Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१-२६०९०९४
०२३१-२६०९४८७

Ref.No.SU/BOS/Science/148 **Date: 26/05/2026**

The Principal,
All Concerned Affiliated Colleges/Institutions
Shivaji University, Kolhapur.

Subject: Regarding revised syllabi of B.Sc. Part-III (Sem.V & VI) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0)

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabi, nature of question paper of B.Sc. Part-III (Sem.V & VI) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

B.Sc. Part-III (Sem. V & VI) as per NEP-2020 (2.0)			
1.	Botany	9.	Geology
2.	Physics	10.	Zoology
3.	Statistics	11.	Chemistry
4.	Mathematics	12.	Electronics
5.	Microbiology	13.	Drug Chemistry
6.	Industrial Microbiology	14.	Pollution
7.	Biochemistry	15.	Food Science and Quality Control
8.	Computer Science (Optional)	16	Biotechnology (Optional/Vocational)

This syllabus, nature of question and equivalence shall be implemented from the academic year 2026-2027 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in>Syllabus>Syllabus as per NEP2020.**

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2026 & March/April 2027. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy Registrar

Encl: as above

for information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	Director, Board of Examinations and Evaluation	7	I.T.Cell /Computer Centre
3	Chairman, Respective Board of Studies	8	Eligibility Section
4	B.Sc.-M.Sc. Exam Section	9	Affiliation Section (T.1) (T.2)
5	Internal Quality Assurance Cell (IQAC Cell)	10	P.G. Seminar Section

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

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NEW SYLLABUS FOR

B. Sc. Part III BIOTECHNOLOGY

(OPT/VOC)

SEMESTER V AND VI

(Faculty of Science and Technology)

Structure and Syllabus in Accordance with National Education Policy - 2020 (NEP 2.0) with Multiple Entry and Multiple Exit

(To be implemented from Academic Year 2026-27)

1. **Year of Implementation:** Revised syllabus will be implemented from June, 2026 onwards.

2. **Preamble:** 100 Marks Biotechnology is a field that combines basics of life science (biology) and technology. It has been one of the most fast-growing fields in last few decades. Biotechnology can be classified in four categories – green biotechnology (agricultural biotechnology), white biotechnology (industrial biotechnology), red biotechnology (medical biotechnology) and blue biotechnology (marine biotechnology). With development of advanced techniques such gene editing and gene manipulations biotechnology can also be divided as conventional biotechnology and advanced biotechnology/modern biotechnology. Conventional Biotechnology involves usage of natural resources such as plants, animals, microorganisms at optimum conditions to obtain higher yields of commercially important products of biological origin. In Modern Biotechnology genetic engineering approach is used to obtain high yielding recombinants to obtain commercially important products of biological origin. Stem cell research, Tissue engineering, Site specific drug delivery techniques are examples of Modern Biotechnology. The realm of Biotechnology involves understanding and application of basic sciences such as Physics, Chemistry and Mathematics as well as applied sciences such as Microbiology, Food technology, Bioinformatics, Recombinant DNA technology. State of the art technologies such as Artificial Intelligence and Machine learning are now being explored for their application in Biotechnology. Biotechnology is one such course that provides an educational environment where STEM- Science Technology Engineering and Mathematics are not only taught but practiced together. India has recently implemented its NEP2020- New educational policy. One of the major objectives of NEP is to bridge gaps in education and industry by empowering the students by providing them with training in skill-based courses. To provide such training there is a need to develop courses/syllabi with subjects which provide knowledge about the current and most relevant technologies. Along with the training of basics of core subject the students need to be exposed to subjects such as entrepreneurship and intellectual property rights to inculcate interest in product development. The proposed credit-based curriculum ensures the requirement of academia and industry. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions) without any additional training. Benefit of society and sustainable development. The policy mainly focuses on flexibility in education, multidisciplinary approach, creativity, developing critical thinking and critical thinking. Keeping these mottos in mind, the new syllabi has been designed which will also help students to develop skill sets required when Biotechnology is chosen as a career.

3. GENERAL OBJECTIVE OF THE COURSE:

(as applicable to the Degree concerned) Objectives: -

i. To impart knowledge of science is the basic objective of education.

ii. To develop scientific attitude is the major objective to make the students open minded, critical, curious.

iii. To develop skill in practical work, experiments and laboratory materials and equipment's along with the collection and interpretation of scientific data to contribute the science.

iv. To understand scientific terms, concepts, facts, phenomenon and their relationships.

v. To make the students aware of natural resources and environment.

vi. To provide practical experience to the students as a part of the course to develop scientific ability to work in the field of research and other fields of their own interest and to make them fit for society.

vii. The students are expected to acquire knowledge of plant and related subjects so as to understand natural phenomenon, manipulation of nature and environment in the benefit of human beings.

viii. To develop ability for the application of the acquired knowledge to improve agriculture and other related fields to make the country self reliant and sufficient.

ix. To create the interest of the society in the subject and scientific hobbies, exhibitions and other similar activities.

4. Program Outcomes (Pos):

• To introduce different Biotechnological aspects.

• To develop aptitude of students in the field of research.

• To impart knowledge in basic and applied aspects of life sciences

• To make students aware of various applications of Biotechnology and develop their practical skill sets.

• To inculcate scientific, social and environmental awareness in students

5. **Program Specific Outcomes (PSOs):**

- The present course curriculum will generate skilled human resource required in academia and Industry.
- The student will be able to achieve basic and advance knowledge based proficiency in applied subjects of life sciences.
- It will create and develop students with interdisciplinary mind set for learning science.
- Student will improve problem solving aptitude using scientific methods in biotechnology and allied subjects.
- Student will adopt scientific approach for implications of biotechnology in society, environment and education.
- It will demonstrate knowledge and learn various biological processes at cellular and molecular level and get expertise in the different techniques used in the fields of Biotechnology. Student will learn to design and perform experiments in the labs to demonstrate the concepts, principles and theories learnt in the classroom.

6. **DURATION:**

- The course shall be a fulltime course.

7. **MEDIUM OF INSTRUCTION**:

- The medium of instruction shall be in English.

8. **ELIGIBILITYFOR ADMISSION**:

- As per guidelines obtained from Shivaji University, Kolhapur by following rules and regarding reservations by Govt. of Maharashtra

9. **FEE STRUCTURE**: -

- **As per Government / University rules**
    i. Refer brochure and prospectus of concern affiliated college/institute to Shivaji University, Kolhapur.
    ii. Other fee will be applicable as per rules and norms of Shivaji University, Kolhapur.

10. Scheme of Teaching and Examination Pattern (Theory/Practical/Internal) :

- The scheme of teaching and examination for the program of study shall be as approved by the Academic Council / Board of Studies.
- The pattern of examination shall consist of a Semester-End Examination along with Internal Assessment.
- Each theory course of 2 credit shall carry 50 marks (40 marks for the Semester-End Examination and 10 marks for Internal Assessment).
- The rule for practical examination shall be as per the circular/ letter issued by respective Board of Studies.
- The examination pattern for On Job Training (OJT) and Field Project (FP) shall be as per the University guidelines.

11. Program Structure:

SHIVAJI UNIVERSITY, KOLHAPUR **NEP-2020 (2.0): Credit Framework for UG (B. Sc. III) Programme under Faculty of Science and Technology**									
SEM (Level)	**COURSES**			**OE**	**VSC/ SEC**	**AEC/VEC/ IKS**	**AEC/VEC/ IKS**	**Total Credits**	**Degree/ Cum. Cr. MEME**
	Course-1	**Course-2**	**Course-3**						
SEM V (5.5)	Major IX (2) Major X (2) Major P V (a) (2) Major P V (b) (2)	Major I (ELEC) (2) Major P I (ELEC) (2)	-	OE-5 (2) (T/P)	VSC II (2) (Major specific) (P)	AEC III (2) (English)	OJT (04)	22	UG Degree 132
SEM VI (5.5)	Major XI (2) Major XII (2) Major P VI (a) (2) Major P VI (b) (2)	Major II (ELEC) (2) Major P II (ELEC) (2)	-	-	VSC III (2) (Major specific) (P) SEC III (2) (T/P)	AEC IV (2) (English) IKS 2 (2) (Major specific)	FP (02)	22	
Credits	**8(T)+8(P)=16**	**4(T)+4(P)=8**		**2(T/P)**	**2(T/P) + 4(P) = 6**	**2+4 = 6**	**4+2 = 6**	**44**	

12. Equivalence in accordance with titles and contents of papers for revised syllabus

Sr. No.	Title of Old Paper	Title of New Paper
1	Course IX (DSC E) Biochemical Techniques	Major mandatory Course IX Advance in Biotechnology (Bioinformatics)
2	Course X (DSC E) Animal Cell culture	Major mandatory Course X Food and Microbial Biotechnology
3	Course XI (DSC E) Bioprocess Engineering	Major Elective Course I Immunology
4	Course XII (DSC E) Fermentation Technology	Major mandatory Course XI Animal and Plant tissue culture
5	Course XIII (DSC E) Plant tissue culture	Major mandatory Course XII Cell Metabolism and Virology
6	Course IVX (DSC E) Environment Biotechnology	Major Elective Course II Environment Biotechnology
7	Course XV(DSC E) Cell Metabolism and Virology	VSC II and III
8	Course XVI (DSC E) Gene Biotechnology and Bioinformatics	English

1

13. Standard of Passing :

- The standard of passing shall be as shown in the table below:

	Semester-End Examination	Internal Assessment	Course Exam (Total)
Maximum Marks	40	10	50
Minimum Marks required for passing	14	4	18

- There shall be a separate head of passing for the Semester-End Examination and the Internal Assessment for each theory course.
- A student must obtain a minimum of 14 marks out of 40 in the Semester-End Examination and 4 marks out of 10 in the Internal Assessment to pass the theory course.
- For practical courses carrying 50 marks, a student must obtain a minimum of 18 marks to pass the examination. For practical courses

carrying 100 marks, a student must obtain a minimum of 35 marks to pass the examination.

- Passing criteria for On Job Training (OJT) and Field Project (FP) shall be as per the University guidelines

14.Nature of Question Paper, Duration and Scheme of Marking:

A) Theory Examinations

a) Maximum Marks : 40

b) Duration : 1 hr 30 min

c) Nature of the Theory Examination Question Paper and Scheme of Marking

Question No.	Nature/Type of Question	Marks
1	Multiple Choice Questions (MCQs) (8 Questions)	8 Marks (1 Mark for Each Question)
2	Broad Answer/Descriptive Type Questions (Attempt Any 2 Out of 3)	16 Marks (8 Marks for Each Question)
3	Short Note Type Questions (Attempt Any 4 Out of 6)	16 Marks (4 Marks for Each Question)
	Total Marks	**40**

B) Practical Examinations

a) The examination of the Major Practical Course shall carry 150 marks per semester (Major Mandatory – 100 marks and Major Elective – 50 marks). It shall be conducted over three consecutive days, with a minimum duration of six hours per day.

b) The Practical Examination for Vocational Skill Courses (VSC–II and VSC–III), Skill Enhancement Course (SEC–III), and Open Elective Course (OE–5) shall carry 50 marks each. These examinations shall be conducted separately over two consecutive days, with a minimum duration of three hours per day.

c) Each candidate must produce a certificate from the Head of the Department of the respective college stating that the candidate has

satisfactorily completed the practical course in accordance with the guidelines laid down by the Academic Council on the recommendations of the Board of Studies and that the laboratory journal has been properly maintained. Every candidate must record observations in the laboratory journal and prepare a report for each exercise performed. The journal shall be checked and signed periodically by a member of the teaching staff and certified by the Head of the Department at the end of the semester. Candidates must produce their certified journals at the time of the practical examination.

d) The nature of question paper and scheme of marking are provided at the end of syllabus.

Structure of B. Sc. Part III Biotechnology

SEM (Level)	Course Code	Course Name	No. of Credits
SEM V (5.5)	MJT-Bt-E-9	Advance in Biotechnology (Bioinformatics)	2
	MJT-Bt-E-10	Food and Microbial Biotechnology	2
	MET-Bt-E- Ia	Major Elective Course I : Immunology	2
	MJP-Bt-E-5a	Major Mandatory Practical Course V (A): Bioinformatics	2
	MJP-Bt-E-5b	Major Mandatory Practical Course V (B):Food and Microbial Biotechnology	2
	MET-Bt-E-Ia	Major Elective Practical Course I (A): Immunology	2
	VSC-P- Bt-E-2	VSC; Dairy Technology	2
	OE-T Bt- E-5	OE :Environment Awareness	2
		On Job Training -OJT	4
		AEC III: English	2
SEM VI (5.5)	MJT-Bt-F-11	Major Mandatory Course XI: Animal Tissue Culture And plant Tissue Culture	2
	MJT-Bt-F-12	Major Mandatory Course XII Cell Metabolism and Virology	2
	MET-Bt-F- Ia	Major Elective Course II (A): Environmental Biotechnology	2
	MJP-Bt-F-6a	Major Mandatory Practical Course VI (A): Plant Tissue Culture	2
	MJP-Bt-F-6b	Major Mandatory Practical Course VI (B): Virology	2
	MET-Bt-F-Ia	Major Elective Practical Course II (A): Environmental Biotechnology	2
	VSC-P- Bt-F-3	VSC III: Industrial Biotechnology	2
	SEC -P Bt- F-3	SEC III: Techniques in research methodology	2
	IKS-T-F-2	IKS 2: Indian Knowledge System -Traditional Biotechnology	2
		FP: Field Project	2
		AEC IV: English	2
		Total Credits	**44**

B. Sc. Part III

BIOTECHNOLOGY

SEMESTER V

Major Mandatory Course IX: Advance in Biotechnology (Bioinformatics)

(Credit-2, Total Lectures- 30)

Learning Objective:

- To make students aware of Food Biotechnology
- To understand concepts of microbial biotechnology
- To study the advantages of fermented food products
- To aware the techniques of food preservation for avoid the spoilage and toxicity
- To aware the impact of Genetically modified food on living things and human

Topic No.	TOPIC	Lectures 30
	Credit I	
1	**Introduction to Bioinformatics** Introduction, Definition, history of Bioinformatics, Computers in Biology and Medicines, Internet, and related programs; Networking HTTP, HTML, WAN, LAN, MAN, approaches of bioinformatics. **Information Resources** : Introduction, aim and objectives, National Centre for Biotechnology Information (NCBI) ,National Library of Medicine (NLM), and National Institute of Health (NIH), EBI, Sequence retrieval system (SRS): Entrez, DB Get.	**15**
2	**Introduction to Genomics and Proteomics databases**: **Genomics:** Human Genome Project (HGP), Goal and applications, final draft of HGP (complete information resources covered). Nucleic acid sequence database: Gene Bank, EMBL, DDBJ. **Proteomics:** Introduction, concept of proteome, Tools and techniques in proteomics- 2D electrophoresis ,PAGE , Isoelectric focusing, MALDITOF, EST, microarray. **Protein sequence Databases**: PDB, Swiss-Prot, TrEMBL, UniPort	**15**

Learning Outcomes:

The students should acquire the knowledge about:

- Various bioinformatics tools and techniques and how to use that for the analysis of the biological experimental data.
- Concepts of various databases and various methods for the data retrieval, data storage, and data mining and use that data for the further analysis.
- In-Silico approach for the protein modeling and drug discovery process.
- Sequencing techniques and gene annotation as well as submission of the sequences to the various databases.

References

1) Bioinformatics methods and applications. S. C. Rastogi, N.Mendiratta,P.Rastogi.
2) Principle of bioinformatics. P. Shanmughavel.
3) Computational Drug Designing. David C. Young
4) Computational Drug Design : A Guide for Computational and Medicinal Chemists.David C. Young
5) An introduction to Bioinformatics. T.K.Attwood, Parry – Smith D.J.
6) A textbook of bioinformatics. Sharma, Munjal, Shankar.

Major Mandatory Course X: Food & Microbial Biotechnology

(Credit-2, Total Lectures- 30)

Learning Objective:

- To make students aware of Food Biotechnology
- To understand concepts of microbial biotechnology
- To study the advantages of fermented food products
- To aware the techniques of food preservation for avoid the spoilage and toxicity
- To aware the impact of Genetically modified food on living things and human

Topic No.	TOPIC	Lectures 30
	Credit I	
1	**Microbial Production and Supplements**: Introduction to food biotechnology and related industries. **Microbial Production-** Enzymes (amylase –koji fermentation), Antibiotics(Penicillin),Vitamins (B12), Amino acids(Lysine), Organic acid (Citric acid). **Dietary supplements:** Single cell Protein (SCP) production, mushrooms production technology, large scale production of algae and yeast. **Fermented Foods, Beverages & Food Packaging:** **Fermented foods of India:** Dairy products, Cheese production technologies, Fermented Pickles– Sauerkraut, Beverages– Beer, Wine (Red table and white table). **Food Packaging:** Definition, selection of a food package. Types of packaging materials and their functioning properties; Aseptic packaging of foods: sterilization techniques of packaging materials.	**15**
	Credit II	

2	**Food Spoilage, preservation & toxicity:** **Types of spoilage**- Physical, Chemical and Biological (auto and microbial) **Preservation methods-** Physical methods(High and Low temperatures, Drying, Irradiation), Chemical methods (Salt, sugar, organic acids, SO2, NO2). **Food Toxicity**–Mycotoxin (Aflatoxin), Exotoxin *(Staphylococcal*), Neurotoxin (Botulinum) **Food borne illness-** Shigellosis, Amoebiasis, Aspergillosis. **Food Safety and Quality Control:** Introduction, Food adulteration, nature of adulterants, methods of evaluation of food adulterants and toxic constituents. **Role of international regulatory agencies:** USFDA and International Organization for Standards (ISO). **Indian food laws and standards:** Prevention of Food Adulteration (PFA) Act, Fruit Products Order (FPO), Meat Products Order (MPO), Cold Storage Order (CSO), Role of AGMARK Standard, Bureau of Indian Standards (BIS) and Food Safety and Standards Authority of India (FSSAI).	**15**

Learning outcome: -

After completing the credit student should gain the-

- Basic concepts of microbial culture mass production.
- Basic Knowledge of fermented food production techniques.
- Different techniques used for food preservation and avoid toxicity preparation
- To study newly prepared genetically modified food analysis for market acceptance

References:

1. Text Book of Biotechnology –Dr. H. K. Das
2. Industrial Microbiology & Biotechnology –Arnold L.
3. Fermentation Technology– Jayantrao Acharekar
4. Basic Biotechnology–Colinand Bjrorn
5. Frontiers in Microbial Biotechnology–Bisel P.S.
6. Industrial Microbiology–Prescotand Dunn
7. Principle of Fermentation Technology–Stanbury P.F., Whitekar H., Hall S.J.
8. Bioprocess Engineering: Principles–Nielson T. and Villadeson J.
9. Industrial Microbiology-L. E. Casida
10. Fermentation Biotechnology- H. A. Modi
11. Industrial Microbiology-A. H. Patel
12. Food Biotechnology-Varun Mehta

Major Mandatory Elective Course I : Immunology

(Credit-2, Total Lectures- 30)

Learning Objective:

To promote critical thinking among students and understand how the immune system works. To provide students with a foundation in concepts related to immunology.

To provide students with knowledge on how the immune system works. To clearly state the role of the immune system.

To understand the types of Antigen-Antibody interactions

Topic Number	Topic	Lectures (30)
	Credit 1	15
1	1.1 Introduction 1.2 Types of immunity- i) Innate - types, factors influencing innate immunity ii) Acquired - Active and Passive 1.3 Types of Defense- A) Nonspecific- a) First line of defense - physical and chemical barriers b) Second line of defense - chemical and biological barriers B) Specific - a) Third line of defense -specific defense mechanism 1.4 Organs of immune system-primary and secondary lymphoid organs - structure and their role 1.5 cells of immune system-monocytes and macrophages, granulocytes, mast cells, dendritic cells, NK cells, B and T lymphocytes and types	
	Credit-II	15
2	2.1 Antigen- definition, nature, types of antigen, factors affecting on antigenicity 2.2 Antibody-definition, chemical nature, basic structure of immunoglobulin, major human immunoglobulin classes (their properties and functions), theories of antibody production. 2.3 Immune response -Primary and secondary immune Response 2.4 Antigen - Antibody reactions-Principle, mechanism and applications of - a)Agglutination b) Precipitation c) Complement fixation	

	d) ELISA e) Fluorescent antibody test 2.5 Hypersensitivity – definition, types – a) Immediate - Anaphylaxis Delayed – homograft rejection	

Learning outcome:-

After completing the credit student should gain the-

- Explain the immunological terms.
- Diagrammatically depict with appropriate labels the organs of the human immune system.
- Diagrammatically depict with appropriate labels the organs of the human immune system
- Explain the significance of cells of immune system-Granulocytic cells,T, B,NK and DC, Phagocytic cells, Mast cells, NKT and FDCs
- Discuss the types of antigen antibody interactions based on nature of antigen
- Explain the features of antibody structure using a labeled diagram
- Compare and contrast: five classes of Ig

References:

1. "Essential Immunology"-11th edition- Delves, Martin, Burton & Roitt
2. "Immunology"-6th edition-Kuby, Kindt, Goldsby & Osborne
3. "Immunology and Serology"- Ashim Chakravar
4. Immunology-An Introduction - 4th edition-Tizzard
5. Essentials of Immunology- S.K.Gupta
6. Immunology- M.P.Arora

MAJOR MANDATORY PRACTICAL COURSE V (a):
Advance in Biotechnology (Bioinformatics)
(Credit-2, Total Lectures- 60)

Course Objectives

1.To introduce students to bioinformatics tools, databases, and computational methods used in biological research.

2.To develop practical skills in retriving and analyzing and interpreting biological data such as DNA,RNA and protein sequences.

Course outcomes

After successful completion of the course,the students will be able to:

1.Perform DNA,RNA and protein sequences analysis using bioinformatics tools

2.conduct sequence alignment and interpet results for evolutionary and functional studies.

Sr.No.	Name of the Practical	
1	Introduction to bioinformatics	Minor
2	Retrieval of nucleotide sequence from gene bank	Minor
3	Retrieval of protein sequence from gene bank.	Major
4	Similarity sequence search using blastn	Major
5	Molecular visualization using rasmol	Major
6	Accessing structural database and downloading the protein structure	Major
7	Multiple sequence alignment	Minor

References :

Bioinformatics: Sequence and Genome Analysis – David W. Mount, Cold Spring Harbor Laboratory Press.

Bioinformatics for Dummies – Wiley Publishing.

Introduction to Bioinformatics – Oxford University Press.

Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Wiley-Interscience.

Essential Bioinformatics – Cambridge University Press.

Fundamentals of Bioinformatics and Computational Biology – PHI Learning.

Bioinformatics: Methods and Applications – PHI Learning.

MAJOR MANDATORY PRACTICAL COURSE V (b):
FOOD AND MICROBIAL BIOTECHNOLOGY
(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the principles and applications of industrial microbiology and fermentation technology.
2. To learn microbiological and biochemical techniques used for assay, production, and analysis of industrially important products.
3. To acquire practical knowledge of microbial fermentation processes involved in production of beverages, organic acids, and fermented foods.

Course Outcomes : After successful completion of the course, the students will be able to:

1. Perform microbiological assays of antibiotics and vitamins such as penicillin and vitamin B12 using standard assay methods.
2. Produce fermented products such as wine and citric acid through microbial fermentation and analyze their physicochemical properties.
3. Enumerate bacteria present in food products such as curd and fruit juice using serial dilution and plating techniques.

Sr.No.	Name of the Practical	
1	Production and analysis of lactic acid /Isolation lactic acid from curd sample.	Major
2	Bioassay of VitaminB-12	Major
3	Calculation of thermal death point of a microbial sample	Minor
4	IsolationofVit-B12requiringmutants	Major
5	Estimation of citric acid by Titrimetric method	Minor
6	Isolation of industrially important microorganisms from natural resources	Minor
7	Production of wine	Major
8	Examination of wine for pH, colour and alcohol content	Minor
9	Enumeration of bacteria from curd by serial dilution and plating	Minor
10	Enumeration of bacteria fruit juice by serial dilution and plating	Major
11	Isolation of lactic acid bacteria from fermented food	Major

References

1. Principles of Microbial Technology, Vol. I & II – Peppler – 2nd Edition – Academic Press.
2. Industrial Microbiology – Casida, L. E. – 1st Edition – Wiley.
3. Industrial Microbiology – Patel, A. H. – 1st Edition – CBS Publishers.
4. Industrial Microbiology – Prescott, L. M. & Dunn, R. – 4th Edition – McGraw-Hill.

MAJOR ELECTIVE PRACTICAL COURSE I :
IMMUNOLOGY
(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the basic principles and applications of immunological, serological, and hematological laboratory techniques.
2. To learn methods for estimation and analysis of important blood parameters such as haemoglobin, ESR, RBC count, WBC count, and differential leukocyte count.
3. To acquire practical knowledge of diagnostic immunology tests including Widal test, CRP test, RPR test, and ELISA.
4. To develop laboratory skills in handling blood samples, performing immunological assays, interpreting results, and maintaining laboratory safety practices.

Course Outcomes

After successful completion of the course, the students will be able to:

1. Perform hematological investigations including haemoglobin estimation, ESR determination, total RBC count, total WBC count, and differential leukocyte count using standard laboratory methods.
2. Demonstrate bactericidal activity of human serum against bacterial cultures and explain the role of immune factors involved in microbial killing.
3. Conduct serological and immunological diagnostic tests such as Widal test, CRP test, RPR test, and ELISA, and interpret the obtained results.
4. Apply laboratory techniques and analytical skills for diagnosis and evaluation of infectious and immunological conditions using blood-based investigations.

Sr. No.	Name of the Practical	
1	Dot ELISA test	Minor
2	Qualitative Widal test	Minor
3	Quantitative Widal test	Major
4	Radial immunodiffusion-Single & double diffusion	Major

5	RPR test	Minor
6	Estimation of hemoglobin by Sahil's method	Minor
7	Blood grouping	Major
8	Separation of serum from blood	Minor
9	Determination of Erythrocyte sedimentation rate (ESR)	Minor
10	Determination of sensitivity of common pathogen to antibiotic by paper disc method	Major
11	Physical and chemical analysis of urine	Major

References

1. Immunology – Kubay, Kindt, Goldsby & Osborne – 6th Edition – Macmillan Press.
2. Essential Immunology – Delves, Martin, Burton & Roitt – 11th Edition – Blackwell Science.
3. Immunology: An Introduction – Tizzard – 4th Edition – Elsevier
4. Basic and Clinical Immunology – Stites, Stobo, H. H. Fudenberg – 5th Edition – Lange Medical Books.

5.Essentials of Immunology – S. K. Gupta – University Press.

6.Immunology – M. P. Arora – CBS Publishers.

7.The Elements of Immunology – Fahim Khan – Pearson Publication, 2009.

8.Practical Immunology: Techniques and Applications – Ivan Lefkovits & Robert L. Malech – Springer, 2000.

9.Clinical Laboratory Immunology – Steven L. Berger – ASM Press, 2015.

10.Hematology and Immunology Laboratory Manual – K. S. Ghai – CBS Publishers, 2010.

VOCATIONAL SKILL COURSE IN BIOTECHNOLOGY
VSCII: DAIRY TECHNOLOGY
(Credit-2, Total Lectures- 60)

Course Objectives:

To provide practical knowledge of milk composition, processing, and quality assessment.

To develop skills in handling, testing, and preservation of milk and dairy products.

To familiarize students with the manufacture of various dairy products and quality control techniques.

To understand the role of hygiene and safety practices in dairy processing.

Course Learning Outcomes: After successful completion of the course, students will be able to:

Understand the composition, properties, and quality parameters of milk.

Perform physical, chemical, and microbiological analyses of milk and dairy products.

Apply standard methods for milk preservation and processing.

Prepare dairy products such as curd, paneer, butter, and yogurt using appropriate techniques.

Evaluate the quality and safety of milk and dairy products.

Sr. No.	Name of Practical	Major / Minor Expt.
1	MBRT test of milk	Major
2	RRT test of milk.	Minor
3	Direct microscopic count of milk.	Major
4	SPC of milk.	Major
5	Coliform count of milk.	Major
6	Estimation of Fat in milk	Major
7	Estimation of Specific gravity of milk.	Major
8	Measurement of Surface tension of milk	Minor
9	Measurement of pH of milk.	Minor
10	Visit to a Dairy plant to observe preparation of Concentrated milk and Dried milk.	Major

Reference Books:

1. Outlines of Dairy Technology – Sukumar De.
2. Milk products preparation and quality control – C.P. Ananthakrishnan.
3. The technology of milk processing – C.P. Ananthakrishnan.
4. Modern Dairy products – Lincoln M. Lampert.
5. Milk and milk products – Eckles, Combs, Harold Macy.

OE V- Environmental awareness for Biotechnologist

(Credit-2, Total Lectures- 30)

Course Objectives:

Students should be able to…

1) Understand the environmental issues.
2) Relate those laws made to safe guard the environment.
3) Know the importance of sustainable development.
4) Correlate knowledge of sustainable development with plant sciences.

Topic No.	TOPIC	Lectures 30
	Credit I	
1	Environmental issues 1.1 Pollution (Air, Water and Land) 1.2 Fresh-water overuse 1.3 Natural disasters 1.4 Fuel and Energy shortage due to overuse 1.5 Increase in wasteland 1.6 Biodiversity loss 1.7 Global warming and climate change (Causes and intensity of the problem)	**15**
	Credit II	
2	Environmental laws and ethics 2.1 Environmental Protection Act 2.2 Wildlife Protection Act 2.3 Forest Conservation Act 2.4 Prevention and Control of Pollution Act (Air, water and Land) 2.5 From unsustainable to sustainable development 2.6 Responsibilities of an Environmentally aware citizen	**15**

Course Outcomes: After successful completion of the course, students will be able to:

1) Explain the causes of environmental issues
2) Discuss concepts related to environmental laws and ethics.
3) Discuss the sustainable development goals.
4) Compare and analyze the importance of plant sciences in meeting the sustainable development goals

Reference Books:-

2) Aagarwal,S.K. 2005. Advanced Environmental Biotechnology. Ashish Publishing House.

3) C.K., Ramesh, and Ajay Singh. 2013. Biotechnology for Environmental Management and Resource Recovery. Springer, India, Private Ltd.

4) H., Salvatore. 2020. Environmental Biotechnology: Principles and Applications. White Press Academic Publications.

5) Joshi, Navneet, Sharma K.C., and Sharma M. 2012. Environmental Biotechnology. LAP Lambert Academic Publishing.

6) K., Garima. 2015. Applied Environmental Biotechnology: Present Scenario and Future Trends. Springer Publications. 6)Kumar, Rajan, and Satya S.S. 2020. Environmental Biotechnology: A New Approach. Daya Publishing House

ON JOB TRAINING (OJT) (As per NEP, 2020)

1. Course Title: **On-the-Job Training (OJT)**

2.Credits: **04**

3.Total LearningHours:**60 Hours**

4.Semester: **Vth Semester**.

5.Course Type: Mandatory |Skill -based| Experiential Learning

6.Nature of Assessment: University(80M) and Internal Assessment(20M) Only

7.Total Marks: **100**

Nature of the Practical Examination Question Paper and Distribution of Marks

A) MAJOR MANDATORY PRACTICAL COURSE V (a)

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting	10
4	Journal	05
	Total Marks	**50**

B) MAJOR MANDATORY PRACTICAL COURSE V (b)

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

C) MAJOR ELECTIVE PRACTICAL COURSE I (A)

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15

3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

D) VSC II: DAIRY TECHNOLOGY- I

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

B. Sc. Part III

BIOTECHNOLOGY

SEMESTER VI

Major Mandatory Course XI: Animal Cell Culture and Plant tissue culture

(Credit-2, Total Lectures- 30)

Learning Objective:

- Master the fundamental techniques of plant tissue culture, including media preparation, sterilization.
- Analyze the physiological and molecular mechanisms by which plants respond to various abiotic stresses.
- Understand the criteria for selecting appropriate model organisms for biological research.

Topic No	Topic	Lectures
	Credit I	
1	**Historical Background** History in Animal tissue culture ,introduction and Characteristics of Animal Cell Culture Scop & applications of ATC **Requirements of Animal cell culture** Overview of ATC Lab Infrastructure, Substrate for cell growth, Equipment's required for animal cell culture (Laminar air flow, CO2 incubator, Centrifuge, Inverted microscope). **Sterilization of Glassware's, Equipment's & culture media** Glassware sterilization, reagent and media sterilization, sterility testing. **Culture media** Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of media). **Techniques in animal cell culture** Isolation of Tissue Desegregation Measurement of cell viability Maintenance of cell Culture **Cell lines** –Types of Cell lines- Primary, Secondary, Established	**15**

2	**Concept & Historical Background** History in plant tissue culture Concept of cell theory, Cellular totipotency, Differentiation, Dedifferentiation, Redifferentiation, Regeneration. **PTC Infrastructure & organization of Lab** Different work areas Equipment's & Instruments required **Media & culture preparation** Role of micro & macro nutrients, Vitamins, amino acid, Hormones, activated charcoal, Solidifying agents. Culture Conditions- pH, Temperature, Humidity. **Aseptic Techniques** Sterilization of Media, Reagent & Glassware Surface sterilization of explants **Callus Culture** Introduction, principle, morphology & internal structure, protocol, factors affecting **Somatic embryogenesis** Introduction, principle, protocol, factors affecting, applications. **Pathways for clonal propagation** **Organogenesis** Introduction, principle, protocol, factors affecting, applications. **Haploid culture** Introduction, principle, protocol, applications, advantages of pollen culture over anther culture	**15**

Learning Outcomes:

After successful completion of the course,the students will be able to:

1: Understand basic concepts with the brief history and practical applications of plant cell cultures.

2: Understand meristem culture and clonal propagation, its importance, applications and limitations.

3. Get the brief idea about the protoplast culture, somatic hybridization along with the practical applications of organ and tissue culture.

4: Understand the concepts and protocols of callus culture, embryogenesis, organogenesis artificial seeds and embryo culture with its advantages and disadvantages.

5. Learn about the haploid production, endosperm culturing suspension cultures and somaclonal variations

References-

1. Introduction to plant tissue culture-M. K. Razdan
2. Plant tissue culture - Theory & practice- S. S. Bhojwani & M. K. Razdan
3. Crop improvement in biotechnology- H. S. Chawla
4. Plant tissue culture- Kalyankumar dey
5. Textbook of biotechnology- R. C. Dubey
6. Plant tissue culture- U. Kumar.
7. Biotechnology- B. D. Singh

Major Mandatory Course XII : Cell Metabolism and Virology

Credit-2, Total Lectures- 30)

Learning Objectives:

The students will gain adequate knowledge about:

- Different classes of bacteria and viruses that infect human regarding their pathogenicity.
- Laboratory characteristics and different methods for laboratory diagnosis of infections caused by bacteria and Viruses.
- They will also be able to select and interpret the different diagnostic tests for bacterial and viral infections.
- concepts of cell metabolism and reactions of Metabolic pathways.

Topic No.	Topic	No. of Lectures
1	**Credit I**	15
	General Metabolism- Introduction, Definition, Reactions of Metabolic Pathways Glycogen metabolism–Glycogenesis, Glycogenolysis Lipid Metabolism Biosynthesis of Saturated Fatty acid-Palmitic Acid β-Oxidation of Fatty acid -Palmitic Acid Cholesterol Biosynthesis Cholesterol Degradation Protein Metabolism Urea Cycle-Reactions & Significance Nucleotide Metabolism	
2	**Credit II**	15

	Virology- Introduction, types on the basis of host and nucleic acid General Characteristics of Viruses General Structures of Viruses- TMV, Adeno virus, T4 Bacteriophage Reproduction of Viruses- Adeno virus, Bacteriophages T4, λ-Phage Animal viruses –Classification ,life cycle ,effect in animal cell AIDS –Structure of HIV ,life cycle, therapeutic agents Isolation & Cultivation of Plant & Animal Viruses- Tissue culture & Embryonated Eggs Prions-concept	

Learning Outcomes:

After successful completion of the course,the students will be able to:

- Different classes of viruses and structure.
- Different methods for laboratory diagnosis of infections caused by bacteria and Viruses.
- Different diagnostic tests for bacterial and viral infections.

References:

1. Biochemistry–Lubert Strayer.
2. Principles of Biochemistry- Lehninger.
3. Virology- Luria &Delbruck.
4. FundamentalsofBiochemistry- J. L. Jainand S. Chand
5. .Life Sciences–Pranav Kumar Moselio Schaechter, Cary Engleberg, N. Barry I. Eisenstein, Gerald medoff.

Major Elective Course II : Environment Biotechnology
(Credit : 02 Lectures : 30)

Learning objectives :

1:To learn the role of microorganisms in protecting the environment .

2: to learn about solid waste management and composting using microorganisms. 3:To study the importance of biofertilizers and biopesticides in sustainable agriculture.

Topic No.	Topic	No. of Lectures
1	**Credit I**	15
	1.1 Conventional and non-conventional fuels and their environmental impacts 1.2 Modern fuels Methanogenesis and biogas production. Bioethanol production and Gasohol experiment Biodisel 1.3 Global environmental problems 1 Greenhouse effect and global warming 2 Ozone depletion 3 Acid rain 1.4 .Types of wastes Types and treatment of Solid waste 1.5 Waste water treatment Methods of treatment- a) Primary - (screening, grinding, grit removal. flocculation, sedimentation, flotation, equalization, coagulation, clarification) b) Secondary- (Aerobic-Trickling filters, activated sludge processes, stabilization ponds) (Anaerobic Up flow anaerobic sludge blanket reactors) c) Tertiary Chemical precipitation. Disposal & recycling of treated wastewater.	
2	**Credit II**	15

	2.1 Bioremediation 1 Definition & types(in situ and ex-situ) 2 Bioremediation of hydrocarbons ,dyes, heavy metals ,pesticides. 3 Bioremediation for Agriculture- Composting and vermicomposting. 2.2 Bioleaching (Bioleaching of Copper &Uranium) Microbial enhancement of oil recovery 2.3 Biopesticides – Concept, Advantages - Bacterial biopesticides (Bacillus thuringiensis), fungal biopesticides (Trichoderma viride) 2.4 Biofertilizers - Rhizobial inoculants, Azotobacter inoculants, Phosphate solubilizing bacteria, VAM, Azolla	

Learning Outcomes: After successful completion of the course,the students will be able to:

1:Understand environmental aspects of conventional and non-conventional fuels and advantages of modern fuels over the conventional fuels.

2:Get an insights of greenhouse effect, global warming, ozone depletion, UV radiations and acid rain.

3: To understand waste water treatments at various levels using different techniques. 4: To understand different of fertilizers and their methods of field application

References:

1. Environmental biotechnology-Indu Shekhar Thakur.
2. Environmental biotechnology-Chatterjee.
3. Environmental biology- Verma &Agarwal.
4. Environmental chemistry-B.K .Sharma.
5. Environmental Pollution- Peavy &Rowe.
6. Environmental problems & solutions- Asthana &Asthana.
7. Environmental science-SiagoCanninhham.
8. Environmental biotechnology-S.N.J ogdand.
9. Environmental Biotechnology -C .S .K Mishra & Juwarkar

MAJOR MANDATORY PRACTICAL
COURSE VI (a): Plant Tissue Culture

(Credits: 02 Total Lecture: 60)

Course Objectives:

To provide knowledge of basic principles and techniques of plant tissue culture.

To develop skills in preparation of culture media, sterilization, and aseptic handling of plant materials.

To understand the methods of micropropagation, callus induction, and plant regeneration.

To familiarize students with laboratory practices used in plant biotechnology and crop improvement.

Course Learning Outcomes: After successful completion of the course, students will be able to

Understand the principles and applications of plant tissue culture.

Prepare and sterilize culture media and laboratory equipment.

Perform aseptic techniques for handling plant explants.

Establish and maintain in vitro cultures under controlled conditions.

Induce callus formation and observe plant growth responses in culture.

PTC		
Sr. No.	**Name of the Practical's**	**Major/ Minor**
1	Requirements for Plant Tissue Culture Laboratory	Minor
2	Aseptic manipulation of various Explants	Minor
3	Preparation of stock solution and media	Major
4	Callus culture technique – Initiation of culture	Major
5	Initiation of anther culture	Minor
6	Synthetic seed production	Minor
7	Initiation of micropropagation – Shoot tip or axillary bud culture technique	Major

References-

8. Introduction to plant tissue culture-M. K. Razdan

9. Plant tissue culture - Theory & practice- S. S. Bhojwani & M. K. Razdan

10. Crop improvement in biotechnology- H. S. Chawla

11. Plant tissue culture- Kalyankumar dey

12. Textbook of biotechnology- R. C. Dubey

13. Plant tissue culture- U. Kumar.

14. Biotechnology- B. D. Singh

MAJOR MANDATORY PRACTICAL COURSE VI (b): VIROLOGY

(Credit-2, Total Lectures- 60)

Course Objectives

1. To understand the basic principles and techniques used in isolation, cultivation, and enumeration of viruses and bacteriophages.
2. To learn methods for enrichment and plaque assay of coliphages from environmental samples.
3. To acquire practical knowledge of virus cultivation and transmission techniques in plant and animal systems.
4. To develop observational and analytical skills for identification of viral disease symptoms and cytopathic effects produced by viruses.

Course Outcomes

After successful completion of the course, the students will be able to:

1. Isolate host bacteria and coliphages from sewage samples using standard microbiological and virological techniques.
2. Perform enrichment, plaque assay, and plaque count methods for cultivation and enumeration of coliphages.
3. Demonstrate virus cultivation by chick embryo inoculation and study mechanical transmission of plant viruses through sap inoculation methods.
4. Identify characteristic symptoms of plant viral diseases and recognize cytopathic effects (CPE) produced by animal viruses.

Sr.No.	Name of the Practical	
1	Enrichment of coliphages from sewage samples	Major
2	Isolation of E.coli phages	Major
3	Isolation of auxotrophic mutant of E.coli by replica plate technique.	Minor
4	Demonstration of virus cultivation by chick embryo inoculation technique	Major
5	Study of mechanical transmission of plant viruses by sap inoculation method	Minor
6	Observation and identification of symptoms of viral diseases in plants	Minor
7	Observation and identification of cytopathic effects (CPE) produced by animal viruses	Major
8	Transformation of E.coli.	Major

References:

1. An Introduction to Virology – K. S. Bilgrami & Shagufta Ashraf – 1st Edition – CBS Publishers & Distributors, 2006.
2. Textbook of Virology – R. C. Dubey & D. K. Maheshwari – 1st Edition – S. Chand Publishing, 2013.
3. Microbiology and Immunology – A. P. Kulkarni & K. G. Barve – 3rd Edition – Nirali Prakashan, 2018.
4. General Virology – C. P. Baveja – 4th Edition – Arya Publications, 2017.
5. Plant Pathology – P. D. Sharma – 3rd Edition – Rastogi Publications, 2011.
6. Plant Virology – Roger Hull – 5th Edition – Academic Press, 2014.

Major Elective practical Course II : Environment Biotechnology

(Credits: 02 Total Lecture: 60)

Course Objectives:

- To introduce students to the principles and applications of environmental biotechnology in pollution control and environmental management.
- To understand the role of microorganisms in biodegradation,

- bioremediation, and waste treatment processes.

Course Learning Outcome: After successful completion of the course, students will be able to:

- Demonstrate an understanding of the principles and applications of environmental biotechnology.
- Perform microbiological and biochemical analyses of environmental samples.
- Assess the quality of water, soil, and wastewater using standard laboratory methods.
- Isolate, cultivate, and characterize microorganisms involved in biodegradation and bioremediation.

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Sr. No.	Practical's	Major/Minor
	Environmental Biotechnology	
1	Determination of BOD	Major
2	Determination of COD	Minor
3	Isolation of Rhizobium from root nodules	Major
4	Isolation of Azotobacter from soil	Major
5	Isolation of Xanthomonas from infected citrus fruits.	Major
6	Isolation of PSB.	Minor
7	Determination of hardness of water	Minor
8	Determination of oligodynamic effect of copper on pathogen	Major

References:

1.Environmental biotechnology-Indu Shekhar Thakur.

2.Environmental biotechnology-Chatterjee.

3.Environmental biology- Verma &Agarwal.

4.Environmental chemistry-B.K .Sharma.

5.Environmental Pollution- Peavy &Rowe.

6.Environmental problems & solutions- Asthana &Asthana.

VOCATIONAL SKILL COURSE III (Major specific):- INDUSTRIAL BIOTECHNOLOGY

(Credits: 02 Total Lecture: 60)

Course Objectives

1. To understand the principles and applications of industrial biotechnology and fermentation technology.

2.To learn microbiological and biochemical techniques used for assay, production, and analysis of industrially important products.

3.To acquire practical knowledge of microbial fermentation processes involved in production of beverages, organic acids, and fermented foods..

Course Outcomes

After successful completion of the course, the students will be able to:

1.Perform microbiological assays of antibiotics and vitamins such as penicillin and vitamin B12 using standard assay methods.

2.Produce fermented products such as wine and citric acid through microbial fermentation and analyze their physicochemical properties.

3.Enumerate bacteria present in food products such as curd and fruit juice using serial dilution and plating techniques.

4.Isolate and identify lactic acid bacteria from fermented food samples and explain their role in food fermentation and preservation.

Sr.No.	Practical	Major/Minor
	Industrial Biotechnology	
1.	Introduction, Microorganisms and enzymes of industrial importance	Minor
2.	Instrumentation, Sterilization of air, media and reactor	Minor
3.	Microbial growth, substrate degradation and product formation kinetics	Major
4.	Determination of Minimum inhibitory Concentration (MIC) of antibacterial compound.	Minor

5.	Production of alcohol/ wine and analysis: i) Alcohol ii) pH and Total acidity iii) Reducing sugar	Major
6.	Screening and isolation of antibiotic producing organism from soil (Crowded plate/Giant colony method).	Major
7.	Antibiotic sensitivity test using paper disc method.	Minor
8.	Production, Recovery and estimation (Bioassay) a of Primary metabolite (Growth factor)	Major
9.	Production, Recovery (Filtration, Solvent extraction)and estimation (Bioassay)a of Secondary metabolite (Antibiotic)	Major

Industrial Visit - Beverages Industry, Food Processing Industry.

References

1. Principles of Microbial Technology, Vol. I & II – Peppler – 2nd Edition – Academic Press.
2. Industrial Microbiology – Casida, L. E. – 1st Edition – Wiley.
3. Industrial Microbiology – Patel, A. H. – 1st Edition – CBS Publishers.
4. Industrial Microbiology – Prescott, L. M. & Dunn, R. – 4th Edition – McGraw-Hill.

SKILL ENHANCEMENT COURSE IN BIOTECHNOLOGY

SEC III:-Techniques in Research Methodology

(Credits: 02 Total Lecture: 60)

Learning Objectives:

- To give a background on the history of research and highlighting the methodologies used to do research.
- To use the basis of these methodologies to understand and appreciate scientific ethics.
- To use the framework of these methodologies for understanding effective lab practices, scientific communication and language.

Topic No.	Research Methodology	Lectures 30
1	Detection of plagiarism in scientific literature	Major

2	Retrieval of scientific research paper using PubMed	Minor
3	Preparation of tables and graph from given raw data	Minor
4	Diagrammatic representation of data: Bar diagram and Pie diagram.	Major
5	Collection, Classification and tabulation of data.	Minor
6	Graphical representation of data: Histogram and Ogives.	Major
7	Measures of dispersion: Problems on Range and standard deviation.	Major
8	Literature review study	Minor

Learning Outcomes:

- Understanding of the methodologies of scientific research,
  applying these torecent published papers.
- Understanding of Data collection and presentation.
- Understanding and practicing scientific reading and to write an effectresearch proposal.

Reference:

1)Writing the doctoral dissertation. Barrons Educational series, 2nd edition,Davis, G.B. and C.A. Parker, 1997. pp 160.

1) Authoring a PhD, thesis: how to plan, draft, write and finish a doctoraldissertation, Duncary, P. 2003.
2) Macmillan, pp 256.MS office, Sexena, S. 2001. Vikas Publishing House Pvt. Ltd., New Delhi Valiela, I. (2001).
3) Doing science: Design, analysis, and communication ofscientific research. Oxford: Oxford University Press.

4) On being a scientist: A guide to responsible conduct in research. (2009).Washington, D.C.: National Academies Press.

5) Gopen, G. D., & Smith, J. A. (n.d.). The Science of Scientific Writing. American Scientist, 78(Nov-Dec 1990), 550-558.

INDIAN KNOWLEDGE SYSTEM (IKS) II : Traditional Biotechnology
(Credits: 02 Total Lecture: 30)

Learning Objectives:

- To understand about Historical Applications
- To understand about Explain Basic Processes.
- To understand Recognize Common Products.
- To understand about Appreciate Cultural and Economic Importance

Sr.No.	Topic	Lectures 30
	Credit I	
1	Fermentation (Earliest Biotechnology) Use of yeast and microbes for: Bread making Alcoholic beverages (soma, wine, beer) Curd, buttermilk, cheese Practiced in India, Mesopotamia, Egypt, China Agriculture & Plant Biotechnology Selective breeding of crops for better yield and taste Seed preservation techniques Organic manure and composting Ancient Indian texts mention crop cycles and soil fertility	**15**
	Credit II	

2	Medical Biotechnology (Traditional Medicine) Ayurveda used plant-based medicines and formulations Knowledge of drug preparation, dosage, and storage Surgical practices described by Sushruta (instruments, wound healing) Industrial & Environmental Practices Use of microbes in: Leather processing Indigo dye production Waste decomposition Natural enzymes used in food and textiles Indian Contributions Charaka Samhita – pharmacology & herbal formulations Sushruta Samhita – surgery, tissue repair	**15**

Learning Outcomes:

- After completing the credit-
- Student will learn about Concept of Traditional Biotechnology.
- Student will learn about to understand Early Fermentation.
- Student will learn to analyze Traditional Medical Biotechnology.
- Student will learn about to Evaluate Indian Contributions to Early Biotechnology

References:

1)Biotechnology –U.Satyanarayana

2) A textbook of plant breeding – B.D . Singh

3) Medical biotechnology – S.N. Jogdand

4) Advances in Biotechnolog S.N.Jogadand

5) Introduction to plant breeding – R . C. Chaudhary

6) A text book of Biotechnology - R. C. Dubey

7) Pharmaceutical Biotechnology – S. P . Vyas ,V. K.Dixit

8) Biotechnology – B. D.Singh

9) Animal & cell biotechnology– Ian, Freshney

10) Animal cell biotechnology–Buttler

Nature of the Practical Examination Question Paper and Distribution of Marks

A) MAJOR MANDATORY PRACTICAL COURSE VI (a)

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting	10
4	Journal	05
	Total Marks	**50**

B)MAJOR MANDATORY PRACTICAL COURSE VI (b)

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

C) MAJOR ELECTIVE PRACTICAL COURSE II (A)

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	50

D) **VSC III: Industrial biotechnology**

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**

E) SEC III: Techniques in research methodology

Question No.	Nature/Type of Question	Marks
1	Major Practical	20
2	Minor Practical	15
3	Spotting / Viva	10
4	Journal	05
	Total Marks	**50**