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

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
PHONE:EPABX-2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

Ref.No.SU/BOS/Science/434 **Date: 15/07/2025**

To,

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

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

Ref: No.SU/BOS/Science/270 & 271 Date: 03/05/2025 Letter.

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-II (Sem.III & IV) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

B.Sc.Part-II (Sem. III & IV) as per NEP-2020 (2.0)			
1.	Botany	8.	Geology
2.	Statistics	9.	Zoology
3.	Mathematics	10.	Chemistry
4.	Microbiology	11.	Electronics
5.	Plant Protection	12.	Industrial Microbiology
6.	B.A./B.A.B.Ed. Geography	13.	Biotechnology(Voc/Opt)
7.	Biotechnology(Entire)		

This syllabus, nature of question and equivalence shall be implemented from the academic year 2025-2026 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in NEP-2020@suk(Online Syllabus)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2025 & March/April 2026. 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,

Dy Registrar
Dr. S. M. Kubal

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

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दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्याससमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

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B.Sc.Part-II (Sem. III & IV) as per NEP-2020 (2.0)			
1.	Botany	8.	Geology
2.	Physics	9.	Zoology
3.	Statistics	10.	Chemistry
4.	Mathematics	11.	Electronics
5.	Microbiology	12.	Drug Chemistry
6.	Plant Protection	13.	Industrial Microbiology
7.	Astrophysics and Space Science	14.	Sugar Technology (Entire)

This syllabus, nature of question and equivalence shall be implemented from the academic year 2025-2026 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in NEP-2020@suk(Online Syllabus)

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Yours faithfully,

By Registrar
Dr. S. M. Kubal

Encl: As above

for Information and necessary action

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SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

A^{++} Accredited by NAAC (2021) with CGPA 3.52

Structure and Revised Syllabus in Accordance with

National Education Policy - 2020

With Multiple Entry and Multiple Exit

Bachelor of Science Part II
Biotechnology (Entire)

Under

Faculty of Science and Technology

(To Be Implemented From Academic Year 2025-26)

INDEX

Shivaji University, Kolhapur

Syllabus for Bachelor of Science (B. Sc. Part-II) Biotechnology (Entire) under the Faculty of Science

(Revised Syllabus will be implemented from June, 2025 onwards.)

Ordinance and Regulations: (As applicable to Degree Course) B] Shivaji University, Kolhapur Revised syllabus for Bachelor of Science (NEP)

1. YEAR OF IMPLEMENTATION:-Revised Syllabi (As per NEP 2020) will be implemented from June 2025 onwards. Guidelines shall be as per B.Sc. Regular Program. Rules and Regulations shall be as per B.Sc. Regular Program except CBCS R. B. Sc. 3 Structure of Program and List of Courses.

2. Preamble:

This syllabus is so designed to give a sound basis to the undergraduate students of B.Sc. Biotechnology (Entire). It is known that Biotechnology is no doubt a youngest branch of life science but it is a very important interdisciplinary subject, where in subjects of Plant science, Animal science, Microbiology, Physics, Chemistry and other sciences are blended in such a way that the students are prepared with basic knowledge of Molecular biology, Biochemistry, Biophysics, Genetic engineering, Bioinformatics, Environmental sciences, Plant and Animal cell culture etc. and their technological applications. Such students having multidisciplinary knowledge are in tremendous demand in industries, education and fundamental research, as trainee workforce. The career opportunities of these students are very wide in different sectors dealing with life sciences.

3. Program Outcomes (POs)

1. **Domain Specific knowledge:** Apply the knowledge of Chemistry, Biochemistry, Microbiology, Plant science, Animal science, Cell biology, Genetics, Immunology, Molecular biology, Metabolic pathways, Enzymology, Plant and Animal Biotechnology, Ecology, Environmental Biotechnology, rDNA Technology, Industrial biotechnology, Medical Biotechnology, Bioinformatics, Nanotechnology, Biostatistics and Computer science to provide the solution to the Scientific and Technological and Social problems as well.
2. **Problem analysis:** Identification and formulation of the problems. Data analysis and Interpretation of the results with basic principles.

3. **Design/Development of solutions:** Design solutions for Scientific and Technological and Social problems of various disciplines that significantly realize domestic, agricultural, medical, pharmaceutical, industrial, societal, environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage:** Making use of sophisticated tools, Sophisticated Instruments, Modern methodology, Microscopy, Chromatography, Spectroscopy, Electrophoresis, Thermal Cycler, Gel documentation, DNA Sequencer, Nanotechnology.

6. **The Science and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, industrial, agricultural issues.

7. **Environment and sustainability:** Application of the knowledge to ensure environmental sustainability

8. **Ethics:** Apply ethical principles in scientific Practices

9. **Individual and team work:** Function effectively as an Individual and as a Member or Leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on Scientific and Technological and problems with society at large. This includes ability to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions to realize outreach to the society.

11. **Life-long learning:** Recognize the need of study and ability to engage in independent and life-long learning in the broadest context of scientific change.

12. **Project management and finance:** Demonstrate knowledge and understanding of the Scientific, Technological and management principles and apply these to the project work, as a member or leader in a team.

Program Specific Outcomes (PSOs)

- **Professional Skills:** An ability to understand the basic concepts of various branches of Biotechnology like Agricultural Biotechnology, Food Biotechnology, Industrial Biotechnology, Medical Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology, Microbial Biotechnology, Fermentation Biotechnology, Genetic Engineering, Bioinformatics, Nanotechnology, Plant- Animal Tissue culture, Immunology and to develop skills of respective disciplines.
- **Problem-Solving Skills:** An ability to solve Scientific and Technological and Social problems using latest technology and to arrive at cost effective and appropriate solutions.

- **Successful Career and Entrepreneurship:** An understanding of social awareness along with ethical responsibility to have a successful career and to sustain zeal for real-world applications using optimal resources as an Entrepreneur.

4. OBJECTIVES OF THE PROGRAM

- To introduce the concepts in various allied subjects.
- To enrich students' knowledge in basic and applied aspects of life sciences.
- To help the students to build interdisciplinary approach in teaching/ learning & in research.
- To inculcate the sense of scientific responsibilities and social awareness.
- To help students build-up a progressive and successful career in academia and industry.
- To make the students knowledgeable with respect to the subject and its practicable applicability.
- To promote understanding of basic and advanced concepts in Biotechnology.
- To expose the students to various emerging areas of Biotechnology.
- To prepare students for further studies, helping in their bright career in the subject.
- To expose the students to different processes used in industries and in research field.
- To prepare the students to accept the challenges in life sciences.
- To develop skills required in various industries, research labs and in the field of human health.

5. DURATION OF THE COURSE : The course shall be a fulltime course.

6. MEDIUM OF INSTRUCTION: The medium of instruction shall be in English

7. ELIGIBILITY FOR ADMISSION: As per guidelines obtained from Shivaji University, Kolhapur by following rules and regarding reservations by Govt. of Maharashtra

8. A) SCHEME OF TEACHING- As per University/BOS guidelines.

B) Examination Pattern

- The standard of passing Examination Ordinances and Rules will be applicable as per the existing system.
- The examination will be conducted as per the rules and regulations of Shivaji University which are applicable at that time.

- **Theory:-**

- There shall be 40 marks for each course (paper). For each course 40:10 pattern shall be applicable, wherein 40 marks shall be for University Assessment (UA) (Time duration: 2 hrs.) and 10 marks for internal assessment (IA).

- There shall be separate passing for theory as well as internal examinations. Minimum 14 marks out of 40 required for passing UA and minimum 4 marks out of 10 required for passing

- **Internal Assessment:-**

- As per UGC guidelines there shall be continuous internal assessment for B.Sc. Programme.

- Internal Examination will be compulsory for all students. If a student fails/remains absent in internal Examination then he / she will have to clear the internal Examination in subsequent attempt/s.

- The internal examination of 10 Marks shall be conducted at the mid of the each semester. The nature of questions shall be MCQ / true / false /one sentence answer type question/ short answer type questions/Home assignments (Time duration: 30 minutes).

- Practical Examination: -

- Practical exam will be conducted after theory exam.

- The practical examination shall be conducted as per respective BOS guidelines.

9.STRUCTURE OF PROGRAMME

	SHIVAJIUNIVERSITY,KOLHAPUR NEP-2020:Credit Framework for UG (B.Sc. Biotechnology) Programme Under Faculty of Science and Technology							
Semester /Level	**Courses**		**OE**	**VSC/SEC**	**AEC/VEC/IKS**	**OJT/FP/ CEP/CC/ RP**	**Total Credits**	**Degree/Cum. Cr.**
	Major	**Minor**						
Semester III (5.0)	**Major V(2)** Molecular Biotechnology I	**Minor V(2)** Genetics	OE-III(2) (T/P)	VSCI(2)(P) Techniques in Environmental Biotechnology	AEC-I(2) English (As per Syllabus of plane B. Sc. II programme)	CC-I(2)	22	UGDiploma88 [Sem4.5 (44)+ (Sem5.0 (44)]
	Major VI(2) Enzyme Biotechnology	**Minor VI(2)** Immunology		SECI(2)(T/P)				
	Major P-III (2) Techniques in Molecular Biology	**Minor P III-(2)** Techniques in Genetics & Immunology						
Semester IV (5.0)	**Major VII(2)** Molecular Biotechnology II	**Minor VII(2)** Physiology and Metabolism	OE-IV (2)(T/P)	SECII(2) (T/P)	AEC-II(2) English (As per Syllabus of plane B. Sc. II programme) VEC-II(2) (Environmental Studies)	CEP-I(2)	22	
	Major VIII(2) Industrial Biotechnology	**Minor VIII (2)** Advances in Cell Biology						
	Major P-IV(2) Techniques in Industrial Biotechnology	**Minor P- IV (2)** Techniques in Metabolism and Enzymology						
Credits	**8(T)+4(P)=12**	**8(T)+4(P)=12**	**2+2=4 (T/P)**	**4(T/P)+2(P)=6**	**2+4=6**	**2+2=4**	**44**	**Exit Option:4 Credits NSQF/Internship/ Skill courses**

Note:

- University may decide to offer maximum of three subjects (Courses) in the first year. The student may select one subject out of combination of three subjects (Courses), (which a student has chosen in the first year) as a **MAJOR** subject (Course) and one subject (Course) as **MINOR** Subject in the second year. Thereby it is inferred that the remaining third subject (Course) shall stand discontinued.
- **DSC:** Discipline Specific Course
- **MAJOR:** Mandatory/Elective
- **MINOR:** Course may be from different disciplines of same faculty of DSC Major
- **OE (Open Elective):** Elective courses/**Open Elective to be chosen compulsorily from faculty other than that of the Major.**
- **VSC/SEC: Vocational Skill** Courses **(MAJOR related)**/**Skill Enhancement Courses**
- AEC/ VEC/ IKS: Ability Enhancement Courses (English, Modern Indian Language)/Value Education Courses/ Indian Knowledge System (Generic/Specific).
- OJT/FP/RP/CEP/CC: On-Job Training (Internship/Apprenticeship) / Field Project (Major related)/ Research Projects (Major related Community Engagement (**Major related)/ Co-Curricular courses(CC)** such as Health & Wellness, Yoga Education, Sport and Fitness, Cultural activities, NSS/NCC and Fine /applied/visual/performing Arts / Vivek Vahini etc.

10. STANDARD OF PASSING AND DETERMINATION OF SGPA/CGPA, GRADING AND DECLARATION OF RESULTS.

As prescribed under rules and regulation of university for each degree.

11. Nature of Question Paper-Theory (40 + 10)

Nature of Question Paper for all (Theory) papers U.G. Courses under Faculty of Science.

B.Sc. Part – II/Sem. – III/IV Examination – 2025 (NEP - 2020)

Biotechnology

Title of the Subject

(Subject Code)

Day & Date: **Total Marks: 40**

Time: (Duration-(1Hr., 30 Min.)

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks
3) Draw neat labeled diagrams wherever necessary.

Q. 1 Objective (8 Marks)

Q.2 Attempt any two of the following (out of three) (16 Marks)

Q.3 Short notes (4 out of 6) (16 Marks)

Nature of question paper: Practical

Practical Examination (As per guidelines of BOS)

A) Every candidate must produce a certificate from the Head of the Department in his college, stating that he has completed in a satisfactory manner a practical course on the lines laid down from time to time by the Academic Council on the recommendations of the Board of Studies and that the laboratory Journal has been properly maintained. Every candidate must have recorded his/her observations in the Laboratory journal and written a report on each exercise performed. Every journal is to be signed periodically by a member of the teaching staff and certified by the Head of the Department at the end of the year. Candidates are to produce their journals at the practical examination and such journals will be taken into account by the examiners in assigning marks.
Note:-At least 80% Practicals should be covered in practical examination.

B) The practical examination will be of 6 hours duration and conducted on two successive days (6 hours per day).

Distribution of Marks for Practical Examination:
1. A) Major experiment 20 marks
   B) Minor experiment 10 marks

2. Spotting 10 marks
3. A) Journal 05 marks
B) Viva-voce 05 marks
Total Marks: 50 marks
Note: Experiments may be arranged as per convenience of the examiner.

12. Syllabus

Semester-III		
Major V: Molecular Biotechnology I		
Topic No.		**Lectures 30**
	Credit-I	
1.	**Experimental Evidences for DNA as a genetic material:-** Griffith's Exp., Avery, Macleod, McCarty Exp., Blender Exp., RNAAs a genetic material Gierer and Schram expt. **Properties and Function of DNA:-** Tm, Cot Curve, Purity of DNA, Acid- Base Nature, Buoyant Density Concept of Gene, Unit of Gene (Cistron, Recon, Muton), Fine Structure of gene, One gene One Polypeptide Hypothesis, interrupted gene. **Nucleic Acid biosynthesis:-** Denovo synthesis of Purine and Pyrimidine ring, Salvage Pathway, Synthesis of Deoxyribonucleotide, Feedback inhibition. **Organization of genome:-**Viral (Lambda,T4), Bacteria (*E. coli*), Eukaryote, Typical Structure of chromosome (Euchromatin Heterochromatin),PackagingofDNA (Nuclesome, SolenoidModel).	**15**
	Credit-II	
2.	**DNA Replication-** Semi conservative model of replication (M.S Expt.). Direction of replication (Uni & Bidirectional). Prokaryotic and eukaryotic replication-Enzymes involved in replication, initiation, elongation and termination. Rolling circle model and telomere replication. **Mutation** Introduction, Types–Spontaneous, Induced. Mutagenesis–Base analogues, Nitrous acid, hydroxylamine, alkylating agent, Acridine dyes, U. V. light. **DNA Repair** DNA repair- Direct repair, Excision repair(Nucleotide and Base),Mismatch repair, SOS repair, Recombination repair, Repair of double strand DNA break.	**15**

Course Outcomes:

Students will able to understand

- The experimental evidences of genetic material.
- The properties and functions of DNA.
- The nucleic acid biosynthesis and genome organization.
- The molecular mechanism of replication, mutation and DNA repair.
-

References:

- Molecular biology by Watson
- Genetics by Strickberger
- Molecular Biology by Glickpastornack
- Molecular biolage Geralad Carph
- Gene By Levin
- Genome by T.A. Brown

Major VI: Enzyme Biotechnology		
Topic No.		**Lectures 30**
	Credit-I	
1.	**Introduction to Enzymology**: Discovery and nomenclature, characteristic of enzymes, concept of apoenzyme and holoenzyme, coenzymes and cofactor, regulation of enzyme activity, enzyme inhibitors and inhibition. **Enzyme Kinetics**: Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action and experimental determination.	**15**
	Credit-II	
2.	**Enzyme Regulation:** General mechanisms of enzyme regulation. Feed back inhibition, Reversible and irreversible covalent modifications of enzymes, Monocyclic and multicyclic cascade systems with specific examples. Allosteric enzymes, Sigmodial Kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance.	**15**

Course Outcomes:

After completing the credits students should gain knowledge about:

- Basics of Enzymology.
- The mechanism of enzyme action.
- The enzyme kinetics.
- The enzyme regulation.

References:

- Nicholas C. P. *Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins*, Oxford University Press. (2009)– UNIT I, II, III.
- Nicholas C. P. and Stevens L. *Fundamentals of Enzymology, The Cell and Molecular Biology of Catalytic Proteins*, New York : Oxford University Press (2000) -UNIT I, II, III.
- Moss, Donald William. *Isoenzymes*. Springer Science & Business Media, (2012). – UNIT I.

- Price, Nicolas C., and Perry A. Frey. *Fundamentals of enzymology. Biochemistry and Molecular Biology Education* 29: (2001) – UNITI and II.
- Tokushige M., *Allosteric Regulation, Selected Papers in Biochemistry*, Tokyo: University of Tokyo Press, Volume 8 (1971). – UNIT III
- Guisan, J. *Immobilization of enzyme & cells*, Humana, 3rd edition (2013) – Unit IV
- Enzymes - Trevor Palmer

Major P III: Techniques in Molecular Biology (2 Cr)	
Sr. No.	**Name of the Practical**
1	Isolation of Eukaryotic DNA and separation from - Plant Material or Animal Material.
2	Purification of DNA by silica membrane.
3	Isolation of Genomic DNA from bacteria.
4	Agarose gel electrophoresis to separate DNA.
5	Isolation of Plasmid from *E. coli.*
6	Determination of Tm of DNA.
7	Isolation and separation of RNA.
8	Separation of RNA by Agarose gel electrophoresis.
9	Separation of protein using SDS-PAGE.
10	Restriction digestion of DNA.

Course outcome:

- At the end of this module, student is expected to know simple techniques for isolation of DNA.
- Models should bring clarity in concepts of agarose gel electrophoresis.
- Models should bring clarity in concepts of SDS-PAGE.
- Student should understand restriction digestion of DNA.

Minor V: Genetics

Topic No.		Lectures 30
	Credit-I	
1.	**Mendel's law of Inheritance** – Mendel's Experiment, Dominance and recessiveness, Principle of segregation, independent assortment, back and test cross. Incomplete dominance, co-dominance, multiple allele. Modifiers, suppressors, pleiotropic gene. Interaction of gene- Epistasis, complimentary gene, duplicate gene. **Linkage** Definition, coupling and repulsion hypothesis, linkage groups. Crossing over-Mechanism and theory. Structural and numerical changes in chromosomes. Maternal effect- Concept and example. Extra chromosomal or cytoplasmic or organellar inheritance- mitochondrial and plastid.	**15**
	Credit-II	
2.	**Transposable elements-**IS elements, transposons and retroelements. Transposons in prokaryotes and eukaryotes, mechanism of transposition, uses of transposons. **Plasmid**- Types, Structure, properties and applications. **Genetic recombination in bacteria-** Definition, fate of exogenote in recipient cell, transformation, conjugation, transduction. **Mechanism of recombination**-The Holliday model, Messelson and Radding model, Double strand break repair model, Fox model for non reciprocal recombination.	**15**

Course Outcome:

Student should understand**:**

- Mendel's laws of inheritance.
- Mechanism of linkage and crossing over.
- Transposable elements and mechanism of transposons.
- Molecular mechanism of genetic recombination.

References:-

- Strickberger "Genetics"
- Freifelder "Genetics"
- Stanier "General Microbiology"
- P. K. Gupta "Genetics"
- C. Sarin "Genetics"
- Larry Snyder Wendy Champness "Molecular Genetics of Bacteria"

Minor VI: Immunology

Topic No.		Lectures 30
	Credit-I	
1.	**Introduction- Types of immunity**-i)Innate (specific and non-specific) ii) Acquired (Active and Passive). **Types of Defense-** a) first line of defense (barriers at the portal of entry, physical and chemical barriers) b) second line of defense (Phagocytosis– oxygen dependent and independent) c) third line of defense-specific defense mechanism. **Complement-** classical and alternative pathways **Introduction to cells and organs of immune system-** Organs of immune system-primary and secondary lymphoid organs- structure and their role. Cells of immune system-a)broad categories of leucocytes, their role and properties b) B-lymphocytes c) T-cells-subsets d) other cells (APC, Null, NK)	**15**
	Credit-II	
2.	**Antigen and Antibody Antigen-** definition , nature, types of antigen, factors affecting antigenicity. **Antibody-** definition, nature, basic structure of immunoglobulin molecule, major human immunoglobulin classes, properties and functions. **Immune response**-primary and secondary immune response, theories of antibody production. **Antigen Antibody reactions**-Principle and applications of a)agglutination b) precipitation c) complement fixation d) ELISA. **Hypersensitivity-** Concept and types with example.	**15**

Course Outcome:

Student should understand**:**

- Types of immunity, types of defense, complement pathways.
- The cell and organ immune system.
- The concepts of antigen, antibody and immune response.
- The mechanism of antigen-antibody reactions and hypersensitivity.

References:-

- Riott "Essential Immunology"
- Kuby "Immunology"
- Ashim Chakravar "Immunology and Serology"
- Tizzard "Immunology-An Introduction"-4th Edition
- S. K. Gupta "Essentials of Immunology"
- M. P. Arora "Immunology"

Minor PIII: Techniques in Genetics and immunology(2Cr)	
Sr. No.	**Name of the Practical's**
1	Isolation of Lac negative mutants of *E. coli* by visual detection method.
2	Isolation of Streptomycin resistant mutants by gradient plate technique.
3	Isolation of vitaminB_{12} requiring mutants by replica plate technique.
4	Study of Transformation in *E. coli*.
5	Study of Conjugation in *E. coli.*
6	Study of U.V survival curve.
7	Detection of antigen /antibody by dot ELISA test
8	Estimation of amount of antigen in the given clinical sample by Radial Immuno diffusion Assay.
9	Characterization of the given antisera qualitatively or quantitatively by immuno Electrophoresis technique
10	Determine the antigen-antibody pattern or Ab titre by using Double Diffusion Technique (Qualitative).
11	Qualitative and Quantitative detection of antibody titer by Widal test of patient serum.
12	Perform RPR card test of given clinical sample.
13	Problems based on Mendelian Inheritance, linkage and crossing over.
14	Study of meiotic abnormality in *Rhoeo.*
15	Study of karyotype by using photograph

Course outcome:

Student should understand**:**

- Isolation techniques of mutants.
- Transformation and Conjugation process.
- Different immunological techniques.
- Mendelian laws, karyotyping and meiotic abnormalities.

AEC-I English (2Cr)
As per Syllabus of plane B. Sc. II programme

Semester-IV

Major VII: Molecular Biotechnology II

Topic No.		Lectures 30
	Credit-I	
1.	**Transcription in prokaryote and Eukaryote** Mechanism of transcription-Enzyme involved, initiation, elongation and termination. Inhibitors of transcription, Post transcriptional modification, Transcriptional control by hormones. **Genetic Code** Properties of genetic code. Assignment of codons with Unknown sequences a) Polyuridylic b) Acid Copolymers method. Assignment of codons with known sequences a) Binding technique b) Repetitive seq. technique. Wobble Hypothesis, Variation in genetic code.	
	Credit-II	
2.	**Translation in prokaryote and Eukaryote** Structure and role of ribosome in translation, Amino acid t-RNA complex formation, Initiation, Elongation, termination of translation Inhibitors of translation. Post-translation modifications (Protein folding, Removal of Leader sequences, Phosphorylation, glycosylation, acetylation). **Regulation of gene expression in prokaryote and eukaryote.** Regulation of gene expression in prokaryote a) Lac operon b) Tryptophan operon c) Arabinose operon. Regulation of gene expression in eukaryote a) Promoter b) Enhancers c) Activators d) Repressor e) Co-Repressors. Regulation of gene expression at transcriptional and translation level. CRISPER-Conept.	

Course Outcome:

After completing the credits students should gain knowledge about:

- The molecular process of transcription in prokaryotes and eukaryotes.
- The concept and properties of genetic code.
- The molecular mechanism of translation in prokaryotes and eukaryotes.
- The regulation of gene expression in prokaryotes and eukaryotes.

References:

- Molecular biology by Watson
- Genetics by Strickberger
- Molecular Biology by Glickpastornack
- Molecular biolage Geralad Carph
- Gene By Levin
- Genome by T.A. Brown

Major VIII: Industrial Biotechnology		
Topic No.		**Lectures 30**
	Credit-I	
1.	**Introduction to Industrial Biotechnology** Concept and range of fermentation technology, Types of fermentations (Batch, continuous, dual, multiple), Concept of solid state & submerged fermentation. Microbial metabolic products-Primary & Secondary products. Basic design of fermenter, Types of fermenters- Stirred tank fermenter, Airlift fermenter, Tower fermenter, Tubular fermenter, Bubble cap fermenter. **Microbial Screening, Scale up and strain improvement** Primary and secondary screening**,** Primary screening of antibiotics, organic acids and amines, enzymes, vitamins and amino acid producers, volatile component degraders, organisms using specific carbon and nitrogen sources. Secondary screening of antibiotic producers**,** Strain improvement- concept and methods -mutation, genetic recombination**,** Scale up of fermentations**,** Maintenance and preservation of industrially important cultures. Microbiological assay.	**15**
	Credit-II	
2.	**Fermentation Media** Composition of typical fermentation media, Criteria for typical fermentation medium, Types of fermentation media, General role of media components-water, carbon source, nitrogen source, minerals, precursors, growth factors, buffers, antifoams, oxidation, reduction potentials, inducers, inhibitors. Optimization of media, Plackett and Burmann design, Factors affecting fermentation process. **Downstream Process and Product Recovery** Downstream Processes in fermentation and bioprocess technology, Solid and liquid separation, Flocculation and Flotation, filtration and centrifugation, Cell disruption by solid and liquid shear, ultrasonication, enzyme action and mechanical disruption. Product recovery and purification- principle, Precipitation, Crystallization, Liquid-Liquid extraction, Distillation (Fractional and Steam), evaporation, Chromatographic separation (Principles), Adsorption and concentration, Membrane filtration, drying and packing	**15**

Course Outcome:

After completing the credits students should gain knowledge about:

- The process of fermentation technology.
- The concept of microbial screening.
- Preparation of fermentation media.
- Downstream process and product recovery.

References:-

- Text Book of Biotechnology – Dr. H. K. Das
- Industrial Microbiology & Biotechnology – Arnold L.
- Fermentation Technology – Jayanto Acharekar
- Basic Biotechnology – Colin and Bjrorn

- Frontiers in Microbial Biotechnology – Bisel P.S.
- Industrial Microbiology – Prescot and Dunn
- Principle of Fermentation Technology – Stanbury P.F ., Whitekar H., Hall S.
- Bioprocess Engineering : Principles – Nielson T. an d Villadeson J.
- Industrial Microbology- L.E. Casida
- Fermentation Biotechnology- H.A. Modi
- Industrial Microbiology- A.H.Patel

Major P IV: Techniques in Industrial Biotechnology (2 Cr)

Sr. No.	Name of the Practical
1.	Primary screening of amylase producers by Replica Plate technique.
2.	Screening and isolation of antibiotic producing organism from soil (Crowded plate/ Giant colony method).
3.	Production and Immobilization of enzyme (Amylase/ Invertase)
4.	Production of alcohol/ wine and estimation by colorimetric method
5.	Production of sauerkraut
6.	Mushroom Cultivation.
7.	Production, Recovery and estimation of Citric Acid
8.	Bioassay of vitamin B12
9.	Bioassay of Penicillin
10.	Isolation and identification of starter organisms from Idli batter/ Dahi
11.	Estimation of lactic acid and total fat of Milk.
12.	Determination of quality of milk by MBRT and Phosphtase test.

Course Outcome:

- Student should get the knowledge of screening and isolation of microorganisms..
- Students know the technique of immobilization of enzymes.
- Students get the knowledge of production techniques viz., sauerkraut, mashroom, citric acid etc..
- Students know how to do milk analysis.

Minor VII: Physiology and Metabolism

Topic No.		Lectures 30
	Credit-I	
1.	**Plant Water Relation:-** Introduction, Absorption of water-Mechanism, Theories (Active and Passive), Translocation of water- Mechanism, Theories (Root pressure, Capillary), Transpiration. **Photosynthesis:-**Ultra structure of chloroplast, Photosynthetic pigments, red drop and Emerson's enhancement effect, mechanism of photosynthesis, light reaction, dark reaction, C-3 pathway, C-4 pathway, CAM, photorespiration. **Respiration:-** Aerobic:-Flow of electrons in ETC, Redox potential components of ETC, Mechanism of ATP generation- Chemiosmotic hypothesis, ATP synthase complex. Anaerobic Respiration:- Alcoholic and Lactic acid fermentation**.**	
	Credit-II	
2.	**Nitrogen Metabolism: -** Role of nitrogen in plants, source of nitrogen, nitrogen fixation- symbiotic & Non-symbiotic, Mechanism of Nitrogen fixation, nif gene- concept and significance, transamination. **Introduction to Plant Hormones** Biosynthesis of plant hormones- Auxin, Cytokinin, Gibberellin. **Growth:-** Definition, phases of growth curve, Photoperiodism, Vernalisation.	

Course Outcomes:

Student should be able to understand

- Basics of plant water relation.
- Overview of photosynthesis.
- The respiratory pathway, electron transport and ATP synthesis.
- Nitrogen metabolism in plants.
- Plant Hormones and growth.

References:-

- Biochemistry- Lubert Stryer
- Biochemistry- Nelson and Cox
- Practical Biochemistry- Wilson and Walker
- Fundamentals of Biochemistry – J. L. Jain
- Principals of Biochemistry- Voet and Voet
- Fundamentals of Plant Physiology- V. K.Jain

Minor VIII: Advances in Cell Biology

Topic No.		Lectures 30
	Credit-I	
1.	**Secretary pathway and protein trafficking** Secretary pathway-ER associated ribosomal translation, co-translational vectoral transport of nascent polypeptide chain to ER lumen. Transport to Golgi apparatus, secretary granules. Transport of proteins to- mitochondria, chloroplast, peroxisomes, nucleus. **Cell signaling** Introduction, general principles of cell signaling. Types of cell signaling-contact dependent signaling, autocrine, paracrine, synaptic, endocrine, gap junctions, combinatorial signaling. Cell surface receptor proteins- Ion channel linked receptors, G-protein linked receptors and enzyme linked receptors. Signaling through G-protein coupled receptors.	**15**
	Credit-II	
2.	**Cell division cycle** Introduction, definition, phases of cell cycle. Regulation of cell cycle- CDK and cyclins (G-CDK, S-CDK, M-CDK and APC). Cell cycle checkpoint-Start checkpoint, G2/M checkpoint, Metaphase to anaphase transition Programmed cell death. Cancer - types, characteristics of cancer cells, causes of cancer, tumor suppressor genes, p53 and Rb. **Cell division** Introduction and types of cell division-amitosis, mitosis and meiosis. Mitosis- history, phases in mitosis, significance. Meiosis -history, phases in meiosis, significance. Role of spindle fibers in chromosome separation. Condensation of chromosome. Synaptonemal complex.	**15**

Course Outcome:

Student should understand**:**

- Secretary pathway, protein trafficking related to cellular transport.
- The role of cell signaling in regulation of cellular metabolism.
- The phases, regulation and checkpoints regarding cell cycle.
- Cell division and its types.

References:-

- Molecular biology of cell-Albert
- Molecular biology & cell biology – Loddish et al
- Cell biology –De Robertis
- Cell biology-Genetics, molecular biology-P.S. Warma & Agarwal
- Genes- Lewin
- Cell biology –Geral karp
- Practical biochemistry – Keith Wilson and Walker

Minor P IV : Techniques in Metabolism and Enzymology (2 Cr)	
Sr. No.	**Name of the Practical's**
1)	Estimation of fructose by Resorcinol method.
2)	Estimation of DNA by Diphenylamine method.
3)	Estimation of RNA by Orcinol Method.
4)	Estimation of Indole-3 Acetic Acid by (Salkowaski reagent) Colorimetric method.
5)	Isolation of Amylase from germinating seed and determination of its activity.
6)	Study of lipase activity.
7)	Study of nitrate reductase activity.
8)	Purification of proteins /enzymes by Ion exchange chromatography using DEAE Cellulose.
9)	Separation of Biomolecules by Gel Filtration Chromatography.
10)	Separation of Amino acids by TLC.
11)	Separation of Amino acids by Paper electrophoresis.

Course outcome:

- Student should get the knowledge of estimation of various biomolecules.
- Students know the technique of isolation of enzymes and their activities.
- Students get the knowledge of purification of proteins and enzymes.
- Students know how to separate biomolecules through chromatography and electrophoresis techniques.

VSCI(P):Techniques in Environmental Biotechnology	
Sr. No.	**Name of the Practical**
1)	Estimation of COD of water sample.
2)	Estimation of BOD of water sample.
3)	Differentiate fecal or non-fecal coli forms by per forming IMViC test.
4)	Determination of phenol coefficient of phenol derivative.
5)	Study of effect of pesticide on *Azotobater* population by viable count method.
6)	Isolation of phages of *E.coli* from sewage.
7)	Determination of TDS of water sample.
8)	Routine bacteriological analysis of water Presumptive, Confirmatory, Completed, MPN.
9)	Determination of total and permanent hardness of water sample.
10)	Isolation of microorganism from air by solid impaction technique.
11)	Study of effect of heavy metal on growth of organisms.

Course outcome:

- Student should get the knowledge of estimation of COD and BOD.
- Students get the knowledge about physicochemical and microbial analysis of water samples.

AEC-II English (2Cr)
As per Syllabus of plane B. Sc. II programme