Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B^{++}'Grade (CGPA2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Biotechnology

Name of the Course: B.Sc. III (Sem. V & VI)

(Syllabus to be implemented from June 2026)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology

Nep 2020 Compliant Curriculum

B.Sc. (Biotechnology) Program Preamble

The Bachelor of Science (B.Sc.) in Biotechnology is an inclusive program providing the fundamental knowledge about the core subjects in life sciences which are important in applied technology. Aligned with the vision of the National Education Policy (NEP) 2020, the program offers a flexible, multidisciplinary, and learner-centric curriculum that encourages critical thinking, innovation, and holistic development. This Three/Four-year bachelor's degree program allows the opportunity to the students to experience holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices. Each year of the curriculum offers progressively advanced learning and is designed to build a strong foundation in Biotechnology. The curriculum is structured around several key components:

1. **Major Courses:** These core courses form the backbone of the program, providing in-depth knowledge and understanding of essential Biotechnology concepts, theories, and methodologies.
2. **Minor Courses:** Students have the opportunity to choose minor courses from related or distinct disciplines, promoting an interdisciplinary approach to learning.
3. **Open Electives/General Electives:** The program encourages intellectual exploration beyond the core discipline by offering a wide range of elective courses. These electives enable students to pursue their interests in diverse subjects, fostering creativity, critical thinking, and a well-rounded educational experience.
4. **Vocational and Skill Enhancement Courses:** Practical skills and technical proficiency are integral to the program, with vocational and skill enhancement courses providing hands-on experience in Biotechnology areas. These courses are designed to prepare students for immediate employment and equip them with the tools necessary for career advancement in various scientific and technological fields.
5. **Ability Enhancement Courses (AEC), Indian Knowledge System (IKS), and Value Education Courses (VEC):** In alignment with NEP 2020, the program integrates courses that emphasize the Indian Knowledge System, ethical values, and life skills. These courses foster a deep appreciation for India's rich cultural heritage, while also developing essential communication and ethical decision-making skills that are vital for personal and professional growth.
6. **Field Projects/Internships/Apprenticeships/Community Engagement Projects/On-Job Training:** To bridge the gap between theoretical knowledge and real-world applications, the program includes opportunities for field projects, internships, apprenticeships, and community engagement. These experiences provide students with practical insights, problem-solving abilities, and exposure to professional environments, enhancing their readiness for careers in Biotechnology and related fields.

7. **Research Methodology and Research Projects:** Research is a critical component of the BSc Biotechnology program, with students acquiring skills in research methodology, data collection, analysis, and scientific inquiry. By engaging in independent research projects, students are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers.

Multiple Entry and Multiple Exit Options:

In accordance with the NEP 2020, the BSc Biotechnology program incorporates a Multiple Entry and Multiple Exit framework, offering students the flexibility to enter or exit the program at various stages. This approach ensures that students can tailor their educational journey according to their personal and professional goals, with options to earn certificates, diplomas, or degrees based on the duration of study completed.

Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions: https://www.education.gov.in/sites/upload_files/mhrd/files/upload_document/abc_doc.pdf

- Year 1:
  Upon completion of the first year, students may exit with a Certificate in Biotechnology.
- Year 2:
  After two years, students may choose to exit with a Diploma in Biotechnology.
- Year 3:
  Completion of the third year qualifies students for a BSc Degree in Biotechnology.
- Year 4:
  The fourth year offers an advanced curriculum with a focus on research, allowing students to graduate with an Honors Degree in Biotechnology.

Eligibility for B.Sc. III Biotechnology:

- Candidates who have passed **B.Sc. II Diploma Course degree as per NEP 2020 structure/ degree with 12+1 Level, under Science Faculty preferably with Biotechnology/ Entrepreneurship/ any Life Science/ Science subject**.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology

Nep 2020 Compliant Curriculum

B.Sc. (Biotechnology) Program Outcomes (PO)

Students graduating from the Bachelor of Science in Biotechnology program will be able to:

Major Courses:

- PO1: Demonstrate in-depth knowledge and understanding of core concepts, theories, and methodologies in the chosen major discipline.
- PO2: Apply disciplinary knowledge to solve complex problems, analyze data, and make informed decisions in professional and research contexts.

Minor Courses:

- PO3: Acquire complementary knowledge and skills from a related or distinct discipline, enhancing interdisciplinary understanding and versatility.

Open Electives/General Electives:

- PO4: Explore diverse subjects beyond the core discipline, fostering a broad-based education and cultivating critical thinking and creativity.

Vocational and Skill Enhancement Courses:

- PO5: Gain hands-on experience and technical proficiency in specific vocational areas, preparing for immediate career opportunities.

Ability Enhancement Courses (AEC), Indian Knowledge System (IKS), and Value Education Courses (VEC):

- PO6: Understand and appreciate the rich heritage of the Indian Knowledge System, integrating traditional wisdom with modern education.
- PO7: Develop ability enhancement skills like communication and life skills along with ethical values, social responsibility, and a strong sense of citizenship, contributing positively to society.

Field Projects/Internship/Apprenticeship/Community Engagement Projects/ On Job Training/ Internship/Apprenticeship:

- PO8: Apply theoretical knowledge to real-world situations through field projects, internships, community engagement and On job Training for gaining practical experience and problem-solving skills.

Research Methodology and Research Project:

- PO9: Acquire research skills, including data collection, analysis, and interpretation, fostering a scientific approach to problem-solving to develop independent research projects handling capabilities.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology

Nep 2020 Compliant Curriculum

B.Sc. (Biotechnology) Program Specific Outcomes (PO)

PO 01 Have a basic understanding about the fundamentals and advances in the core subjects of biotechnology.
PO 02 Understand the interdisciplinary importance of Biotechnology as an applied science.
PO 03 Awareness about the local, national and global scenarios in context with Biotechnology.
PO 04 Implement the basic concepts and laboratory skills for the scientific application of Biotechnology required in industry, academics, research organizations etc.
PO 05 Interpret and communicate the biological data.

Structure as per NEP-2020

B. Sc. (Biotechnology)

Difficulty Level	Sem	Faculty			Generic/ Open Elective GE/OE	Vocational and Skill Enhance-ment Course (SEC/VSC)	Ability Enhancement Course (AEC), IKS, VEC	Field Project/ RP/Internship/ Apprenticeship/ Community Engagement & Services	Credits	Cumulative Credits
		Major		Minor						
		DSC	DSE							
4.5 100-200	I	DSC 1-1 (2+2) DSC 2-1 (2+2) DSC 3-1 (2+2)	--	--	GE1/OE1 (2)	SEC-1 (2)	L1-1(2) IKS-1 (2) VEC-1 (2) (Indian Constitution and Democracy)	--	22	**44 UG CERTIFICATE (44)**
	II	DSC 1-2 (2+2) DSC 2-2 (2+2) DSC 3-2 (2+2)			GE2/OE2 (2)	SEC-2 (2)	L1-2 (2) VEC-2 (2)	CC-1 (2)	22	
5.0/200	III	DSC 1-3 (2+1) DSC 1-4 (2+1)	--	DSC 2-3 (2+1) DSC 2-4 (2+1)	GE3/OE3 (2)	VSC1 (2) (DSC1) VSC2 (2) (DSC2)	L2-1 (2)	CC-2 (2)	22	**44 UG DIPLOMA (88)**
	IV	DSC 1-5 (2+1) DSC 1-6 (2+1)		DSC 2-5 (2+1) DSC 2-6 (2+1)	GE4/OE4 (2)	VSC3 (2) (DSC1) VSC4 (2) (DSC2)	L2-2 (2)	FP1/CEP1 (2)	22	
5.5/300	**V**	**DSC 1-7 (3+2) DSC 1-8 (3+2) DSC 1-9 (3+2)**	**DSE 1-1 (2+1) OR DSE 1-2 (2+1)**	**--**	**--**	**VSC5 (2) (Hands on Training related to DSE)**	**IKS-2 (2) (Related to Major Subject)**		**22**	**44 UG DEGREE (132)**
	VI	**DSC 1-10 (3+2) DSC 1-11 (3+2) DSC 1-12 (3+2)**	**DSE 1-3 (2+1) OR DSE 1-4 (2+1)**	**--**	**--**	**VSC6 (2) (Hands on Training related to DSE)**	**--**	**FP2/CEP2/ OJT1 (2)**	**22**	
OR										

6.0/400	**VII**	DSC 1-13 (4+2) DSC 1-14 (4+2)	DSE 1-5 (4+2)	Research Methodology (4)	--	--	--	--	22	**44 UG HONORS DEGREE IN MAIN SUBJECT**
	VIII	DSC 1-15 (4+2) DSC 1-16 (4+2)	DSE 1-6 (4+2)	--	--	--	--	OJT/In House Project/Internship/ Apprenticeship (4)	22	

Abbreviations:

VSC: Vocational Skill Course **SEC:** Skill Enhancement course **VSEC:** Vocational Skill and Skill Enhancement Course	**GE/OE:** Generic/ Open Elective	**IKS:** Indian Knowledge System **AEC:** Ability Enhancement Course **VEC:** Value Education Course
CC: Co-curricular Course	**FP:** Field project **RP:** Research Project	**OJT:** On Job Training

B.Sc. Part- III Biotechnology

NEP 2020 Structure w.e.f. June- 2026

B.Sc. Part- III Biotechnology NEP 2020 Structure							
SEM	**Faculty**		**GE/OE**	**VSC**	**IKS**	**Field Project**	**Credits**
	DSC	**DSE**					
V	**DSC1-7 (3+2)** **Genetic Engineering- I** **(45 Period)**	**DSE1-1 (2+1)** **Recent Trends in Biotechnology** **(30 Period)**	**---**	**VSC 3 (2)** **Hands-on Training on Modern Techniques in Biotechnology**	**IKS 2 (2)** **Understanding IKS in Science/Indian Knowledge Systems in Agriculture, Health and Engineering**	**---**	**22**
	DSC1-8 (3+2) **Animal Biotechnology** **(45 Period)**	**or** **DSE1-2 (2+1)**					
	DSC1-9 (3+2) **Industrial Biotechnology- I (Bioprocess Technology)** **(45 Period)**	**Cyber Security** **(30 Period)**					

VI	**DSC1-10 (3+2)** **Genetic Engineering-II** **(45 Period)** **DSC1-11 (3+2)** **Bioinformatics** **(45 Period)** **DSC1-12 (3+2)** **Industrial Biotechnology-II (Food and Dairy Technology)** **(45 Period)**	**DSE1-3 (2+1)** **Advances in Plant Biotechnology** **(30 Period)** **or** **DSE1-4 (2+1)** **Intellectual Property Rights** **(30 Period)**	**---**	**VSC 4 (2)** **Hands-on Training on Plant Biotechnological Techniques and IPR Regulations**	**---**	**FP2/CEP2/OJT1 (2)**	**22**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Sc. Part- III Subject: Biotechnology

[According to NEP 2020 W.E.F. June 2026]

Sem.	Paper	Title of Paper	Credits		Marks			
			T	PR	T-CA	PR-CA	T-UA	PR-UA
V	**DSC 1-7**	Genetic Engineering- I	**3**	**2**	**30**	**20**	**45**	**30**
	DSC 1-8	Animal Biotechnology	**3**	**2**	**30**	**20**	**45**	**30**
	DSC 1-9	Industrial Biotechnology-I (Bioprocess Technology)	**3**	**2**	**30**	**20**	**45**	**30**
	DSE 1-1 A	Recent Trends in Biotechnology	**2**	**1**	**20**	**10**	**30**	**15**
	DSE 1-1 B	Cyber Security	**2**	**1**	**20**	**10**	**30**	**15**
	VSC 5	Hands-on Training on Modern Techniques in Biotechnology	**---**	**2**	**--**	**20**	**--**	**30**
	IKS 2	Understanding IKS in Science/Indian Knowledge Systems in Agriculture, Health and Engineering	**2**	**---**	**20**	**---**	**30**	**---**
VI	**DSC 1-10**	Genetic Engineering- II	**3**	**2**	**30**	**20**	**45**	**30**
	DSC 1-11	Bioinformatics	**3**	**2**	**30**	**20**	**45**	**30**
	DSC 1-12	Industrial Biotechnology-II (Food and Dairy Technology)	**3**	**2**	**30**	**20**	**45**	**30**
	DSE 1-2 A	Advances in Plant Biotechnology	**2**	**1**	**20**	**10**	**30**	**15**
	DSE 1-2 B	Intellectual Property Rights	**2**	**1**	**20**	**10**	**30**	**15**
	VSC 6	Hands-on Training on Plant Biotechnological Techniques and IPR Regulations	**---**	**2**	**--**	**20**	**--**	**30**
	FP2/CEP2/OJT1	**FP2/CEP2/OJT1**	**---**	**2**	**--**	**20**	**--**	**30**

Structure as per NEP-2020
B. Sc. III (Biotechnology)

SEMESTER-V					
Sr.No.	**Course Type**	**Course**	**Code**	**Paper Title**	**Credit**
1.	Major	DSC 1-7 (T)		Genetic Engineering- I	2
		DSC 1-7 (P)		Practical Course on Genetic Engineering- I	3
2.	Major	DSC 1-8 (T)		Animal Biotechnology	2
		DSC 1-8 (P)		Practical Course on Animal Biotechnology	3
3.	Major	DSC 1-9 (T)		Industrial Biotechnology-I (Bioprocess Technology)	2
		DSC 1-9 (P)		Practical Course on Industrial Biotechnology-I	3
4.	Minor	DSE 1-1 (T)		Recent Trends in Biotechnology	2
		DSE 1-1 (P)		Practical Course on Recent Trends in Biotechnology	1
		OR			
		DSE 1-2 (T)		Cyber Security	2
		DSE 1-2 (P)		Practical Course on Cyber Security	1
5.	VSC	VSC5 (Hands on Training related to DSE)		Hands-on Training on Modern Techniques in Biotechnology	2
6.	AEC	IKS-2 (2) (Related to Major Subject)		Understanding IKS in Science/Indian Knowledge Systems in Agriculture, Health and Engineering	2
				Total	**22**
SEMESTER-VI					
1.	Major	DSC 1-10 (T)		Genetic Engineering- II	2
		DSC 1-10 (P)		Practical Course on Genetic Engineering- II	3
2.	Major	DSC 1-11 (T)		Bioinformatics	2
		DSC 1-11 (P)		Practical Course on Bioinformatics	3
3.	Major	DSC 1-12 (T)		Industrial Biotechnology-II (Food and Dairy Technology)	2
		DSC 1-12 (P)		Practical Course on Industrial Biotechnology-II	3
4.	Minor	DSE 1-3 (T)		Advances in Plant Biotechnology	2
		DSE 1-3 (P)		Practical Course on Advances in Plant Biotechnology	1
		OR			

		DSE 1-4 (T)		Intellectual Property Rights	2
		DSE 1-4 (P)		Practical Course on Intellectual Property Rights	1
5.	VSC	VSC6 (Hands on Training related to DSE)		Hands-on Training on Plant Biotechnological Techniques and IPR Regulations	2
6.	FP2/CEP 2/OJT1	FP2/CEP2/ OJT1		Field Project 2 / Community Engagement Program 2 / On-Job Training 1	2
				Total	**22**

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: Course Name: Genetic Engineering- I (Theory)**
***TeachingScheme:** **Lectures - 03 Hrs/Week, 03 Credits**	***Examination Scheme** **UA: 45 Marks** **CA: 30 Marks**

Course Preamble:

Genetic Engineering-I introduces the basic principles and tools used for manipulation of genetic material. The course provides foundational knowledge of recombinant DNA technology, gene cloning, and molecular techniques, preparing students for advanced studies and practical applications in biotechnology.

Course Objectives:
During this course, the student is expected to:

- To explain the basic principles and historical development of genetic engineering.
- To identify and describe the role of enzymes and tools used in recombinant DNA technology.
- To differentiate between various cloning vectors and host systems.
- To understand and explain gene cloning strategies and gene expression systems.
- To recognize biosafety issues and ethical considerations related to genetic engineering

Course Outcomes:
At the end of this course:

- Students will be able to explain the basic principles and historical development of genetic engineering.
- Students will be able to identify and describe the role of enzymes and tools used in recombinant DNA technology.
- Students will be able to differentiate between various cloning vectors and host systems.
- Students will be able to understand and explain gene cloning strategies and gene expression systems.
- Students will be able to recognize biosafety issues and ethical considerations related to genetic engineering.

DSC 1-7: Genetic Engineering- I (Theory)

Unit I	Genetic Engineering: Enzymes and Tools	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Introduction to Genetic Engineering: Definition, scope and history of genetic engineering, Milestones in recombinant DNA technology, Basic principles of genetic manipulation, Tools of genetic engineering – overview, Ethical, legal and biosafety aspects of genetic engineering.

Enzymes and Tools of Recombinant DNA Technology: Restriction endonucleases – types (Type I, II, III), nomenclature, mechanism of action, DNA ligases – types and mechanism, DNA modifying enzymes – alkaline phosphatase, polynucleotide kinase, terminal transferase, DNA polymerases – Klenow fragment, Taq polymerase, reverse transcriptase, Linkers, adaptors and molecular markers.

Unit II	Gene cloning vectors	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Cloning Vectors : Plasmid vectors – pBR322, pUC series (features and applications), Bacteriophage vectors – Lambda phage vectors, M13 vectors, Cosmid and phagemid vectors, Shuttle vectors, Artificial chromosomes – BAC, YAC (structure and applications).

Unit III	Gene cloning techniques and expression	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Gene Cloning Techniques: Preparation of genomic and cDNA libraries, Methods of DNA fragmentation, Ligation and transformation methods, Host systems – E. coli, yeast and mammalian cells, Selection and screening of recombinants, Blue-white screening and antibiotic selection.

Gene Expression and Regulation: Expression vectors – features and design, Promoters, operators and regulatory elements, Inducible and constitutive expression systems, Fusion proteins and affinity tags, Factors affecting gene expression.

Suggested Reading:

1. Primrose, S.B., & Twyman, R. (2006). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
2. Brown, T.A. (2010). Gene Cloning and DNAAnalysis: An Introduction (6th ed.). Wiley-Blackwell.
3. Winnacker, E.L. (2003). From Genes to Clones: Introduction to Gene Technology (4th ed.). Panima Publishing Corporation.
4. Green, M.R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual (4th ed.). Cold Spring Harbor Laboratory Press.
5. Glick, B.R., & Pasternak, J.J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press.
6. Dale, J.W., & von Schantz, M. (2007). From Genes to Genomes: Concepts and Applications of DNATechnology (2nd ed.). Wiley-Blackwell.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
8. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Cold Spring Harbor Laboratory Press.
9. Clark, D.P., & Pazdernik, N.J. (2012). Biotechnology: Applying the Genetic Revolution (2nd ed.). Elsevier Academic Press.
10. Campbell, A.M., & Heyer, L.J. (2006). Discovering Genomics, Proteomics, and Bioinformatics (2nd ed.). Benjamin Cummings.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: DSC 1-7, Course Name: Genetic Engineering- I (Practical)**
***TeachingScheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Objectives:
During this course, the student is expected to:

- To provide hands-on training in recombinant DNA technology
- To develop skills in molecular biology techniques
- To understand practical applications of genetic engineering
- To familiarize students with laboratory safety and biosafety norms

Course Outcomes:
At the end of this course:

- Students will be able to provide hands-on training in recombinant DNA technology
- Students will be able to develop skills in molecular biology techniques
- Students will be able to understand practical applications of genetic engineering
- Students will be able to familiarize students with laboratory safety and biosafety norms

	Based on: Genetic Engineering- I (2 Credits)
1	Familiarization with instruments – Micropipettes, centrifuge, autoclave, hot air oven, UV transilluminator
2	Preparation of buffers and solutions (Tris buffer, TAE/TBE buffer)
3	Isolation of genomic DNA from bacteria
4	Isolation of plasmid DNA (alkaline lysis method)
5	Quantification of DNA using UV–Visible spectrophotometer
6	Estimation of DNA purity (A260/A280 ratio)
7	Restriction digestion of DNA using restriction endonucleases
8	Analysis of restriction fragments using gel documentation system

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: Course Name: Animal Biotechnology (Theory)**
***Teaching Scheme:** **Lectures - 03 Hrs/Week, 03 Credits**	***Examination Scheme** **UA: 45 Marks** **CA: 30 Marks**

Course Preamble:
Animal Biotechnology is an important interdisciplinary field that applies principles of molecular biology, genetics, and cell culture to improve animal health and develop biomedical products. This course introduces students to the fundamental concepts and techniques used in animal biotechnology. It begins with the basic understanding of animal cell culture methods. It further explores the development, characterization, preservation, and cryopreservation of animal cell lines, along with techniques used for producing transgenic animals and cloning. Advanced topics such as stem cell technology, including embryonic, adult, and induced pluripotent stem cells, are also covered. In addition, the course highlights important medical applications of animal biotechnology such as vaccine production, monoclonal antibody generation through hybridoma technology, gene therapy, and molecular diagnosis. Ethical considerations and regulatory guidelines related to animal biotechnology are also discussed to provide a balanced scientific perspective.

Course Objectives:
During this course, the student is expected to:

- To understand fundamentals of animal biotechnology
- To learn animal cell culture principles
- To study transgenic animals and cloning
- To explore applications in medicine and industry

Course Outcomes:
At the end of this course:

- Students will be able to explain fundamentals of animal biotechnology
- Students will be able to describe animal cell culture techniques
- Students will be able to understand cryopreservation and cell line development
- Students will be able to explain transgenic animal production and cloning
- Students will be able to apply concepts in medical and industrial biotechnology

DSC 1-8: Animal Biotechnology (Theory)

Unit I	Introduction to Animal Biotechnology	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Basics of Animal Biotechnology - Definition and scope, Historical development, Ethical issues, Regulatory guidelines**,** Animal Cell Structure and Organization **-** Cell membrane, Organelles, Cell cycle, Apoptosis

Animal Cell Culture Techniques- Types of Animal Cell Culture (Primary culture, Secondary culture, Continuous cell lines, Organ culture), Culture Media and Environment - Types of media Serum and supplements, pH and temperature, Sterility

Unit II	Cell Line Development and Preservation	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Cell Line Characterization – Morphology, Growth kinetics, Chromosomal analysis, Contamination testing**,** Cryopreservation **-** Freezing methods, Cryoprotectants, Storage systems, Revival techniques

Transgenic Animals and Cloning - Production of Transgenic Animals (Microinjection, Embryonic stem cells)**,** Animal Cloning**-** Somatic cell nuclear transfer, Dolly experiment, Advantages, Limitations

Unit III	Applications of Animal Biotechnology	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Stem Cell Technology- Definition and types of stem cells (Embryonic stem cells, Adult stem cells, Induced pluripotent stem cells), Properties and applications, Stem cell culture, Ethical issues.

Animal Biotechnology in Medicine- Production of vaccines, Monoclonal antibodies – Hybridoma technology, Gene therapy – Types and applications, Molecular diagnosis.

Suggested Reading:

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA
4. Molecular Biotechnology – S. B. Primerose
5. Principals of Gene Manipulation – Primerose
6. Culture of animal cell 3rd edition-R Ian Freshney
7. M. K. Sateesh (2010) Bioethics and Biosafety; I. K. International Publishing House Pvt. Ltd.
8. LIFE SCIENCES PROTOCOL MANUAL (2018) Compiled by Dr. P. Hemalatha Reddy, Dr. Suman Govil, Department of Biotechnology, Ministry of Science & Technology, Government of India
9. P.M. Swami (2008) Laboratory Manual on Biotechnology; Rastogi Publications

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: DSC 1-8, Course Name: Animal Biotechnology (Practical)**
***Teaching Scheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Based on: Animal Biotechnology (2 Credits)	
1	Study of animal biotechnology laboratory setup and biosafety guideline
2	Preparation of animal cell culture media
3	Trypan blue exclusion test for cell viability
4	Study of cryopreservation and revival of animal cells (demonstration)
5	Isolation of genomic DNA from animal tissue
6	Study of CPSEA and IAEC Guidelines for Animal Experimentation
7	Sterilization and Maintenance of Laminar Air Flow and required glass wares
8	Primary cell culture from animal tissue
9	Separation of lymphocytes using Ficoll gradient
10	Study of HeLa and Vero cell lines
11	Field visit to semen bank or silk worm rearing or animal cell culture lab.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year BSc (Biotechnology) Semester-V

Vertical : DSC

Course Code: Course Name: Industrial Biotechnology-I (Bioprocess Technology) (Theory)

***TeachingScheme:**	***Examination Scheme**
Lectures - 03 Hrs/Week, 03 Credits	**UA: 45 Marks** **CA: 30 Marks**

Course Preamble:

This course introduces the fundamental principles of fermentation technology, emphasizing the design, operation, and functions of bioreactors (fermenters) and the formulation of suitable fermentation media. It further explores the screening of industrially important microorganisms through primary and secondary screening methods, along with strategies for strain improvement, preservation, and maintenance in culture collection centers. Concepts of fermentation scale-up and methods for detection and assay of fermentation products using physical, chemical, and biological techniques are also included.

Finally, the course covers downstream processing techniques such as filtration, centrifugation, extraction, distillation, and chromatographic purification. It also introduces fermentation economics and the role of computers in modern fermentation technology.

Course Objectives:

During this course, the student is expected to:

- Understand the principles, design, functions, and operational aspects of bioreactors/fermenters used in industrial fermentation processes.
- Learn the composition, preparation, and sterilization of fermentation media, along with inoculum development and microbial growth kinetics.
- Study the methods of primary and secondary screening of industrial microorganisms and strategies for strain improvement, preservation, and maintenance.
- Understand the principles of scale-up in fermentation processes and the methods used for detection and assay of fermentation products.
- Gain knowledge of downstream processing techniques including separation, purification, product formulation, fermentation economics, and computer applications in fermentation technology.

Course Outcomes: At the end of this course

- Explain the structure, functions, and operational parameters of fermenters and their role in industrial bioprocesses.
- Prepare and evaluate fermentation media and describe microbial growth kinetics in fermentation systems.
- Apply principles of microbial screening, strain improvement, and preservation of industrially important microorganisms.
- Describe the scale-up of fermentation processes and perform basic assays for detection and analysis of fermentation products.
- Explain and evaluate different downstream processing techniques and understand the economic and technological considerations in industrial fermentation.

DSC 1-9: Industrial Biotechnology-I (Bioprocess Technology) (Theory)

Unit I	Bioreactors/fermenters and media	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Bioreactors/fermenters and media : Introduction, Basic functions of a fermenter, Operation of the fermenter. Fermentation Media: Introduction, Characteristics of an ideal fermentation medium, raw materials used, Types of Fermentation media, media sterilization, inoculum media, screening for fermentation media. Inoculum preparation. Microbial growth Kinetics.			
Unit II	**Screening and scale-up**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Screening: Introduction, Primary and secondary screening. Strain Improvement. Preservation and maintenance of industrial strains, Culture Collection Centers for Microorganisms, Scale up of fermentation. Detection and assay of fermentation products: Physical- chemical assays, Biological assays.			
Unit III	**Downstream processing**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Downstream processes: Solid-liquid separation, coagulation and Flocculation, Filtration, Centrifugation, Disintegration methods, Precipitation, Solvent extraction, Distillation, Purification by Chromatographic Techniques, Product Formulation. Fermentation economics. Application of computer in fermentation technology			

Suggested Reading:

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. H. A. Modi (2009) .Fermentation Technology Vol.I and Vol. II. Pointer Published by Pointer, Jaipur

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: DSC 1-9, Course Name: Industrial Biotechnology-I (Practical)**
***Teaching Scheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Objectives:
During this course, the student is expected to:

- Gain hands-on experience with laboratory fermentors and understand the basic principles of fermentation processes.
- Learn techniques for screening and isolation of industrially important microorganisms, including antibiotic-producing strains from soil.
- Understand the practical aspects of microbial production of industrial products such as antibiotics, citric acid, enzymes, and bioinsecticides.
- Perform recovery and assay procedures for fermentation products such as citric acid and enzymes like amylase.
- Develop practical skills in food and beverage fermentation processes and gain exposure to industrial fermentation practices through an industry visit.

Course Outcomes:
At the end of this course:

- Operate and understand the basic working of a laboratory fermentor used in microbial fermentation.
- Isolate and screen microorganisms from environmental samples for production of useful metabolites such as antibiotics.
- Perform microbial fermentation for the production of industrially important products including citric acid, amylase, and bioinsecticides.
- Carry out recovery, purification, and assay of fermentation products using appropriate laboratory techniques.
- Demonstrate practical understanding of food and beverage fermentation processes and relate laboratory practices with industrial biotechnology applications.

Based on: Industrial Biotechnology-I (2 Credits)	
1	Introduction to laboratory Fermentor
2	Screening of Antibiotic producing microorganisms from soil by crowded plate technique
3	Fermentative production of antibiotics
4	Production, recovery and assay of citric acid by *Aspergillus niger*.
5	Production, recovery of Amylase.
6	Assay of amylase
7	Production of sauerkraut by microorganisms
8	Production of Bioinsecticides by using *B. thuringienesis*.
9	Production of wine from fruits
10	Industry visit

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSE** **Course Code: Course Name: Recent Trends in Biotechnology (Theory)**

***TeachingScheme:** **Lectures - 02 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Objectives:
During this course, the student is expected to:

To understand and explain the principles and applications of enzyme technology.
To analyze metabolic networks using metabolic flux analysis and metabolic control analysis (MCA) for pathway optimization and strain improvement.
To evaluate environmental biotechnology approaches including bioremediation and bioleaching for sustainable environmental management.
To explain the role of emerging technologies such as Artificial Intelligence in biological data analysis and advanced gene editing tools like CRISPR-Cas systems in modern biotechnology.
To understand and assess recent advancements in healthcare biotechnology including precision medicine, neural interfaces, and mRNA-based therapeutics and vaccines.

Course Outcomes:
At the end of this course:

- Students will be able to understand and explain the principles and applications of enzyme technology.
- Students will be able to analyze metabolic engineering.
- Students will be able to evaluate environmental biotechnology approaches.
- Students will be able to explain the role of emerging technologies such as Artificial Intelligence in biological data analysis and advanced gene editing tools like CRISPR-Cas systems in modern biotechnology.
- Students will be able to understand and assess recent advancements in healthcare biotechnology including precision medicine, neural interfaces, and mRNA-based therapeutics and vaccines.

DSE 1-3: Recent Trends in Biotechnology- (Theory) (2 Credits - 30L)			
Unit I	**Modern biotechnology**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Enzyme Technology – Immobilized enzymes, enzymes in diagnostics and therapeutics **Mutagenesis** - Site directed mutagenesis, Cassette mutagenesis, PCR-site directed mutagenesis, random mutagenesis **Metabolic Engineering** - Analysis of metabolic network, metabolic flux analysis, metabolic control analysis (MCA) **Environmental technologies** – Bioremediation – in situ and ex situ, Bioleaching			
Unit II	**Emerging trends in Biotechnology**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Artificial intelligence in biotechnology – analysis of complex biological data, CrisperCas9 and advanced gene editing, advanced drug discovery **Healthcare** - Precision medicines, neural interfaces, mRNA therapeutics and vaccines **Sustainable technology** – Eco tolerant and pathogen resistant plant varieties, biopesticides, biodegradable plastics			

Suggested Reading:

1. S. M. Bhatt, "Enzymology and Enzyme technology", S. Chand & Company LTD.
2. Trevor Palmer, Philip Bonner, "Enzymes – Biochemistry, Biotechnolgy, Clinical chemistry", 2nd Ed. Affiliated East-West Press Private Limited, New Delhi.
3. Martin L.Yarmush, "Biotechnology for Biomedical Engineers – Principles and Applications in Engineering Series", CRC Press, Boca Raton London New York Washington,D.C
4. Hans-Joachim Jordening, Josef Winter, "Environmental Biotechnology: Concepts and applications", Willey Interscience, A John Willey & Sons, INC., Publication.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernhard R. Glick and Cheryl L. Patten (2022) 6th Edition, John Wiley and Sons
6. Environmental Biotechnology by M. H. Fulekar (2010), CRC Press
7. Russell P. J. (2014), IGenetics: A Molecular Approach, 3rd Edition, Pearson New International Edition

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: DSE 1-3, Course Name: Recent Trends in Biotechnology (Practical)**
***TeachingScheme:** **Practical - 02 Hrs/Week, 01 Credits**	***Examination Scheme** **UA: 15 Marks** **CA: 10 Marks**

Course Objectives:
During this course, the student is expected to:

- Understand and perform experimental techniques related to enzyme activity and immobilization of microbial cells.
- Learn modern molecular biology methods such as gene expression profiling using qPCR and analysis of proteomics data.
- Study emerging biotechnological applications including mRNA vaccines, bioplastic production, and AI-based drug discovery approaches.
- Develop analytical skills through biochemical techniques such as identification of amino acids using thin layer chromatography (TLC).
- Examine real-world applications of biotechnology through case studies, including the development of stress-tolerant or pathogen-resistant plant species.

Course Outcomes:
At the end of this course:

- Demonstrate immobilization techniques and evaluate enzyme activity in immobilized microbial systems.
- Perform and interpret gene expression analysis using qPCR and analyze proteomics data for biological insights.
- Explain the principles and applications of modern biotechnologies such as mRNA vaccines, bioplastics, and AI-assisted drug discovery.
- Apply chromatographic techniques such as TLC for identification and analysis of biomolecules.
- Analyze case studies in biotechnology and understand the development of improved plant varieties with enhanced stress or pathogen resistance.

Based on: Recent Trends in Biotechnology (1 Credit)	
1	Immobilization of yeast cells to study invertase activity
2	Gene expression profiling using qPCR
3	Expression analysis of proteomics data
4	Study of mRNA vaccines
5	Production of Bioplastic
6	Case study of development of stress tolerant/pathogen resistant plant species.
7	Introduction to drug discovery using AI tools
8	To identify amino acids in a sample using TLC

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSE** **Course Code: Course Name: Cyber Security (Theory)**
***TeachingScheme:** **Lectures - 02 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble:

Course Objectives:
During this course, the student is expected to:

Course Outcomes:
At the end of this course:

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DSE 1-4: Cyber Security			
Unit I		**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Unit II		**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**

Suggested Reading:

1.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: DSE 1-4, Course Name: Cyber Security (Practical)**
***TeachingScheme:** **Practical - 02 Hrs/Week, 01 Credits**	***Examination Scheme** **UA: 15 Marks** **CA: 10 Marks**

Course Objectives:
During this course, the student is expected to:

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Course Outcomes:
At the end of this course:

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Based on: Cyber Security (2 Credits)	
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पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : AEC** **Course Code: Course Name: IKS-2 (Related to Major Subject)**
***TeachingScheme:** **Lectures - 02 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Objectives:
During this course, the student is expected to:

- To familiarize learners with major sequential development in Indian science, engineering and technology.
- To review & strengthen the ancient discovery and research in physics, chemistry, maths, metallurgy, astronomy, architecture, textile, transport, agriculture and Ayurveda etc.
- To help students to trace, identify and develop the ancient knowledge systems to make meaningful contribution to development of science today
- To help to understand the apparently rational, verifiable and universal solution from ancient Indian knowledge system for the scientific, technological and holistic development of physical, mental and spiritual wellbeing.

Course Outcomes:
At the end of this course:

- Students will be able to understand major sequential development in Indian science, engineering and technology.
- Students will be able to review and strengthen the ancient discovery and research in physics, chemistry, maths, metallurgy, astronomy, architecture, textile, transport, agriculture and Ayurveda etc.
- Students will be able to trace, identify and develop the ancient knowledge systems to make meaningful contributions to the development of science today.
- Students will be able to understand the apparently rational, verifiable and universal solution from the ancient Indian knowledge system for the scientific, technological and holistic development of physical, mental and spiritual wellbeing.

AEC: IKS-2 (2)
(Related to Major Subject) I (Theory)

Unit I	Indian Science and Technology	No. of Lectures: 15	Weightage (UA): 15-23 Marks

A: Indian Traditional Knowledge; Science and Practices
Introduction to the Science and way of doing science and research in India, Traditional agricultural practices, Traditional water-harvesting practices, Traditional Livestock and veterinary Sciences Traditional Houses & villages, Traditional Forecasting, Traditional Ayurveda & plant based medicine, Traditional writing Technology

B: Ancient Indian Science (Physics, Chemistry, Maths)
Physics in India: Vaisheshika darshan Atomic theory & law of motion, theory of panchmahabhoota, Brihath Shathaka (divisions of the time, unit of distance), bhaskarachaya (theory of gravity, surya siddhanta & sidhanta shriomani), Lilavati (gurutvakashan Shakti).
Chemistry in India Vatsyayana, Nagarjuna,Khanda, Al-Biruni, Vagbhaṭa – building of the ras-shala (laboratory), working arrangements of ras-shala, material and equipment, Yaśodhara Bhaṭṭa-process of distillation, apparatus, saranasamskara, saranataila
Mathematics in India: Baudhayana's Sulbasutras, Aryabhaṭa, Bhaskaracharya-1, Bhaskaracharya-2

C: Ancient Indian Science (metallurgy, Astronomy, Architecture)
Metallurgy in India: Survarṇa(gold) and its different types, prosperities, Rajata(silver), Tamra(copper), Loha(iron), Vanga(tin), Naga / sisa(lead), 13 Pittala(brass)
Astronomy in India Vedang Jyotish, aryabhatta siddhanta, Karabakutuhala (Aryabhaṭa, Varahamihira, Brahmagupta, Bhaskara,
Architecture in India: Nagara (northern style), Vesara (mixed style), and Dravida (southern style), Indian vernacular architecture, Temple style, Maratha architecture.

Unit II	Ancient Indian Science	No. of Lectures: 15	Weightage (UA): 15-23 Marks

A: Ancient Indian Science (Textile, Agriculture, Transport)
Textile Technology in India: Cotton (natural cellulose fiber), silk, wool (natural protein fibers), ,Agriculture in India: krishisuktas, Krishiparashara, Types of crops, Manures, use of animals in warfare, animal husbandry, Animals for medicines. Ancient transport in India.

B: Ancient Indian Science (Ayurveda & Yoga)
Ayurveda for Life, Health and Well-being: Introduction to Ayurveda: understanding Human body and Pancha maha bhuta, the communication between body & mind, health regimen for wellbeing, introduction to yoga (raja yoga, astang yoga, gyan yoga), understanding of Indian psychological concept, consciousness, tridosha & triguna.

Suggested Reading:

1. Textbook on IKS by Prof. B Mahadevan, IIM Bengaluru.
2. Kapur K and Singh A.K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust, Bombay, 1995.
3. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008.
4. SK Das, The education system of Ancient hindus, Gyan publication house, India
5. R P Kulkarni, Glimpese of Indian Engineering and Technology (Ancient & Medieval period, Munshiram

Manoharlal Publishers Pvt. Ltd. 2018 14
6. AK Pathak, Science and Technology in India, Anshika prakashan pratapgarh, 2016
7. PB Sharma, S. Narain, Doctors Scientists and Engineers of Ancient India, Kalpaz Publications 2017
8. NVP, Unithiri, Indian Scientific Traditions (Professor K.N. Neelakantan Elayath Felicitation Volume), publication division University of Calicut, 2006
9. Anonyms, History of Science in India- Volume-I Part-I (Physics, Mathematics and Statistics), the national academy of science, India & the ramkrishna mission institute of culture, 2014
10. R N Basu, T K Bose, CS, Cakraborty History of Science in India - Agricultural Science (Volume V), the national academy of science, India & the ramkrishna mission institute of culture 2014
11. A Gosh, History of Science in India (Volume-I Part-II Astronomy), the national academy of science, India & the ramkrishna mission institute of culture, 2014
12. Dharmpal, Indian science and technology in the eighteen century, rashtrottahana sahitya, 1983
13. Subhash Vats, Religion and Dharma, Khanna Publishing House.
14. S Biswal, B L ray, vedic Science and technology, DK Print world, 2009
15. A.K Bag, Histroy of technology in Indian (Set 3 vol), Indian Nation Science Academy, 1997.
16. M.C. Bora, Bhartiya Knowledge Systems, Khanna Publishing House, 2024.
17. AR vasudev Murty, Science and Technology in Ancient India as Reflected in the Mahabharata, Sanskrit Bharati, 2019.
18. Sampadananda Mishra, The Wonder That is Avadhanam, IKS.
19. Prateek Pattanaik, Avadhana (Tradition in Odisha), IKS.
20. S. Vaishnavi, The Art of Avadhana (Unveiling the Secrets of Human Attention and Memory), IKS.
21. Surbhi Bhagat, Jain Dharma me Avadhana, IKS

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-V** **Vertical : DSC** **Course Code: VSC 5,** **Course Name: Hands on Training on Recent Trends in Biotechnology**

***TeachingScheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble:

This practical course provides hands-on training in important techniques used in molecular biology, biotechnology, and biochemical analysis. Students learn methods for isolation and electrophoretic analysis of genomic DNA from bacteria, animal tissues, and soil. The course introduces genetic techniques such as bacterial transformation, replica plating for mutant analysis, and blue–white screening. Protein analysis methods including SDS-PAGE and Western blotting are also covered. Students gain experience in DNA profiling using RFLP/RAPD markers and Southern blotting. Applications of biotechnology are demonstrated through microbial bioremediation, liver function tests (SGOT–SGPT), and enzyme biosensors. A laboratory visit further familiarizes students with modern laboratory practices and instrumentation used in biotechnology.

Course Objectives:
During this course, the student is expected to:

- Develop practical laboratory skills in molecular biology and biotechnology techniques, including DNA isolation, bacterial transformation, mutant screening, protein analysis, and nucleic acid blotting methods.
- Gain hands-on exposure to applied biochemical, environmental, and diagnostic techniques such as enzyme assays, biosensors, bioremediation experiments, and industrial or research laboratory practices.

Course Outcomes:
At the end of this course:

- Perform and interpret fundamental molecular and protein analysis techniques such as DNA extraction, electrophoresis, blotting, transformation, and genetic screening with proper laboratory protocols.
- Demonstrate the ability to apply biotechnological methods in environmental, clinical, and industrial contexts, including enzyme analysis, biosensor studies, microbial applications, and professional laboratory practices.

Based on: Practicals based on DSE 1-1 or DSE 1-2 (2 Credits)	
1	Isolation of genomic DNA from bacteria/animal tissue
2	Electrophoretic analysis of genomic DNA isolated from different sources
3	Isolation of total DNA from soil
4	Bacterial transformation (making competent cells, calculating transformation efficiency)
5	Replica plate technique for the study of mutant strains
6	Blue-white screening (auxotrophic strain)
7	SDS-PAGE
8	Western blotting
9	DNA profiling using RFLP/RAPD markers
10	Southern blotting
11	Decolorization of a textile dye to demonstrate the concept of microbial bioremediation
12	SGOT-SGPT liver function test
13	Study of glucose/urease enzyme biosensor
14	Laboratory visit

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-VI** **Vertical : DSC** **Course Code: Course Name: Genetic Engineering- II (Theory)**
***TeachingScheme:** **Lectures - 03 Hrs/Week, 03 Credits**	***Examination Scheme** **UA: 45 Marks** **CA: 30 Marks**

Course Preamble:
Genetic engineering is a core area of modern biotechnology that enables precise manipulation and analysis of genetic material for research, medical, agricultural, and industrial applications. This course introduces students to the fundamental principles and techniques used in genetic engineering. It covers essential molecular biology tools such as electrophoresis, blotting techniques, autoradiography, PCR, and molecular markers used for DNA analysis and identification. The course also explores various DNA transfer and cloning strategies in prokaryotic and eukaryotic systems, including transformation, transfection, transduction, and Agrobacterium-mediated gene transfer. In addition, students learn methods for screening recombinant clones and the construction of clone banks. The course further introduces classical and modern DNA sequencing techniques, probe design, and labeling methods. Overall, the course provides a comprehensive understanding of the techniques that form the foundation of genetic manipulation and molecular biotechnology.

Course Objectives:
During this course, the student is expected to:

- Understand the basic principles and scope of genetic engineering and its role in modern biotechnology.
- Learn the principles and applications of molecular techniques such as electrophoresis, blotting, PCR, autoradiography, and molecular markers.
- Study DNA transfer and cloning strategies in prokaryotic and eukaryotic systems using different vectors and transformation techniques.
- Understand methods for screening and selection of recombinant clones and construction of genomic or cDNA libraries.
- Gain knowledge of different DNA sequencing techniques and the use of molecular probes for detection and analysis of nucleic acids.

Course Outcomes:
At the end of this course:

- Explain the principles and applications of major genetic engineering techniques used in molecular biology.
- Describe and compare different molecular analysis methods including electrophoresis, blotting, PCR,

and DNA fingerprinting.

- Demonstrate understanding of cloning strategies and gene transfer methods in prokaryotic and eukaryotic systems.
- Interpret the principles behind screening and selection of recombinant clones and construction of clone libraries.
- Explain different DNA sequencing methods and the role of nucleic acid probes in genetic analysis and biotechnology research.

DSC 1-10: Genetic Engineering- II (Theory)

Unit I	Genetic Engineering techniques	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**

Introduction, and scope, basic techniques: Types of Electrophoresis, Blotting techniques for Nucleic acids and proteins, principles of autoradiography, Dot Blot technique, Molecular markers: DNA Fingerprinting, DNA Foot-Printing RFLP, RAPD, AFLP, PCR and its types

DNA transfer techniques: Transformation, Transfection and Transduction, Cloning strategies: Cloning from mRNA in plasmid and bacteriophage vector, cloning from genomic DNA, cloning large DNA fragments in BAC and YAC vectors. Selection and screening of recombinants

Unit II	Cloning in Prokaryotes and Eukaryotes	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**

Methods of direct transformation: PEG mediated microinjection, particle bombardment, electroporation. use of chromogenic substrates, insertional inactivation, and complementation of defined mutations, Screening using nucleic acid hybridization: nucleic acid probes and screening clone banks.

Methods of indirect transformation: Agrobacterium mediated gene transfer techniques

Unit III	Methods of DNA sequencing	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**

Methods of DNA sequencing: Maxam's and Gilbert's method, Sanger's dideoxy method, Ligation mediated sequencing, Automated DNA sequencing, chromosome walking and Primer Walking. Probes: Genomic DNA probes, cDNA probes, synthetic oligonucleotide probes, RNA probes, methods of labeling probes

Suggested Reading:

- Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K. 2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
- Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
- Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Third Year BSc (Biotechnology) Semester-VI** **Vertical : DSC** **Course Code: DSC 1-10, Course Name: Genetic Engineering- II (Practical)**
***Teaching Scheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Objectives:
During this course, the student is expected to:

- To provide hands-on training in recombinant DNA technology
- To develop skills in molecular biology techniques
- To understand practical applications of genetic engineering
- To familiarize students with laboratory safety and biosafety norms

Course Outcomes:
At the end of this course:

- Understand the principle and working of Polymerase Chain Reaction (PCR) and its applications in DNA amplification.
- Perform DNA amplification using PCR and interpret the results obtained from the reaction.
- Analyze amplified DNA by agarose gel electrophoresis and identify DNA fragments based on size.
- Understand and perform restriction digestion of DNA using restriction endonucleases and analyze restriction patterns.
- Explain the principle of SDS-PAGE and perform separation of proteins based on molecular weight.

Based on: Genetic Engineering- II (2 Credits)	
1	Polymerase Chain Reaction (PCR) – principle and demonstration
2	Amplification of DNA using PCR (where facilities permit)
3	Analysis of PCR products by agarose gel electrophoresis
4	Restriction digestion of DNA using restriction endonucleases
5	SDS-PAGE – principle and separation of proteins
6	Protein staining methods (Coomassie Brilliant Blue)
7	Sequence retrieval from biological databases
8	Basic sequence alignment (BLAST – demonstration)

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-VI** **Vertical : DSC** **Course Code: Course Name: Bioinformatics (Theory)**
***TeachingScheme:** **Lectures - 03 Hrs/Week, 03 Credits**	***Examination Scheme** **UA: 45 Marks** **CA: 30 Marks**

Course preamble:

This course introduces the fundamental principles, scope, and applications of bioinformatics in modern biology and biotechnology. It enables students to understand biological databases, data formats, and methods for storage, retrieval, and interpretation of genomic and proteomic data. The course develops conceptual knowledge of sequence alignment, genome annotation, and protein structure analysis using computational tools. It also provides an understanding of multiple sequence alignment and phylogenetic approaches for studying evolutionary relationships among organisms.

Course Objectives:
During this course, the student is expected to:

- Understand the fundamental concepts, scope, and applications of bioinformatics along with the structure and use of major biological databases and data formats.
- Develop the ability to perform and interpret sequence and structural analyses, including sequence alignment, genome annotation, and basic protein structure prediction using standard bioinformatics tools.
- Apply multiple sequence alignment and phylogenetic methods to analyze biological data and infer evolutionary relationships among organisms.

Course Outcomes:
At the end of this course:

- Demonstrate knowledge of bioinformatics concepts, biological databases, and standard data formats used in genomics and proteomics.
- Analyze nucleotide and protein sequences using appropriate computational tools and interpret results related to gene prediction and protein structure.
- Perform multiple sequence alignment and construct basic phylogenetic analyses to explain evolutionary relationships among organisms.

DSC 1-11: Bioinformatics (Theory)			
Unit I	**Introduction to Bioinformatics and Biological Databases**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Definition, scope, history of bioinformatics, Applications in genomics, proteomics, medicine, agriculture Types of biological data; Primary, secondary, and composite databases- NCBI, EMBL, DDBJ, KEGG, UniProt, PDB, Prosite; Data formats – FASTA, GenBank			
Unit II	**Sequence and Structural Bioinformatics**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Pairwise and multiple sequence alignment concepts; BLAST principles and interpretation; Scoring matrices – PAM, BLOSUM (overview); Genome annotation basics; Prokaryotic and eukaryotic gene prediction Protein structure levels (primary to quaternary); Structure classification databases- SCOP, CATH; Physicochemical property prediction from primary protein sequence, secondary and tertiary structure prediction from protein sequence			
Unit III	**Multiple Sequence Alignment and Phylogenetics**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Multiple alignments – consensus sequence, methods, tools (e.g. Clustal Omega) and applications Phylogenetic analysis: Elements of phylogeny, methods of phylogenetic analysis, phylogenetic tree of life, phylogenetic analysis tools- PHYLIP			

Suggested Reading:

1. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
2. An introduction to Computational Biochemistry. (C. Stain Tsai, A John Wiley and Sons, Inc., publications).
3. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
4. Bioinformatics. (C.S.C. Murthy, Himalaya Publishing House, Mumbai.)
5. Biotechnology. (U. Satyanarayan, U Chakrapani, Books and allied Private Ltd)
6. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
7. Basic Bioinformatics. (S. Ignacimuthu, S.J., Narosa Publication House, Pvt., Ltd.)
8. Bioinformatics. (R. Sunderlingam, V. Kumaresan, Saras Publication.)
9. NCBI Web site: http://www.ncbi.nlm.nih.gov
10. EMBl Website: http://ebi.ac.uk

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Third Year BSc (Biotechnology) Semester-VI
Vertical : DSC
Course Code: DSC 1-11, Course Name: Bioinformatics (Practical)

*TeachingScheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA: 30 Marks CA: 20 Marks

Course Preamble:
This practical course introduces students to essential bioinformatics tools and databases used for the retrieval, analysis, and interpretation of biological data. Students will learn to access and analyze nucleotide and protein sequence information from major biological databases such as PubMed, GenBank, UniProtKB, and the Protein Data Bank (PDB). The course also provides hands-on experience with computational tools for protein structure visualization, prediction of physicochemical properties, and structure prediction using modern platforms such as AlphaFold. In addition, students will perform sequence similarity searches using BLAST, conduct multiple sequence alignments, and construct phylogenetic relationships using appropriate software tools. The course also familiarizes students with scientific data management and analysis tools such as Mendeley for reference management and ImageJ for scientific image processing, thereby developing essential computational skills required in modern biological research.

Course Objectives:
During this course, the student is expected to:

- Develop practical skills in retrieving, organizing, and interpreting biological information from major literature, nucleic acid, protein, and structure databases using standard bioinformatics resources.
- Gain hands-on experience with computational tools for sequence alignment, protein analysis and visualization, structure and property prediction, phylogenetic analysis, reference management, and basic scientific image processing.

Course Outcomes:
At the end of this course:

- Efficiently access and manage biological data and literature from multiple bioinformatics databases and use appropriate software tools for sequence alignment, protein analysis, and structure visualization/prediction.
- Perform basic phylogenetic analysis, manage scientific references, and apply introductory image analysis techniques to support data interpretation and scientific reporting.

Based on: Bioinformatics (2 Credits)	
1	Literature database- retrieval of literature from PubMed
2	Nucleic acid database- retrieval of nucleic acid sequence from GenBank
3	Protein information database- retrieval of protein information from UniProtKB
4	Protein structure database- retrieval of protein structure from RCSB-PDB
5	Protein structure visualization using RASMOL/PyMol
6	Protein information prediction using Expasy- prediction of physicochemical properties of a protein using ProtParam
7	Protein structure prediction using AlphaFold
8	Basic Local Alignment Search Tool (BLAST)
9	Multiple sequence alignment using Clustal Omega
10	Phylogenetic analysis using PHYLIP
11	Introduction to reference manager software Mendeley
12	Introduction to the scientific image processing tool ImageJ

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-VI** **Vertical : DSC** **Course Code:** **Course Name: Industrial biotechnology – II (Food and Dairy Technology) (Theory)**
***TeachingScheme:** **Lectures - 03 Hrs/Week, 03 Credits**	***Examination Scheme** **UA: 45 Marks** **CA: 30 Marks**

Course Preamble:
Food biotechnology integrates principles of microbiology and biotechnology to improve the safety, quality, preservation, and processing of food products. This course introduces students to the role of microorganisms in food systems, including factors affecting microbial growth and the mechanisms of food spoilage. It also covers general methods used in food preservation to extend shelf life and maintain food quality. Special emphasis is placed on dairy biotechnology, including the microbiology of milk, microbial spoilage of milk products, and pasteurization techniques used in the dairy industry. The course further introduces methods used for microbiological examination of foods, including indicator organisms, cultural and enumeration techniques, and modern rapid detection methods such as immunological and DNA/RNA-based techniques. Overall, the course provides a comprehensive understanding of the application of biotechnology and microbiological methods in food safety, quality control, and food processing industries.

Course Objectives:
During this course, the student is expected to:

- Understand the role of microorganisms in food processing, spoilage, and preservation.
- Study the intrinsic and extrinsic factors affecting microbial growth in different food products.
- Learn the microbiology of milk, methods of pasteurization, and microbial spoilage of dairy products.
- Understand different microbiological techniques used for detection and enumeration of microorganisms in food.
- Gain knowledge of modern rapid detection methods including immunological and DNA/RNA-based techniques used in food quality control.

Course Outcomes:
At the end of this course:

- Explain the role of microorganisms in food processing, spoilage, and preservation.
- Describe factors influencing microbial growth in foods and methods used to control food spoilage.
- Explain the microbiology of milk and evaluate pasteurization methods used in the dairy industry.
- Apply microbiological techniques for detection and enumeration of microorganisms in food samples.
- Interpret modern rapid detection methods for identifying foodborne microorganisms and toxins for food safety assessment.

DSC 1-12: Industrial biotechnology – II (Food and Dairy Technology) (Theory)

Unit I	Biotechnology of Food Processing	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Food Microbiology: Chemical and physical properties of food affecting microbial growth (intrinsic and extrinsic factors). Microbial spoilage of different food products cereals and cereal products, sugar and sugar products, vegetables and fruits, meat and meat products, eggs and poultry, fish and sea products.

General methods of food preservation: Asepsis, use of high temperatures, use of low temperatures, drying, food additives, radiation

Unit II	Biotechnology of Dairy	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Milk Microbiology: Milk - Definition, composition and constituents of milk, Normal flora of milk, Microbial spoilage of different milk products.
Pasteurization of milk - Methods of Pasteurization – LTH, HTST, and UHT. Phosphatase test for determination of efficiency of Pasteurization

Unit III	Methods for Microbiological Examination of Foods	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Methods for the Microbiological examination of foods: Indicator organisms, Direct Examination, Cultural techniques, Enumeration methods plate counts, Most Probable Number Counts, Dye reduction tests-MBRT, Resazurin Test, Rapid methods for detection of Specific organisms and Toxins- Immunological methods, DNA/RNA methodology

Suggested Reading:

1. Food Microbiology (1995)-Adams M.R. and Moss, M.O., New Age International Limited.
2. Food Microbiology –Frazier, W.C., Westhoff, D.C. IVedition, Tata McGraw Hill Publisher.
3. Industrial Microbiology by A. H. Patel, Mac Millan India Pvt. Ltd.
4. Modern Food Microbiology VI th edition- James M Jay. An Aspen publication.
5. Applied Dairy Microbiology –Elmer Marth and James Steele 2nd edition, publisher Marcel Dekker
6. Microbial Technology Volume II- Peppler and Perlman, Academic Press.
7. Modern Food Microbiology (2018)-K. R. Aneja, MEDTECH publishers
8. Food Microbiology (1995)-Adams M. and Dick M., second edition, MEDTECH publishers.
9. Quality control for the food industry (2017) -Amihud Kramer and Bernard Twigg, Volume II 3rd edition, MEDTECH publishers.
10. Dairy and food products for engineering (2018)-Arthur W. Farrall. second edition, MEDTECH publishers.
11. Basics in Food microbiology (1998)-George I. Banwart 2nd edition CBC publishers and distributors

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***TeachingScheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble:
This practical course is designed to provide students with hands-on experience in microbiological and biochemical techniques used in food and dairy biotechnology. The course focuses on methods for analyzing the microbiological quality of milk and other food products, including enumeration of microorganisms, detection of spoilage organisms, and assessment of pasteurization efficiency. Students will perform experiments to isolate and study different groups of microorganisms such as lactic acid bacteria and lipolytic microbes associated with dairy products. The course also introduces biochemical analysis of food components including estimation of milk sugar, vitamins, and mineral content. In addition, students will learn antimicrobial sensitivity testing through determination of minimum inhibitory concentration (MIC) and gain practical exposure to fermentation processes such as wine production. Overall, the course develops essential laboratory skills required for food quality control and dairy microbiology.

Course Objectives:
During this course, the student is expected to:

- Learn microbiological techniques for enumeration and analysis of microorganisms in milk and food samples.
- Understand methods for determining the quality and pasteurization efficiency of milk.
- Isolate and identify spoilage microorganisms and beneficial microbes associated with dairy products.
- Perform biochemical analysis of food components such as sugars, vitamins, and minerals present in milk.
- Develop practical skills in antimicrobial testing and fermentation processes relevant to food biotechnology.

Course Outcomes:
At the end of this course:

- Perform standard microbiological methods for enumeration and quality analysis of microorganisms in milk.
- Evaluate the quality and safety of milk using tests such as MBRT and alkaline phosphatase test.
- Isolate and study different types of microorganisms involved in food spoilage and fermentation.
- Conduct biochemical estimations of important food components such as lactose, vitamins, and minerals.
- Demonstrate antimicrobial sensitivity testing and basic fermentation processes used in food

biotechnology.

Based on: Industrial biotechnology – II (2 Credits)	
1	Enumeration of bacteria in milk by Standard Plate Count
2	Qualitative analysis of milk sample by Methylene Blue Reduction Time Test.
3	Determination of efficiency of pasteurization of milk by alkaline phosphatase test.
4	Isolation of spoilage microorganisms from spoiled vegetables/fruits
5	Isolation of lipolytic microorganisms from butter.
6	Isolation of lactic acid bacteria from the curd sample.
7	Estimation of milk sugar by Benedict's method.
8	Assay of growth factor.(Vitamin)
9	Determination of Minimum inhibitory concentration of antibiotic against test microorganism by tube-dilution technique.
10	Production of wine from any fruit.
11	Determination of Calcium / Magnessium in milk

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year BSc (Biotechnology) Semester-VI
Vertical : DSE
Course Code: Course Name: Advances in Plant Biotechnology (Theory)

***Teaching Scheme:** **Lectures - 02 Hrs/Week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Preamble:
Plant biotechnology has become an important tool for crop improvement and sustainable agriculture. This course introduces the principles and techniques of plant tissue culture used for the development of improved plant varieties. Students will learn methods such as micropropagation through meristem culture, virus indexing, and the production of haploids through anther and microspore culture. Techniques like ovule, ovary, and endosperm culture are also discussed for plant breeding applications. The course further covers in vitro fertilization methods including embryo rescue and wide hybridization, along with protoplast culture and fusion techniques. In addition, students are introduced to plant genetic transformation methods and their applications in developing transgenic plants with desirable traits such as disease resistance, stress tolerance, and improved productivity. Overall, the course provides an understanding of modern biotechnological approaches used in plant improvement and crop development.

Course Objectives:
During this course, the student is expected to:

- Understand the principles and techniques of plant tissue culture used in crop improvement.
- Learn methods of micropropagation, meristem culture, and virus indexing for production of disease-free plants.
- Study haploid production techniques such as anther and microspore culture and their role in plant breeding.
- Understand advanced tissue culture techniques including embryo rescue, wide hybridization, and protoplast fusion.
- Gain knowledge of plant genetic transformation methods and their applications in developing improved crop varieties.

Course Outcomes:
At the end of this course:

- Explain the principles and applications of plant tissue culture techniques used in crop improvement.
- Describe methods for micropropagation and production of disease-free plants through meristem culture and virus indexing.
- Explain haploid production techniques and their significance in plant breeding programs.
- Interpret the role of advanced techniques such as embryo rescue, wide hybridization, and protoplast fusion in plant biotechnology.
- Describe plant genetic transformation methods and evaluate their applications in developing transgenic crops with desirable traits.

DSE 1-3: Advances in Plant Biotechnology (Theory)			
Unit I	**Plant tissue culture techniques for crop improvement**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Micropropagation- Meristem tip culture and virus indexing Production Of Haploids- Anther and microspore culture, Ovule, ovary and endosperm culture In vitro fertilization- Embryo rescue and wide hybridization- Protoplast culture and fusion techniques			
Unit II	**Plant genetic transformation and its applications**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Agrobacterium - mediated gene transfer, Ti plasmid, Ri plasmids as vector) role of virulence genes; Direct method of gene transfer- Particle bombardment , electroporation and microinjection. Engineering plants to overcome biotic and abiotic Stress Engineering plant quality and proteins			

Suggested Reading:

References:

1. An introduction to Plant Tissue Culture 2nd edn. Razdan, M. K, Science Publishers, USA.
2. Textbook of plant biotechnology, Chawala P.K.2002, Oxford & IBH, New Delhi.
3. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture:Theory and Practice, Elsevier Pub.
4. Chrispeels, M. J. 2002. Plant Tissue Culture: Genetical Aspects. Jones and Bortlett Publishers, International.
5. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.
6. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondary metabolism, lower Academic Publisher.
7. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
8. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14 Blackwell Publ)
9. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21th century (Academic press).
10. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture: Theory & Practice (Elsevier)
11. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
12. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
13. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
14. H K Das Textbook of Biotechnology 4th edition

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***TeachingScheme:** **Practical - 02 Hrs/Week, 01 Credits**	***Examination Scheme** **UA: 15 Marks** **CA: 10 Marks**

Course Preamble:

This practical course provides hands-on training in important laboratory techniques used in plant biotechnology and tissue culture. The course begins with fundamental sterilization methods essential for maintaining aseptic conditions in plant tissue culture laboratories. Students will learn techniques for isolation of beneficial microorganisms such as *Rhizobium* and gain experience in establishing plant cell suspension cultures. The course also introduces advanced plant biotechnology techniques including protoplast isolation, fusion and culture, as well as isolation of the Ti plasmid from *Agrobacterium tumefaciens*. In addition, students will perform anther culture for haploid production and learn the technique of synthetic seed production. Overall, the course develops practical skills and understanding of plant tissue culture and genetic transformation techniques used in crop improvement and plant biotechnology research.

Course Objectives:
During this course, the student is expected to:

- Learn and apply sterilization techniques required for maintaining aseptic conditions in plant biotechnology laboratories.
- Isolate and study beneficial microorganisms such as *Rhizobium* from soil or root nodules.
- Understand the principles and procedures involved in establishing plant cell suspension cultures.
- Perform advanced plant biotechnology techniques such as protoplast fusion and Ti plasmid isolation.
- Gain practical experience in plant tissue culture methods such as anther culture and synthetic seed production for crop improvement.

Course Outcomes:
At the end of this course:

- Demonstrate proper sterilization techniques for maintaining aseptic conditions in tissue culture laboratories.
- Isolate and identify beneficial soil microorganisms such as *Rhizobium*.
- Establish and maintain plant cell suspension cultures under laboratory conditions.
- Perform protoplast fusion and understand the role of Ti plasmid in plant genetic transformation.
- Apply plant tissue culture techniques such as anther culture and synthetic seed production for plant propagation and crop improvement.

Based on: Advances in Plant Biotechnology (1 Credit)	
1	Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, laboratory fumigation
2	Isolation of Rhizobium from soil or root nodules
3	Initiation and establishment of cell suspension culture.
4	Protoplast fusions and culture by calcium ion or polyethylene glycol (PEG) method.
5	Isolation of Ti plasmid from Agrobacterium tumefaciens.
6	Anther culture for production of haploids.
7	Synthetic seed production.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-VI** **Vertical : DSE** **Course Code: Course Name: Intellectual Property Rights (Theory)**
***TeachingScheme:** **Lectures - 02 Hrs/Week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Preamble:
This course introduces the fundamental concepts and significance of Intellectual Property Rights (IPR) in the context of science and innovation. It provides an overview of different forms of intellectual property such as patents, copyrights, trademarks, trade secrets, and geographical indications, along with their advantages and limitations. The course also examines national and international frameworks governing IPR, including major agreements under the World Intellectual Property Organization and the World Trade Organization. Students will learn the procedures involved in patenting, rights of patentees, and issues related to infringement. Additionally, the course highlights plant breeders' rights, protection of new plant varieties, and the role of IPR in promoting innovation in biotechnology and agriculture.

Course Objectives:
During this course, the student is expected to:

- The course envisages information on IPR
- To learn, understand and analyze the Laws and Relations relating to Intellectual Property Rights in India along with the glimpse of International practices.

Course Outcomes:
At the end of this course:

- Apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyze the social impact of intellectual property law and policy. Analyze ethical and professional issues which arise in the intellectual property law context.
- To create public awareness about the economic, social and cultural benefits of IPRs

DSE 1-4: Intellectual Property Rights (Theory)

Unit I	Introduction to IPR and IPR in India & abroad	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Introduction to Intellectual Property Rights: IPRs Policy, Novelty, Utility Inventiveness/Non-obviousness, Kinds of Intellectual Property Rights-copyright, patent, trademark, trade secrets, geographical indications (GI), Advantages and Disadvantages of IPR. Patentable subject matter, Patentability criteria, non-patentable inventions, Pharmaceutical products and process patent.

Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention 1883, the Berne Convention 1886, the Universal Copyright Convention 1952, the WIPO Convention 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.

Unit II	Patenting and Plant Breeder's rights	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Types of patenting, Rights of patentee, Procedure for granting a patent and obtaining patents in India and Abroad (ICT), Grounds for opposition Working of Patents, Compulsory License Acquisition, Surrender, Revocation, restoration Transfer of patent rights, Patenting of biological materials with examples and case studies, Infringement.
International Union for the Protection of New Varieties of Plants (UPOV), Breeders exemption, Plant variety protection in India. Farmer's right, Procedure for registration, effect of registration and term of protection, advantages and disadvantages of PBR.

Suggested Reading:

1. Biotechnology: New Venture Creation : David H. Holt
2. Patterns of Biotechnology: Jack M. Kaplan
3. Biotechnology and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.
6. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
7. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

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***TeachingScheme:** **Practical - 04 Hrs/Week, 01 Credits**	***Examination Scheme** **UA: 15 Marks** **CA: 10 Marks**

Course Objectives:
During this course, the student is expected to:

- To familiarize students with the basic concepts and importance of Intellectual Property Rights (IPR) in biotechnology.
- To train students in searching and analyzing patents using Indian and international patent databases such as those of the Indian Patent Office and the World Intellectual Property Organization.
- To demonstrate the procedure involved in filing patents at national and international levels.
- To develop the ability to analyze case studies related to biotechnological patents and drug clinical trials with ethical considerations.
- To introduce students to plant variety protection, copyright, and trademark issues relevant to biotechnology.

Course Outcomes:
At the end of this course:

- Students will be able to perform patent searches using Indian and international patent databases.
- Students will understand the procedure and requirements for patent filing in India and internationally.
- Students will be able to analyze biotechnology patent case studies and interpret patent documents.
- Students will understand ethical issues related to clinical trials of drugs in India.
- Students will gain knowledge of plant variety protection, copyright, and trademark applications in biotechnology.

Based on: Intellectual Property Rights (1 Credit)	
1	Indian and ICT patent search
2	Patent Database Training
3	Demonstration of Indian and International patent filing
4	Case study of Biotechnological patents
5	A case study on clinical trials of drugs in India with emphasis on ethical issues.
6	Plant Variety Protection Exercise
7	Copyright and Trademark in Biotechnology

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Third Year BSc (Biotechnology) Semester-VI** **Vertical : VSC** **Course Code: VSC6, Course Name:Hands-on Training related to DSE (Practical)**
***TeachingScheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Objectives: **During this course, the student is expected to:**
To develop practical skills in basic plant biotechnology techniques such as plant genomic DNA isolation and analysis of plant metabolites. To train students in experimental methods for studying plant physiology and soil nutrient analysis. To provide hands-on experience in genetic transformation techniques used in plant biotechnology, such as Agrobacterium tumefaciens–mediated transformation. To introduce students to different forms of intellectual property protection relevant to plant innovations, including patents, plant variety protection, and geographical indications. To familiarize students with technology transfer processes, licensing agreements, and issues related to biopiracy and protection of traditional knowledge.

Course Outcomes: **At the end of this course:**
Students will be able to perform plant genomic DNA isolation and estimate important plant secondary metabolites. Students will gain practical knowledge of plant physiological measurements and soil nutrient analysis. Students will understand the principles and applications of **Agrobacterium tumefaciens–mediated plant transformation. Students will be able to compare different IPR mechanisms and prepare documents such as mock patents and DUS descriptor sheets. Students will develop awareness of biopiracy, traditional knowledge protection, and basic procedures involved in technology transfer and licensing in plant biotechnology.

Based on: Hands-on Training related to DSE (2 Credits)	
1	Plant genomic DNA isolation (CTAB method)
2	Estimation of Total Phenolics/Secondary Metabolites from plant sample
3	Measuring the photosynthetic rate of *Hydrilla verticillata* shoots
4	Measuring the NPK content of soil
5	Agrobacterium-mediated transformation of Tobacco plants
6	Comparison of Patent, Plant Variety Protection and Geographical Indication
7	Drafting a Mock Patent for a Plant-Based Innovation
8	Preparation of DUS Descriptor Sheet (Plant Variety Protection)
9	Case Study: Biopiracy and Traditional Knowledge Protection
10	Technology transfer: Drafting a simple licensing agreement for a micropropagated plant variety
11	Industry/laboratory visit

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***TeachingScheme:** **Practical - 04 Hrs/Week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Objectives:
During this course, the student is expected to:

- Perform and design individual research/ laboratory/ practical/ project work.
- Get hands-on training about the skills essential for practical work in a concerned subject.

Course Outcomes:
At the end of this course:

- Students can perform and design individual research/ laboratory/ practical/ project work.
- Students get hands-on learning about the skills essential for practical work in a concerned subject.

Field Project (FP)/Community Engagement Project (CEP)/On-Job Training (OJT)
On-Job Training (OJT)

- Under the three-year UG program, the students must complete Field Project/Community Engagement Project/On-Job Training of 02 credits during the sixth semester of the third year in the respective Major Subject.
- The period of apprenticeship/internship training shall be a total of 30 Contact Hours (2 credits).
- An internal assessment of the Field Project/Community Engagement Project/On-Job Training will be of 20 Marks.
- A progress report showing the proof of ongoing Field Project/Community Engagement Project/On-Job Training, certified by respective Major Subject Teacher must be presented for the internal assessment.
- A university assessment of the OJT/internship/ field project will be of 30 Marks. A completion report certified by Major Subject Teacher and Concerned Trainer/Authority must be presented for the University assessment.

Note: For more information on guidelines follow link https://www.ugc.gov.in/pdfnews/0063650_Draft-Guidelines-for-Internship-and-Research-Internship-for-Under-Graduate-Students.pdf

Guidelines for Field Projects / Community Engagement Projects

Step 1: Project Selection and Planning

1. Identify a Research Topic – Choose an Biotechnological / Life Sciences issue relevant to local ecosystems, pollution, bioremediation, restoration, medicinal plants' properties, diagnostics or community engagement.
2. Set Objectives – Define clear, measurable goals and expected outcomes of the project.
3. Review Literature – Conduct a preliminary study on the chosen topic using research papers, reports, and case studies.
4. Select a Study Area – Choose a location based on the relevance of the study, accessibility, and feasibility.

Step 2: Methodology and Data Collection

5. Prepare a Work Plan – Develop a timeline, logistics, and required resources for fieldwork.
6. Select Appropriate Methods – Depending on the topic, use techniques such as surveys, sampling, interviews, GIS images, sample analysis, etc.
7. Design Data Collection Tools – Prepare field survey sheets, questionnaires, checklists, and sampling protocols.
8. Field Visits and Observations – Conduct field surveys, interact with local communities, and gather primary data.
9. Community Engagement (For CEP-1) – Organize awareness programs, stakeholder meetings, or workshops involving the community.

Step 3: Data Analysis and Interpretation

10. Compile and Organize Data – Sort collected data in tabular, graphical, or GIS formats for better visualization.
11. Analyze Findings – Use statistical tools, comparative analysis, or qualitative assessment to derive meaningful insights.
12. Compare with Existing Literature – Relate findings with previous research or case studies.

Step 4: Report Writing and Presentation

13. Prepare a Structured Report – Include sections such as Introduction, Objectives, Methodology, Results, Discussion, Conclusion, and Recommendations.
14. Use Visual Representations – Add graphs, charts, and photographs to support the findings.
15. Draw Conclusions and Suggestions – Provide solutions or recommendations based on project outcomes.

Step 5: Presentation and Submission –

Present findings in a seminar or community meeting and submit a final report to the department

Theory Question Paper Pattern

UA

Punyashlok Ahilyadevi Holkar Solapur University, Solapur Faculty of Science & Technology
Nature of Question Paper for CBCS Pattern
B. Sc. / B.C.A (Part- III) w.e.f. AY 2026-27

Time: Total Marks: 30

Instructions

1) All Questions are compulsory
2) Figure to right indicate full marks.

Q.1 Choose correct alternative. (MCQ) **06 Marks**

Q.2. Answer the following. (Any three) **6 (2+2+2)**

A)
B)
C)
D)
E)

Q.3. Answer the following (Any two). **6 (3+3)**

A)
B)
C)

Q.4. Answer the following (Any two). **6 (3+3)**

A)
B)
C)

Q.5. Answer the following (Any one). **6 Marks**

A)
B)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology.
Nature of Question Paper
B. Sc. (Part-III) w.e.f. Year 2026-27 University Assessment (UA)

Time: Total Marks:45

Instructions
1) All Questions are compulsory.
2) Figure to right indicate full marks.

Q.1.A)	Choose correct alternative. (MCQ) 5 Marks			
1)				
2)				
3)				
4)				
5)				
Q.1.B)	Choose correct alternative (True /False) 4 Marks			
1)				
2)				
3)				
4)				

Q.2.	Answer the following (Any Three) 9 Marks
1)	
2)	
3)	
4)	
Q.3.A)	Answer the following (Any One) 5 Marks
1)	
2)	
Q.3.B)	Answer the following (Any One) 4 Marks

1)		
2)		
Q.4.A)	Answer the following (Any One)	5 Marks
1)		
2)		
Q.4.B)	Answer the following (Any One)	4 Marks
1)		
2)		
Q.5.	Answer the following (Any One)	9 Marks
1)		
2)		

Theory Question Paper Pattern

CA

Punyashlok Ahilyadevi Holkar Solapur University, Solapur Faculty of Science & Technology
Nature of Question Paper for CBCS Pattern
B. Sc. / B.C.A.(Part- III) w.e.f. AY 2026-27

Time: Total Marks: 20

Internal Evaluation System for 20 Marks

Choose any two of the following

Home Assignment / Unit Test / Tutorial /Seminar

Pattern of Examination

External Evaluation + Internal Evaluation

30 Marks + 20 Marks = 50 Marks

Passing Criteria –

1. Written Exam – 12 out of 30
2. Continuous Assessment (CA) – 08 out of 20

Practical Question Paper Pattern

UA

Punyashlok Ahilyadevi Holkar Solapur University, Solapur Faculty of Science & Technology
Nature of Question Paper for CBCS Pattern
B. Sc. / B.C.A (Part- III) w.e.f. AY 2026-27

Time: Total Marks: 30

Instructions
1) All Questions are compulsory
2) Figure to right indicate full marks.

Q.1 Proceed to perform _____ 12 Marks
(Any one of the major practical listed in respective practical course)

Q.2 Proceed to perform _____ 08 Marks
(Any one of the minor practical listed in respective practical course)

Q.3 Certified Laboratory Record 05 Marks

Q.4 Viva Voce 05 Marks

Practical Question Paper Pattern

CA

Punyashlok Ahilyadevi Holkar Solapur University, Solapur Faculty of Science & Technology
Nature of Question Paper for CBCS Pattern
B. Sc. / B.C.A (Part- III) w.e.f. AY 2026-27

Time: Total Marks: 20

Internal Evaluation System for 20 Marks
Choose any two of the following
Practical Assessment / Written Test (Principle writing) / Tutorial /Seminar/ Spotting

Pattern of Examination
External Evaluation + Internal Evaluation
30 Marks + 20 Marks = 50 Marks

Passing Criteria –
1. Practical Exam – 12 out of 30
2. Continuous Assessment (CA) – 08 out of 20

Note: Theory and practical examiners should be appointed from the list provided by the BOS as per section 48(3) of Maharashtra Public University Act 2016.