro fertilization, and somatic cell cloning. Understand ethical issues and applications like recombinant vaccines and probiotics for disease

control.

6. Understand gene transfer techniques in animals, including vectors, gene constructs, selectable markers, transfection methods, production of transgenic animals, integration and identification of transgenes, and ethical considerations in transgenesis. Stay updated on recent advances and applications.

Content of Theory	60 hrs
Unit–I History and terminology	**15**
Pluripotency, Differentiation, Reprogramming, Embryonic stem cells (ESCs), Induced pluripotent stem cells (iPSCs), Multipotency, Trans differentiation, Chimera, and gene knockout 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. Germplasm conservation and establishment of gene banks. Large-scale culture of cell lines- monolayer, suspension, and immobilized cultures.	
Unit -II Organ and histotypic culture	**15**
Technique, advantages, limitations, applications. Biotransformation - Induction of cell line mutants and mutations. 3D cultures. Whole embryo culture. Somatic cell hybridization. Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Commercial applications of animal tissue culture. Hazards and safety aspects of tissue culture.	
Unit -III	**15**
Manipulation of animal reproduction and characterization of animal genes, Manipulation of reproduction in animals. Artificial insemination, embryo transfer, and *in vitro* fertilization. Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues. Production of recombinant vaccines. Probiotics for disease control.	
Unit - IV Vectors for gene transfer in animals	**15**
Retrovirus, Gene constructs promoter/ enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase, dihydrofolate reductase, CAT. Transfection of animal cells- calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, microinjection. Methods for producing transgenic animals- retroviral, microinjection, engineered stem cell. Targeted gene transfer. Transgene integration and identification methods. Transgenic and genome-edited animals. Ethical issues in transgenesis. Recent advances and applications in the field.	

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	Animal Biotechnology	Practical Credits	02
Course No./ Course Code:	BTC5–P	Contact hours	60 hrs

Content of Practical

1. Preparation of cell culture media: Preparation of basic cell culture media, such as Dulbecco's Modified Eagle Medium (DMEM), supplemented with fetal bovine serum (FBS), antibiotics, and other required additives.
2. 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.
3. Filter sterilization: Practice filter sterilization for sensitive media ingredients.
4. 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.
5. Cell passaging and subculturing: Practicing subculturing cells by passaging them from one culture vessel to another, following proper techniques for detachment, trypsinization, and seeding at appropriate densities.
6. Cell freezing and thawing: Learn or demo the cryopreservation process by freezing and thawing cells using cryoprotective agents and controlled cooling and thawing rates.
7. 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.
8. 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.
9. Cytotoxicity assays: Students can assess the cytotoxic effects of substances (e.g., drugs, chemicals) on cultured cells using assays like the MTT or LDH assay.
10. 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	

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10. Freshney, I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (8th ed.). Wiley-Blackwell.
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B.Sc. Biotechnology 5th Semester

Program Name	**B.Sc. Biotechnology**		Semester	**5th Semester**
Course Title	**Genetic Engineering (Theory + Practical)**			
Course Code:	BTC5–T		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- Fundamentals of Genetic Engineering	**15**
Introduction to Genetic Engineering - Definition, scope, and historical overview of genetic engineering. Importance and applications in various fields. **DNA Structure and Manipulation** - Structure and organization of DNA molecules. Techniques for DNA isolation and purification. Methods for quantification and characterization of DNA samples. **RNA Analysis and Gene Expression**- Types and functions of RNA molecules. Methods for RNA isolation and purification. Analysis of gene expression using techniques such as Northern hybridization. Introduction to Polymerase Chain Reaction (PCR) and its variants for gene expression analysis **Recombinant DNA technology** – Introduction to molecular cloning. 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, DNA modifying enzymes, other nucleases, Polymerases, Ligase, kinases, and phosphatases. Techniques for molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.	
Unit II- Practices in Genetic Engineering	**15**
Unit 2: Techniques - Protein Expression and Purification. Techniques for expressing recombinant proteins using bacterial, animal, and plant expression systems. Strategies for protein purification and characterization **Gene Manipulation Techniques** - Methods of gene delivery. Physical, chemical, and biological methods. transformation, transfection, electroporation, and micro-injection. Gene knockout techniques in bacterial and eukaryotic organisms. **Genome Editing** - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis, and other genome editing methods.	

Ethical and Regulatory Considerations - Discussion of ethical implications associated with genetic engineering. Introduction to regulatory guidelines and safety considerations for genetic engineering research and applications

Unit III- Applications of Genetic Engineering	**15**
Introduction to Applications. Overview of the diverse applications of genetic engineering. Gene therapy and its potential in treating genetic disorders. Strategies for gene delivery in therapeutic applications. Diagnostic Applications. DNA fingerprinting and its applications in forensics. Molecular diagnostic techniques and their role in disease diagnosis. Use of genetic engineering in the development of therapeutics and vaccines. Production of biopharmaceuticals using recombinant DNA technology. Crop Improvement and Biotechnology in Agriculture. Genetic engineering for crop improvement, including enhanced traits and disease resistance. The role of biotechnology in sustainable agriculture.	

Unit IV- Advances in Genetic Engineering	**15**
Industrial Applications. Industrial applications of genetic engineering, such as enzyme production, biofuel production, and bioremediation. Scale-up techniques and process optimization in industrial settings. Introduction to synthetic biology and its integration with genetic engineering. Design and construction of artificial biological systems Bioinformatics and Computational Tools. Introduction to bioinformatics and its role in genetic engineering. Use of computational tools for sequence analysis, gene prediction, and protein structure analysis.	

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:**	BTC5–P	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. **Cloning and Plasmid Manipulation**
   Restriction enzyme digestion and ligation reactions
   Transformation of bacterial cells with recombinant plasmids
   Colony selection and screening for successful cloning
5. **Protein Expression and Purification**
   Selection of expression system (e.g., bacterial, yeast, insect cells)
   Plasmid construction for protein expression
   Protein expression induction and optimization
   Protein purification techniques (e.g., affinity chromatography, gel filtration)
6. **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)
7. **Gene Knockdown and RNA Interference (RNAi)**
   Design and synthesis of small interfering RNA (siRNA)
   Transfection of siRNA into cells for gene knockdown
   Evaluation of gene knockdown efficiency (e.g., qPCR, Western blot)
8. **Genome Editing Techniques**
   Introduction to the CRISPR-Cas9 system and its applications
   Design of guide RNA (gRNA) for target gene editing
   Transfection of CRISPR-Cas9 components into cells
   Analysis of genome editing efficiency (e.g., T7 endonuclease I assay, Sanger sequencing)
9. **Bioinformatics for Genetic Engineering**
   Introduction to bioinformatics databases and tools
   Sequence analysis (e.g., BLAST, multiple sequence alignment)
   Prediction of protein 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**	

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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.
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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	Environmental Biotechnology (Theory)			
Course Code:	BTC5–T		No. of Theory Credits	03
Contact hours	60hrs		Duration of ESA/Exam	03 Hours
Formative Assessment Marks	35		Summative Assessment Marks	40

Course Objectives:

1. Understand the fundamental concepts and principles of environmental biotechnology and Explore the interrelationship between biotechnology and the environment.
2. Gain knowledge of the various applications of biotechnology in environmental conservation, pollution control, and sustainability.
3. Develop an understanding of the key techniques and methodologies used in environmental biotechnology research and applications.
4. Learn about microbial processes and their role in environmental biotechnology.
5. Understand the principles of bioremediation and its application in the clean-up of environmental pollutants.
6. Explore the potential of bioenergy production and waste management through biotechnological approaches.
7. Identify and characterize the most important contaminants in the Bioprocess and other industrial wastes.
8. Analyze the effect of different contaminant on different bioprocess and in analytical techniques.
9. Bioreactor performance in biological treatment of different contaminants.
10. Reuse/recycle the biological waste to clean technology such as energy, biofuel, bio fertilizer through bioremediation

Course out comes:

1. Demonstrate a comprehensive understanding of the fundamental concepts and principles of environmental biotechnology.
2. Apply knowledge of biotechnological techniques to address environmental challenges, such as pollution control and waste management.
3. Analyze and evaluate environmental biotechnology case studies, research findings, and real-world applications.
4. Design and implement biotechnological approaches for environmental remediation, utilizing microbial processes and biodegradation principles.
5. Evaluate the ethical and sustainable aspects of environmental biotechnology practices and make informed decisions regarding their application in environmental conservation.
6. Communicate scientific concepts and research findings related to environmental biotechnology effectively, both in written and oral forms, to diverse audiences.

Content of Theory	60 hrs
Unit I- Fundamentals of Environmental Biotechnology	**15**
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. Biotechnological Methods of Pollution Detection-General bioassay methods for pollution detection. Cell biological methods for assessing pollution levels. Immunoassays for detecting specific pollutants. DNA-based methods for pollution identification. Use of biosensors in pollution monitoring. Biotechnological Methods in Pollution Abatement-Reduction of CO2 emission using biotechnological approaches. Conventional wastewater treatment methods. Utilizing algae for wastewater treatment. Bioreactors for advanced wastewater treatment. Addressing eutrophication through biotechnological interventions. Application of cell immobilization techniques in pollution abatement.	
Unit II- Definition and principles of bioremediation	**15**
Importance of bioremediation in environmental cleanup. Types of contaminants suitable for bioremediation. Factors influencing bioremediation efficiency. Role of microorganisms in bioremediation processes. Types of microorganisms used in bioremediation (bacteria, fungi, algae). Metabolic pathways involved in contaminant degradation Genetic engineering and bioaugmentation in enhancing microbial capabilities. In-situ Bioremediation Methods. Bioaugmentation. Biostimulation. Bioventing. Phytoremediation. Ex-situ Bioremediation Methods- Composting, Landfarming, Biopile and bioslurry systems. Xenobiotics. Environmental Monitoring and Assessment. Importance of monitoring during bioremediation processes. Sampling techniques and analysis of contaminants. Assessment of microbial activity and degradation effectiveness. Long-term monitoring and post-remediation assessment.	
Unit III- Wastewater Treatment and Management	**15**
Introduction to Wastewater Management. Wastewater Characterization and Composition. Biological Processes in Wastewater Treatment. Activated Sludge Process and Biological Nutrient Removal Anaerobic Digestion and Biogas Production from Wastewater. Membrane Bioreactors and Advanced Biological Treatment Technologies. Bioremediation of Contaminated Wastewater. Emerging Biotechnologies for Wastewater Treatment. Sustainable Approaches in Wastewater Management Case Studies and Innovations in Wastewater Biotechnology.	
Unit IV- Solid Waste Management	**15**
Introduction to Solid Waste Management. Solid Waste Characterization and Classification. Biotechnology Applications in Solid Waste Management. Composting and Vermicomposting Techniques for Organic Waste Recycling and Waste Minimization Strategies. Bioenergy Production from Organic Waste Bioplastics and Bio-based Materials in Solid Waste Management. Hazardous Waste Management and Biotechnological Solutions. Technological Innovations in Solid Waste Biotechnology. Case Studies and Success Stories in Solid Waste Management. Bio metallurgy and bio-mining	

Reference Books

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2. Banerjee, S., & Santhosh, C. (2019). Environmental biotechnology: Concepts and applications. CRC Press.

3. Mishra, A. K. (2016). Environmental biotechnology: Basic concepts and applications. CRC Press.
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Program Name	B.Sc. Biotechnology	Semester	5th Semester
Course Title	Biotechnology Skills and Analytical Techniques		
Course No.	VOC- I	No. of Theory Credits	2+1 (Theory+ Practical)
Contact hours	45 hrs	Duration of ESA/Exam	2hrs
Formative Assessment Marks/ Practical Component	20	Summative Assessment Marks	30

Course Outcomes (COs): At the end of the course the student should be able to:

1. Demonstrate skills as per National Occupational Standards (NOS) of the "Lab Technician/Assistant" Qualification Pack issued by the Life Sciences Sector Skill Development Council-LFS/Q0509.
2. Develop knowledge of laboratory safety procedures and protocols and acquire skills in handling and maintaining laboratory equipment and instruments.
3. Operate analytical equipment and instruments as per standard operating procedures (SOP)
4. Knowledge about major activities of the biotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.
5. Demonstrate soft skills, such as decision-making, planning, organizing, problem-solving, analytical thinking, critical thinking, and documentation.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-13)

Course Outcomes (COs)/Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12	13
Develop knowledge of laboratory safety procedures and protocols and acquire skills in handling and maintaining laboratory equipment and instruments.	✔	✔											
Operate analytical equipment and instruments as per standard operating procedures (SOP)		✔	✔									✔	
Knowledge about major activities of the biotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.		✔							✔		✔		
Demonstrate soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking and documentation.	✔	✔						✔	✔				

Program Name	B.Sc. Biotechnology	Semester	5th Semester
Course Title	Biotechnology Skills and Analytical Techniques		
Course No.	VOC- I	No. of Theory Credits	2+1 (Theory+ Practical)
Contact hours	45 hrs	Duration of ESA/Exam	02hrs
Formative Assessment Marks/ Practical Component	20	Summative Assessment Marks	30

Content	Total 30 Hrs
Unit-I Insights into the biotechnology industry and basic professional skills	15 Hrs
Biotechnology Industry in Indian and Global Context- Organization in the context of large/medium/small enterprises, their structure, and benefits. **Industry-oriented professional skills:** Planning and organizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, and risk assessment. Interpersonal skills: Writing skills, reading skills, oral communication, conflict resolution techniques, interpretation of research data, and troubleshooting in the workplace. **Digital skills:** Basic computer skills (MS Office, excel, power point, internet) for the workplace. Professional E-mail drafting skills and PowerPoint presentation skills. Overview of good manufacturing practices (GMP), Good Documentation practices (GDP), and good laboratory practices (GLP).	
Unit- II Basic laboratory skills and Analytical Techniques	15 Hrs
Analytical skills in the laboratory: Preparations of solutions, molarity, molality, normality, mass percent % (w/w), percent by volume (%v/v), parts per million (ppm), parts per billion (ppb), dilution of concentrated solutions. Standard solutions, stock solution, and solution of acids. Reagent bottle label reading and precautions. **Analytical techniques:** Basic principle, operation, application, maintenance, calibration, validation, and troubleshooting of instruments- Microscope-Simple, compound, TEM, SEM, fluorescence. Centrifuge and different types, Hot air oven, pH meter, different types of pH electrodes Autoclave, pH meter, Incubator, BOD, COD, cell counter, Laminar airflow, Spectroscopy-Colorimeter, UV-Visible spectroscopy. Electrophoresis- Agarose Gel electrophoresis, SDS-PAGE, PCR, Conductivity meter, and Potentiometer. Biosafety cabinets.	

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

Course title	Quality control methods in biology (Practical)	Practical credits	5th Semester
Course No.	VOC -1	Contact hours	4hrs/week 25Marks
Content			
Unit-1			
Methods and practices of cleaning and management of lab: Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirements for cleaning specific areas, equipment, ventilation area, personal protective requirements Calibration of and use of micropipette.			

Unit-2
Preparation of Standard Operating Procedure (SOP) for various equipment in the QC Lab, Best practices of using and storing chemicals: Knowledge and practice in handling chemicals, labelling, and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labelling, storage, and disposal. **Handling and calibration of lab equipment-** weighing balance, Autoclave, Hot air Oven, Incubator, Centrifuge, Water bath, Colony Counter, and stability chamber, Preparation of Normality, Molarity, and buffer solutions
Unit-3
Preparation of media: Maintenance and storage of purified water for media (plant tissue culture media, microbiological media, and animal cell culture media) preparation. Preparation and storage of concentrated stock solutions. Documentation and disposal of expired stocks. Collection of indents of media requirement, preparation, and storage. Media coding, documentation, and purpose of usage. Demonstration, handling, and troubleshooting of High-Performance Liquid Chromatography and Gas chromatography. Demonstration of Polymerase Chain Reaction (PCR), Hands-on training on colorimeter and spectrophotometer, Industry visit, or analytical laboratory visit.

Note: Semester end examination is only in the theory component; questions from the practical part could be included, if any.

References:

1. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch (2017). "Principles of Instrumental Analysis". Cengage Learning.
2. J. Perry Gustafson (2017). "Analytical Methods and Techniques for Advanced Sciences". CRC Press.
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4. Michael Lufaso (2016). "Laboratory Skills for Science and Medicine: An Introduction". CRC Press.
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6. Colin A. Ramsden (2014). "Analytical Molecular Biology". Oxford University Press.
7. John M. Walker and Ralph Rapley (2014). "Molecular Biomethods Handbook". Humana Press.
8. Gary D. Christian, Purnendu K. Dasgupta, and Kevin A. Schug (2013). "Analytical Chemistry". Wiley.
9. Roger L. Lundblad and Fiona M. Macdonald (2010). "Handbook of Biochemistry and Molecular Biology". CRC Press.

Program Name	B.Sc. Biotechnology	Semester	5^{h} Semester
Course Title	Skills in Bioinformatics		

Course No.	VOC- 2	No. of Theory Credits	2+1 (Theory+ Practical)
Contact hours	45 hrs	Duration of ESA/Exam	02hrs
Formative Assessment Marks/ Practical Component	20	Summative Assessment Marks	30

Course Outcomes (COs): At the end of the course the student should be able to:

1. Demonstrate skills as per National Occupational Standards (NOS) of "Bioinformatics Associate/Analyst" Qualification Pack issued by Life Sciences Sector Skill Development Council- LFS/Q3102, Level 4
2. Students will become proficient in using various bioinformatics tools like sequence alignment, genome assembly, and databases commonly used in the field of Biotechnology
3. Students will develop skills in analyzing and interpreting biological data generated through high-throughput technologies.
4. Students will develop skills in analyzing and interpreting biological data generated through high-throughput technologies, perform statistical analysis, data mining, and visualization techniques to extract meaningful insights from complex biological datasets and communicate effectively and collaborate in a multidisciplinary bioinformatics environment.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-13)

Course Outcomes (COs)/ Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12	13
Students will become proficient in using various bioinformatics tools like sequence alignment, genome assembly, and databases commonly used in the field of Biotechnology						✔	✔						
Students will develop skills in analyzing and interpreting biological data generated through high-throughput technologies.							✔	✔					
Students will develop skills in analyzing and interpreting biological data generated through high-throughput technologies, perform statistical analysis, data mining, and visualization techniques to extract meaningful insights from complex biological datasets and communicate effectively and collaborate in a multidisciplinary bioinformatics environment.						✔	✔	✔					

Program Name	B.Sc. Biotechnology	Semester	5th Semester
Course Title	Bioinformatics Associate/Analyst		
Course No.	VOC- 2	No. of Theory Credits	2+1 (Theory+ Practical)

Contact hours	45 hrs	Duration of ESA/Exam	02hrs
Formative Assessment Marks/ Practical component	20	Summative Assessment Marks	30

Content	Total 30 Hrs
Unit-I Essentials of Bioinformatics	15 Hrs
Introduction, Overview of bioinformatics and its applications in biology and medicine Introduction to biological databases and data formats. Bioinformatics Database search engines – Text-based search engines (Entrez, DBGET / LinkDB). Sequence file formats: Various file formats for bio-molecular sequences: GenBank, FASTA, GCG, MSF etc. Sequence Analysis: Sequence databases and retrieval methods, Basics of sequence analysis and sequence alignment algorithms, pairwise sequence alignment techniques (e.g., Needleman-Wunsch, Smith-Waterman), Multiple sequence alignment algorithms (e.g., ClustalW, MUSCLE), Sequence similarity searching (e.g., BLAST, FASTA). Basics of Object-Oriented Programming like (C++ / JAVA), JavaScript, R and Python / Perl, and operating system like Linux. Genome Database- Plant genome database- Plant GDB, Microbial Genomes database: -MBGD, Viral genome database:-ICTVdb Practical applications: Case studies and projects illustrating the application of bioinformatics in genomics, personalized medicine, or other relevant areas	
Unit- II Structural Bioinformatics, Molecular Modelling and Drug Designing	15 Hrs
Introduction to Structural Bioinformatics, Protein Structure Prediction: Introduction to protein structure and its importance, Prediction of protein secondary structure and tertiary structure. Protein structure visualization tools. Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and Analysis tools Introduction to protein-ligand interactions and drug discovery. Analysing Molecular Surfaces, cavities, and intermolecular interaction. Gene Expression Analysis: Introduction to gene expression data analysis, Pre-processing and normalization of gene expression data. Ethical considerations in bioinformatics research. Communication and collaboration in a bioinformatics team	

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

Course title	**Bioinformatics Associate/Analyst (Practical)**	Practical credits	1 25 Marks
Course No.	VOC -2	Contact hours	4hrs/week

Content

1. Use of different biological databases and Bioinformatics search engines (e.g., PubMed, UniProt)
2. Retrieval of DNA and protein sequences from online databases.
3. Analysis of sequence properties such as length, GC content and amino acid composition
4. Performing sequence similarity searches using tools like BLAST
5. Aligning multiple DNA or protein sequences using tools like ClustalW or MUSCLE.
6. Analysis of gene structure using ORFfinder, GenScan
7. Identifying conserved regions or motifs within the alignment
8. Analyzing molecular interactions, intra and inter molecular interactions, salt bridges and crystal contacts.
9. Predicting genes within a DNA sequence using tools like GeneMark or Glimmer
10. Evaluation and visualization of 3D structure of biomolecules using open source resources

11. Constructing phylogenetic trees using methods like neighbor-joining or maximum likelihood and interpreting and visualizing the tree to understand evolutionary patterns
12. Understanding of Kyto Encyclopedia of Genes and Genome (KEGG) database for biological pathways, metabolism, cellular process, genetic information processing.
13. Visualization of gene expression patterns through heatmap

Note: Semester end examination is only in the theory component and questions from the practical part could be included, if any.

References:

1. David W. Mount (2021). "Bioinformatics: Sequence and Genome Analysis". Cold SpringHarbor Laboratory Press.
2. Andreas D. Baxevanis and B. F. Francis Ouellette (2018). "Bioinformatics: A Practical Guideto the Analysis of Genes and Proteins". Wiley.
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