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

SHIVAJI UNIVERSITY, KOLHAPUR - 416 004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर - ४१६ ००४,महाराष्ट्र
दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९३/९४

**SU/BOS/Science/498** **Date: 10/07/2023**

**To,**

| | |
|---|---|
| The Principal,<br>All Concerned Affiliated Colleges/Institutions<br>Shivaji University, Kolhapur | The Head/Co-ordinator/Director<br>All Concerned Department (Science)<br>Shivaji University, Kolhapur. |

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

**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 revised syllabi, nature of question paper and equivalence of B.Sc. Part-II (Sem. III & IV) as per NEP-2020 degree programme under the Faculty of Science and Technology.

| **B.Sc.-II (Sem. III & IV) as per NEP-2020** | | | |
|---|---|---|---|
| 1. | Computer Science (Opt) | 8. | Food Technology &Management (Entire) |
| 2. | Computer Science (Entire) | 9. | Biochemistry |
| 3. | Animation (Entire) | 10. | Biotechnology (Optional/Vocational) |
| 4. | Information Technology (Entire) | 11. | Biotechnology (Entire) |
| 5. | Food Science and Technology (Entire) | 12. | Environmental Science (Entire) |
| 6. | Food Science | 13. | Pollution |
| 7 | Food Science and Quality Control (Entire) | | |

This syllabus, nature of question and equivalence shall be implemented from the academic year 2023-2024 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in**)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2023 & March/April 2024. 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**

**Copy to:**

| | | | |
|---|---|---|---|
| 1 | The Dean, Faculty of Science & Technology | 8 | P.G. Admission/Seminar Section |
| 2 | Director, Board of Examinations and Evaluation | 9 | Computer Centre/ Eligibility Section |
| 3 | The Chairman, Respective Board of Studies | 10 | Affiliation Section (U.G.) (P.G.) |
| 4 | B.Sc. Exam/ Appointment Section | 11 | Centre for Distance Education |

# Shivaji University, Kolhapur

## Choice Based Credit System with Multiple Entry and Multiple Exit options as per NEP-2020

## Bachelor of Science (B. Sc. Part-II) Biotechnology (Entire)

## Programme Structure Under Faculty of Science & Technology

(To be implemented from Academic Year 2023-24)

**Choice Based Credit System (CBCS) with Multiple Entry and Multiple Exit (MEME) Options as per NEP-2020**

**To be implemented from the Academic Year 2023-24**

**First Year Bachelor of Science Biotechnology (Entire) (Level-6)**

**Programme Structure ( NEP-2020 PATTERN)**

## R. B.Sc. 3:(A) (i) Structure of B.Sc. Programme (Semester III & IV)

**SEMESTER–III(Duration–6 Months)**

| Sr. No. | Course (Subject) Title | TEACHING SCHEME | | | | | | EXAMINATION SCHEME | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | PRACTICAL | | | THEORY | | | | | | PRACTICAL | | | |
| | | | | | | | | Internal | | University | | | | | | | |
| | | Credits | No. of lectures | Hours | Credits | No. of lectures | Hours | Max | Min | Hours | Max Marks | Total Marks | Min | Hours | Max | Min | |
| 1 | DSC-C | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | | | |
| 2 | DSC-C | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | | | |
| 3 | DSC-C | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | | | |
| 4 | DSC-C | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | | | |
| 5 | DSC-C | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | | | |
| 6 | DSC-C | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | | | |
| 7 | AECC-C | **4** | 4 | 3.2 | ----- | ----- | ----- | ---- | --- | ---- | --- | --- | --- | **PRACTICAL EXAMINATION IS ANNUAL** | | | |
| 8 | SEC-III | Any one from pool of courses | | | 2 | - | - | ----- | ----- | - | --- | --- | --- | 2 | **50** | **18** | |
| **Total** | | **16** | **22** | **17.6** | **14** | **24** | **19.2** | **60** | | | **240** | **350** | | | | | |

## SEMESTER–IV(Duration–6 Months)

| Sr. No. | Course (Subject) Title | TEACHING SCHEME | | | | | | EXAMINATION SCHEME | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | PRACTICAL | | | THEORY | | | | | | PRACTICAL | | | |
| | | | | | | | | Internal | | University | | | | | | | |
| | | Credits | No. of lectures | Hours | Credits | No. of lectures | Hours | Max | Min | Hours | Max Marks | Total Marks | Min | Hours | Max | Min |
| 1 | DSC-D | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | As per BOS Guidelines | **50** | **18** |
| 2 | DSC-D | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | **50** | **18** |
| 3 | DSC-D | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | **50** | **18** |
| 4 | DSC-D | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | **50** | **18** |
| 5 | DSC-D | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | **50** | **18** |
| 6 | DSC-D | **2** | 3 | 2.4 | **2** | 4 | **3.2** | 10 | 4 | 2 | 40 | 40 | 14 | | **50** | **18** |
| 7 | AECC-C<br>AECC-D | --- | --- | --- | ----- | ----- | ----- | ---- | --- | 3 | 70 | 100 | 25 | | | |
| | | | | | | | | | | Project | 30 | | 10 | | | |
| 8 | SEC-IV | Any one from pool of courses | | | 2 | | | | | | | | | 2 | **50** | **18** |
| **Total** | | **12** | **18** | **14.4** | **14** | | | **60** | | | **340** | **400** | | | **350** | |
| | | **28** | **40** | **32** | **28** | **48** | **38.4** | **120** | | | **580** | **750** | | | | |

- Student contact hours per week: 36.8 Hours (Min.)
- Theory and Practical Lectures :48 Minutes Each
- Total Marks for B.Sc.-II (Including EVS) **1100**
- Total Credits for B.Sc.-II (Semester III & IV):
- **DSC:** -Discipline Specific Core Course
- **AECC**- Ability Enhancement Compulsory Course (C): Environmental Studies: EVS Theory and AECC-D EVS Project (Theory:70 & Project:30 marks)
- ***There shall be separate passing for internal and University theory as well as practical / project examinations.***
- ***Practical Examination shall be conducted annually for 50 Marks per course (subject) and minimum 18 marks are required for passing.***
- ***There shall be Separate passing for each theory courses of 40 marks each. i.e. minimum 14 marks are required for passing out of 40.***

***Examination of SEC shall be either theory or practical depending upon type of SEC.***

**Nature of Question Paper for B.Sc. Biotechnology (Entire) Part – I, II & III (40 + 10 Pattern) according to Revised Structureas Per NEP – 2020 to be implemented from academic year 2023-24**

Maximum Marks: 40
Duration: 2 hrs

**Q. 1 Select the most correct alternate from the following** **[8]**

i) to viii) MCQ one mark each with four options

A)
B)
C)
D)

**Q.2 Attempt any TWO of the following** **[16]**

A)
B)
C)

**Q. 3 Attempt any FOUR of the following** **[16]**

a)
b)
c)
d)
e)
f)

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# SHIVAJI UNIVERSITY, KOLHAPUR.

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**Accredited By NAAC with 'A' Grade**

**Syllabus For**
**Choice Based Credit System with Multiple Entry and Multiple Exit options as per NEP-2020**

**Bachelor of Science (B. Sc. Part-II) Biotechnology (Entire)**

**SEMESTER III AND IV**

**Programme Structure Under aculty of Science & Technology**

**(To be implemented from Academic Year 2023-24)**

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

1. TITLE: **Bachelor of Science (B. Sc. Part-II) Biotechnology (Entire)** under the Faculty of Science

2. YEAR OF IMPLEMENTATION:-Revised Syllabi (As per NEP 2020) will be implemented from June 2023 onwards.

3. 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.

4. 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.

GENERAL 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.

Program Specific Outcomes:

- 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.

5. DURATION The course shall be a fulltime course.

6. PATTERN:- Pattern of examination will be semester.

7. FEE STRUCTURE:- As per Government / University rules

1. Refer brochure and prospectus of concern affiliated college/institute to Shivaji University, Kolhapur.
2. Other fee will be applicable as per rules and norms of Shivaji University, Kolhapur.

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

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

Structure of Program and List of Courses are as follows:

## B. Sc. Part II (Semester III and IV)

| Course code | Name of Course | Course code | Name of course |
|---|---|---|---|
| **Semester III** | | **Semester IV** | |
| **DSC BT C1** | Genetics | **DSC BT D1** | Immunology |
| **DSC BT C2** | Fundamentals of Biophysics | **DSC BT D2** | Advances in Cell Biology |
| **DSC BT C3** | Metabolic Pathways | **DSC BT D3** | Plant Biochemistry |
| **DSC BT C4** | Enzymology | **DSC BT D4** | Environmental Biotechnology |
| **DSC BT C5** | Molecular Biology-I | **DSC BT D5** | Molecular Biology-II |
| **DSC BT C6** | Plant Tissue Culture | **DSC BT D6** | Animal Tissue Culture |
| **AECC-C** | Environmental Studies ( Theory) | **AECC-D** | Environmental Studies ( Project) |

## AECC – C:- Ability Enhancement Compulsory Course : Environmental Studies

## Practicals (Annual Pattern)

| | | | |
|---|---|---|---|
| **DSC BTP 5** | Techniques in Molecular Biology | **DSC BTP 8** | Techniques in Genetics, Immunology |
| **DSC BTP 6** | Techniques in Metabolic Pathways | **DSC BTP 9** | Techniques in Cell Biology |
| **DSC BTP 7** | Techniques in Plant Tissue Culture | **DSC BTP 10** | Techniques in Environmental Biotechnology |

# Bachelor of Science (B. Sc. Part-II) Biotechnology (Entire)
## SEMESTER III
## DSC BTC1- 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.<br>Incomplete dominance, co-dominance, multiple allele.<br>Modifiers, suppressors, pleiotropic gene.<br>Interaction of gene- Epistasis, complimentary gene, duplicate gene.<br>**Linkage**<br>Definition, coupling and repulsion hypothesis, linkage groups.<br>Crossing over-Mechanism and theory.<br>Structural and numerical changes in chromosomes.<br>Maternal effect- Concept and example.<br>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.<br>**Plasmid**- Types, Structure, properties and applications.<br>**Genetic recombination in bacteria-** Definition, fate of exogenote in recipient cell, transformation, conjugation, transduction.<br>**Mechanism of recombination**-The Holliday model, Messelson and Radding model, Double strand break repair model, Fox model for non reciprocal recombination. | **15** |

**References:**


1. Strickberger "Genetics"
2. Freifelder "Genetics"
5. Stanier "General Microbiology"
6. P. K. Gupta "Genetics"
7. C. Sarin "Genetics"
8. Larry Snyder Wendy Champness "Molecular Genetics of Bacteria"

# DSC BTC2- Fundamentals of Biophysics

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit- I** | |
| **1.** | **IR spectroscopy** – Introduction, vibration spectra (without proof), possible modes of vibrations of atoms in polyatomic molecules, Instrumentation, Applications.<br>**Atomic Absorption Spectroscopy:** Introduction, Principle, Instrumentation, Applications.<br>**Flame Photometry:** Introduction, Principle, Instrumentation, Applications. | **15** |
| | **Credit-II** | |
| **2.** | **Electrophoresis:** Introduction, Principle, theory and applications of native and SDS PAGE, pulse field electrophoresis, capillary electrophoresis, immunoelectrophoresis.<br>**Chromatography:** Introduction, Theory, Principle and applications of column chromatography, size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, HPLC, GLC.<br>**Tracer technique:** Introduction, α, β, γ radiations, measurement (scintillation counting, Geiger-Muller counting), radioactive isotopes, half life of isotopes, autoradiography. | **15** |

**References:**


1. Instrumental Methods of Chemical Analysis – Gurudeep R. Chatwal, Sham K. Anand (Himalaya Publishing House).
2. Handbook on Analytical Instruments –R. S. Khandpur. ( Mc. Graw Hill).
3. Biophysical Chemistry - Upadhyay, Nath, Upadhyay (Himalaya Publishing House).
4. Introduction to Molecular Spectroscopy – C.N.Banwell.
5. Biophysics ,Mohan P. Arora, Himalaya Publishing House,Delhi
6. Practical Biochemistry- Wilson and Walker

# DSC BTC3 - Metabolic Pathways

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit- I** | |
| **1.** | **Metabolism:-** Introduction to metabolism, anabolism & catabolism, catabolism & its three stages, types of metabolic reactions, Methods employed to study metabolism (by cell free extract, using auxotrophic mutants, radioisotopes), High energy compounds enlist some examples 5 to 6.<br>**Carbohydrates Metabolism:-**Reactions and energetics of Glycolysis, Gluconeogenesis, TCA cycle, Glyoxylate cycle, HMP and its significance. | **15** |
| 2. | **Credit-II** | **15** |
| | **Lipid Metabolism:** Biosynthesis of fatty acid with respect to Palmitic acid & degradation of fatty acid (β-oxidation) with respect to Palmitic acid.<br>**Respiration:-**<br>Aerobic:-Flow of electrons in ETC, Redox potential components of ETC, Mechanism of ATP generation- Chemiosmotic hypothesis, ATP synthase complex.<br>Anaerobic Respiration:- Alcoholic and Lactic acid fermentation**.** | |

**References:-**


1) Biochemistry- Lubert Stryer
2) Biochemistry- Nelson and Cox
3) Practical Biochemistry- Wilson and Walker
4) Fundamentals of Biochemistry – J. L. Jain
5) Principals of Biochemistry- Voet and Voet
6) Fundamentals of Plant Physiology- V. K. Jain

# DSC BTC4 - Enzymology

| 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.<br><br>**Enzyme Kinetics**:<br>Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km.<br>Bisubstrate reactions.<br>Graphical procedures in enzymology - advantages and disadvantages of alternate plotting.<br>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** |

**References:-**


1. Nicholas C. P. *Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins*, Oxford University Press. (2009)– UNIT I, II, III.

2. 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.

3. Moss, Donald William. *Isoenzymes*. Springer Science & Business Media, (2012). – UNIT I.

4. Price, Nicolas C., and Perry A. Frey. *Fundamentals of enzymology. Biochemistry and Molecular Biology Education* 29: (2001) – UNITI and II.

5. Tokushige M., *Allosteric Regulation, Selected Papers in Biochemistry*, Tokyo: University of Tokyo Press, Volume 8 (1971). – UNIT III

6. Guisan, J. *Immobilization of enzyme & cells*, Humana, 3rd edition (2013) – Unit IV

7. Enzymes - Trevor Palmer

# DSC BTC5 - Molecular Biology- I

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

**References:**


1) Molecular biology by Watson
2) Genetics by Strickberger
3) Molecular Biology by Glickpastornack
4) Molecular biolage Geralad Carph
5) Gene By Levin
6) Genome by T.A. Brown

# DSC BTC6 - Plant Tissue Culture

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit- I** | |
| **1.** | **Introduction to plant tissue culture-** Definition, History ,Cellular totipotency, techniques in plant tissue culture.<br>**Infrastructure & Organization Of Plant Tissue Culture Laboratory-General and aseptic laboratory-** different work areas, equipments and instruments required and other requirements.<br>**Aseptic Techniques-** Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization, aseptic workstation and precautions to maintain aseptic conditions.<br>**Culture Medium-** Composition of basal M.S. medium and preparation of media.<br>**Callus Culture Techniques-** Introduction, principle, protocol, morphology and internal structure, genetic variations and applications.<br>**Somatic Embryogenesis-** Introduction, principle, protocol, factors affecting, applications and limitations.<br>**Organogenesis-** Introduction, principle, protocol, applications.<br>**Ovary and ovule Culture Technique-** Introduction, principle, protocol, and applications. | **15** |
| | **Credit-II** | |
| **2.** | **Anther & Pollen Culture Technique-** Introduction, principle, protocol, factors affecting and applications.<br>**Micropropagation-** Introduction, stages of Micropropagation, factors affecting, advantages and applications.<br>**Different Pathways of Micropropagation**- Axillary bud proliferation, somatic embryogenesis, organogenesis and meristem culture.<br>**Somaclonal Variation-** Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, applications and limitations.<br>**Suspension Culture Technique**- Introduction, principle, protocol, types, growth measurement, synchronization and applications.<br>**Plant Protoplast Culture:-** History, Principle, protocol for isolation- Mechanical and Enzymatic, protoplast culture and importance. | **15** |

**References:-**


1] Introduction to plant tissue culture- M.K. Razdan
2] Plant tissue culture-Theory & practice-S.S.Bhojwani & M.K. Razdan
3] Plant tissue culture-Kalyankumar Dey
4] Biotechnology- B.D. Singh
5] A text book of Biotechnology- R.C. Dubey
6] Plant tissue culture-U.Kumar
7] Plant cell, tissue & organ culture-Gam Borg & Phillips
8] Fundamentals of Biotechnology- S.S. Purohit
9] Biotechnology- H.S. Chawla
10] Crop Improvement In biotechnology- H.S.Chawla

# Bachelor of Science (B. Sc. Part-II) Biotechnology (Entire)
## SEMESTER IV
## DSC BTD1-Immunology

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit- I** | |
| **1.** | **Introduction-**<br>**Types of immunity**-i)Innate (specific and non-specific) ii) Acquired (Active and Passive),<br>**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.<br>**Complement-** classical and alternative pathways<br>**Introduction to cells and organs of immune system-**<br>Organs of immune system-primary and secondary lymphoid organs-structure and their role.<br>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**<br>**Antigen-** definition , nature, types of antigen, factors affecting antigenicity.<br>**Antibody-** definition, nature, basic structure of immunoglobulin molecule, major human immunoglobulin classes, properties and functions.<br>**Immune response**-primary and secondary immune response, theories of antibody production.<br>**Antigen Antibody reactions**-Principle and applications of a)agglutination b) precipitation c) complement fixation d) ELISA.<br>**Hypersensitivity-** Concept and types with example. | **15** |

**References:**


1. Riott “Essential Immunology”
2. Kuby “Immunology”
3. Ashim Chakravar “Immunology and Serology”
4. Tizzard “Immunology-An Introduction”-4th Edition
5. S. K. Gupta “Essentials of Immunology”
6. M. P. Arora “Immunology”

# DSE BTD2- Advances in Cell Biology

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

**References:-**


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

# DSC BTD3 -Plant Biochemistry

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit- I** | **15** |
| **1.** | **Plant Water Relation:-** Introduction, Absorption of water-Mechanism, Theories (Active and Passive), Translocation of water- Mechanism, Theories (Root pressure, Capillary), Transpiration.<br>**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. | |
| **2.** | **Credit-II** | **15** |
| | **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.<br>**Introduction to Plant Hormones**<br>Biosynthesis of plant hormones- Auxin, Cytokinin, Gibberellin.<br>**Growth:-** Definition, phases of growth curve, Photoperiodism, Vernalisation. | |

**References:-**


1) Biochemistry- Lubert Stryer
2) Biochemistry- Nelson and Cox
3) Practical Biochemistry- Wilson and Walker
4) Fundamentals of Biochemistry – J. L. Jain
5) Principals of Biochemistry- Voet and Voet
6) Fundamentals of Plant Physiology- V. K.Jain

# DSC BTD4 Environmental Biotechnology

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit I** | |
| **1.** | **Water Pollution**<br>-Definition, Sources and Types-Physical, Chemical and Biological, Hardness [Mechanism, Determination, Types],Water softening methods [Clark's method, Use of cation and anion exchange resins], COD and BOD [Concept, Determination], Eutrophication (Concept, Types and Control), Purification of water (Physical Methods-UV Treatment, Distillation, Chemical Methods- Chlorination, Ozonization)<br>**Air Pollution**<br>-Definition, Sources, London and LA Smogs (Mechanisms of Formation), Greenhouse Effect (Concept, Reasons, Role of dipole moment of gaseous molecules), Ozone Depletion (Role of CFCs, Control), Instrumental analysis methods of $SO_2$, $NO_x$.<br>**Soil Pollution**<br>-Definition, Sources, Role of pesticide in soil pollution, control Measures.<br>**Environmental Toxicology**<br>Definition, classification and concept, Pesticide Toxicity – Classification (Organic and Inorganic), Mode of action of toxicants (Metals, organophosphates, carbamates and mutagens), Bioconcentration, Bioaccumulation, Biomagnification, Potentiation and Synergism, Control of Toxic effects- Biotransformation and excretion. | **15** |
| | **Credit II** | |
| **2.** | **Environmental quality Assessment and Monitoring**<br>Definition, Quality of environment for life on earth and man. Deterioration of environment quality, short term studies, rapid assessment, continuous-short and long term monitoring, Basic Concept of Environment Impact Assessment.<br>**Bioremediation Techniques**<br>-Definition, Principle, *Insitu and Exsitu* Bioremediation, Bioremediation of waste waters (MSW, BSW and ISW), Activated Sludge Process, Lagoons, Oxidation ponds, Trickling filter.<br>Solid Waste Treatment [Plastics and Aromatics], Slurry Phase Treatment, Agricultural Bioremediation- Microbial Composting, Biogas, Land, Farming and paste Control, Bioremediation of Industrial wastes, Xenobiotics, Bioaugmentation and Biofiltration. | **15** |

**References:-**


1. Applied and enviornmental Microbiology; Amann, R.I Stromely,J.Stahl.
2. Enviornmental Biotechnology. , Chattergy.
3. Enviornmental Biology,Verma Agerwal
4. Enviornmental pollution, Peavy and Rowe.
5. Enviornmental problems and solution., Asthana and Asthana.
6. Enviornmental Science., Saigo, Canninhham

# DSC BTD5 - Molecular Biology-II

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit I** | |
| **1.** | **Transcription in prokaryote and Eukaryote**<br>Mechanism of transcription-Enzyme involved, initiation, elongation and termination. Inhibitors of transcription , Post transcriptional modification, Transcriptional control by hormones.<br>**Genetic Code**<br>Properties of genetic code. Assignment of codons with Unknown sequences a) Polyuridylic b) Acid Copolymers method.<br>Assignment of codons with known sequences a) Binding technique b) Repetitive seq. technique.<br>Wobble Hypothesis, Variation in genetic code. | **15** |
| **2.** | **Translation in prokaryote and Eukaryote**<br>Structure and role of ribosome in translation, Amino acid t-RNA complex formation, Initiation, Elongation, termination of translation Inhibitors of translation.<br>Post- translation modifications (Protein folding, Removal of Leader sequences, Phosphorylation, glycosylation, acetylation).<br>**Regulation of gene expression in prokaryote and eukaryote.**<br>Regulation of gene expression in prokaryote a) Lac operon b) Tryptophan operon c) Arabinose operon.<br>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. | **15** |

**References:**


1) Molecular biology by Watson
2) Genetics by Strickberger
3) Molecular Biology by Glickpastornack
4) Molecular biolage Geralad Carph
5) Gene by Levin
6) Genome by T.A. Brown

# DSC BTD6 Animal Tissue Culture

| Topic No. | | Lectures 30 |
|---|---|---|
| | **Credit I** | |
| **1.** | **History and Introduction of Animal Cell culture**- History of animal cell culture<br>**Requirements of Animal cell culture-** Characteristics of animal cell in culture, substrate for cell growth, Equipment's required for animal cell culture (Laminar air flow, $CO_2$ incubator, Centrifuge, Inverted microscope)<br>**Culture media-** Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of media).<br>**Laboratory design and layout-**Construction and services, layout of aspetic room (sterile handling area, laminar air flow, service bench), incubation (incubators, hot room), preparation area (media preparation, washing area, storage).<br>**Cultured cells- Biology and Characterization-** Characteristics of cultured cells, cell adhesion, cell proliferation, cell differentiation, metabolism of cultured cells, Initiation of cell culture, Evolution and development of cell lines.<br>**Characterization of cultured cells-** Morphology of cells, species of origin of cells, Identification of tissue of origin, transformed cells, Identification of specific cell lines.<br>**Measurement of growth parameters of cultured cells-** Growth cycle of cultured cells, plating efficiency of cultured cells<br>**Cell synchronization-** Cell separation by physical means, cell separation by chemical blockade<br>**Senescence and apoptosis-** Cellular senescence, Measurement of senescence, Apoptosis, Measurement of apoptosis. | **15** |
| | **Credit II** | |
| **2.** | **Basic technique of mammalian cell culture-** Isolation of tissue, disaggregation of tissue, measurement of viability, primary cell culture, Cell lines, Maintainance of cell culture, Subculture, Stem cell cultures<br>**Scale up of Animal cell culture-**Scale up in suspension-stirrer culture, continuous flow culture, Airlift fermenter culture, Scale up in monolayer- Roller bottle culture, multisurface culture, multiarray disks and tubes, Microcarrier culture, Perfused monolayer culture.<br>**Contamination-** Concept and Sources of contamination, types of microbial contamination, eradication of contamination.<br>**Applications of cell culture-**In transplantation, and tissue engineering, monoclonal antibodies, culture based vaccine, valuable recombinant product, cloning, ethics and morality.<br>**Stem Cell technology:** General introduction and applications. | **15** |

**References:-**


1] Animal tissue culture- Paul
2] Culture of animal cell 3rd edition-R Ian Freshney
3] Animal cell culture- R.W.Masters
4] Animal biotechnology-M.M.Ranga
5] Animal biotechnology-R.Sasidhara

## DSC BT P5 Techniques in Molecular Biology

| Sr. No. | Name of the Practical |
|---|---|
| **Major Experiments** | |
| **1** | Eukaryotic DNA Isolation from - Plant Material and Animal Material. |
| **2** | DNA isolation from fungi. |
| **3** | Purification of DNA by silica membrane. |
| **4** | Plasmid isolation from *E. coli.* |
| **5** | Determination of Tm of DNA. |
| **6** | Isolation of RNA. |
| **7** | SDS-PAGE for separation of protein using CCB and Silver staining. |
| **Minor Experiments** | |
| **1** | Genomic DNA isolation from bacteria. |
| **2** | Agarose gel electrophoresis to separate DNA. |
| **3** | Agarose gel electrophoresis to separate RNA. |
| **4** | Restriction digestion of DNA. |

## DSC BT P6 Techniques in Metabolic Pathways

| Sr. No. | Name of the Practical |
|---|---|
| **Major Experiments** | |
| **1** | Estimation of fructose by Resorcinol method. |
| **2** | Estimation of DNA by Diphenylamine method. |
| **3** | Estimation of RNA by Orcinol Method. |
| **4** | Isolation of Amylase from germinating seed and determination of its activity. |
| **5** | Paper electrophoresis of Amino Acids. |
| **6** | Purification of proteins /enzymes by Ion exchange chromatography using DEAE Cellulose. |
| **Minor Experiments** | |
| **1** | Separation of Amino acids by TLC. |
| **2** | Separation of Biomolecules by Gel Filtration Chromatography. |
| **3** | Study of lipase activity. |
| **4** | Study of nitrate reductase activity. |
| **5** | Estimation of Indole-3 Acetic Acid by (Salkowaski reagent) Colorimetric method. |

## DSC BT P7 Techniques in Plant Tissue Culture

| Sr. No. | Name of the Practical |
|---|---|
| **1** | Laboratory Organizations & general techniques. |
| **Major Experiments** | |
| **1** | Preparation of M.S. stock solutions & medium . |
| **2** | Micropropagation stage I-Initiation of micropropagation of shoot tip. |
| **3** | Micropropagation stage I-Initiation of micropropagation of axillary bud. |
| **4** | Callus culture technique- Initiation of culture and study of callus morphology. |
| **Minor Experiments** | |
| **1** | Suspension culture technique-Initiation of culture. |
| **2** | Aseptic *in vitro* seed germination. |
| **3** | Embryo culture technique. |
| **4** | Anther Culture technique. |
| **5** | Micropropagation stage II- multiplication of culture. |
| **6** | Micropropagation stage III-Rooting- *in vitro* . |
| **7** | Micropropagation stage IV-Acclimatization & hardening. |
| | **Visit to commercial Plant Tissue Culture Laboratory** |

## DSC BT P8 Techniques in Genetics & Immunology

| Sr. No. | Name of the Practical |
|---|---|
| **Major Experiments** | |
| **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 vitamin $B_{12}$ requiring mutants by replica plate technique. |
| **4** | Transformation in *E. coli*. |
| **5** | Conjugation in *E. coli.* |
| **6** | U.V survival curve. |
| **7** | ELISA-dot ELISA. |
| **Minor Experiments** | |
| **1** | Radial immunodiffusion Assay. |
| **2** | Immunoelectrophoresis- (Qualitative ). |
| **3** | Double Immunodiffusion Technique (Qualitative). |
| **4** | Widal test – Qualitative and Quantitative. |
| **5** | RPR card test. |
| **6** | Problems based on Mendelian Inheritance, linkage and crossing over. |
| **7** | Study of meiotic abnormality in *Rhoeo.* |
| **8** | Study of karyotype by using photograph. |

## DSC BT P9 Techniques in Cell Biology

| Sr. No. | Name of the Practical |
|---|---|
| **Major Experiments** | |
| **1** | Isolation of chloroplast. |
| **2** | Isolation of nucleus. |
| **3** | Isolation of mitochondria. |
| **4** | Study of Meiosis. |
| **5** | Isolation of giant chromosomes using Drosophila / Chironomous larvae. |
| **Minor Experiments** | |
| **1** | Study of separation of chromosome by paradichlorobenzene (PDB). |
| **2** | Study of methodology of cell lyses. |
| **3** | Use of dialysis to separate smaller molecules than larger molecules. |
| **4** | Effect of temperature and organic solvent on membrane permeability of cells |
| **5** | Study of Mitosis. |
| **6** | Measurement of size of pollens/cell organelle/spores by micrometry. |
| **7** | Study of plasmolysis. |

## DSC BT P10 Techniques in Environmental Biotechnology

| Sr. No. | Name of the Practical |
|---|---|
| **Major Experiments** | |
| **1** | Estimation of COD of water sample. |
| **2** | Estimation of BOD of water sample. |
| **3** | 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. |
| **Minor Experiments** | |
| **1** | Determination of TDS of water sample. |
| **2** | Routine bacteriological analysis of water Presumptive, Confirmatory, Completed, MPN. |
| **3** | Determination of total and permanent hardness of water sample. |
| **4** | Isolation of microorganism from air by solid impaction technique. |
| **5** | Study of effect of heavy metal on growth of organisms. |
| | **Visit to ETP plant** |

**Nature of Question Paper**
**Theory-**

| | **Nature of Question Paper** | |
|---|---|---|
| **Q. No.1** | **Multiple choice based objective type.** | **8 Marks** |
| **Q. No. 2** | **Attempt any two of the following (out of three)** | **16 Marks** |
| **Q. No. 3** | **Attempt any four of the following (out of six)** | **16 Marks** |
| **Total** | | **40 marks** |

**Practical-**
**Annual Practical examination**

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.

B) The practical examination will be conducted on two (2) consecutive days for each practical not less than 5 hours on each day of the practical exanimation.

**Distribution of Marks for Practical Examination**

Major Experiment 20 Marks
Minor Experiment 10 Marks
Spotting 10 Marks (5 spots- each carry two marks)
Journal & Viva- 10 Marks
Total Marks- 50
Note- Experiments may be arranged as per convenience of the examioner.

## Equivalence of the CBCS and revised CBCS with MEME options as per NEP-2020 syllabus.

## B. Sc. Part II (Semester III)

| CBCS | | CBCS with MEME options as per NEP-2020 | |
|---|---|---|---|
| **Course code** | **Name of Course** | **Course code** | **Name of course** |
| **Semester III** | | **Semester III** | |
| **DSC BT 17** | Genetics | **DSC BT C1** | Genetics |
| **DSC BT 18** | Fundamentals of Biophysics | **DSC BT C2** | Fundamentals of Biophysics |
| **DSC BT 19** | Metabolic Pathways | **DSC BT C3** | Metabolic Pathways |
| **DSC BT 20** | Ecology | **DSC BT C4** | Enzymology |
| **DSC BT 21** | Molecular Biology-I | **DSC BT C5** | Molecular Biology-I |
| **DSC BT 22** | Plant Tissue Culture | **DSC BT C6** | Plant Tissue Culture |
| **AECC-C** | Environmental Studies ( Theory) | **AECC-C** | Environmental Studies ( Theory) |

## AECC – C:- Ability Enhancement Compulsory Course : Environmental Studies

## B. Sc. Part II (Semester IV)

| CBCS | | CBCS with MEME options as per NEP-2020 | |
|---|---|---|---|
| **Course code** | **Name of Course** | **Course code** | **Name of course** |
| **Semester IV** | | **Semester IV** | |
| **DSC BT 23** | Immunology | **DSC BT D1** | Immunology |
| **DSC BT 24** | Advances in Cell Biology | **DSC BT D2** | Advances in Cell Biology |
| **DSC BT 25** | Plant Biochemistry | **DSC BT D3** | Plant Biochemistry |
| **DSC BT 26** | Environmental Biotechnology | **DSC BT D4** | Environmental Biotechnology |
| **DSC BT 27** | Molecular Biology-II | **DSC BT D5** | Molecular Biology-II |
| **DSC BT 28** | Animal Tissue Culture | **DSC BT D6** | Animal Tissue Culture |
| **AECC-C** | Environmental Studies ( Project) | **AECC-D** | Environmental Studies ( Project) |

## AECC – C:- Ability Enhancement Compulsory Course : Environmental Studies

## Practicals (Annual Pattern)

| CBCS | | CBCS with MEME options as per NEP-2020 | |
|---|---|---|---|
| **DSC BTP 5** | Techniques in Genetics, Immunology and Cell Biology | **DSC BTP 8** | Techniques in Genetics, Immunology |
| | | **DSC BTP 9** | Techniques in Cell Biology |
| **DSC BTP 6** | Techniques in Molecular Biology and Metabolic Pathways | **DSC BTP 5** | Techniques in Molecular Biology |
| | | **DSC BTP 6** | Techniques in Metabolic Pathways |
| **DSC BTP 7** | Techniques in Plant Tissue Culture and Environmental Biotechnology | **DSC BTP 7** | Techniques in Plant Tissue Culture |
| | | **DSC BTP 10** | Techniques in Environmental Biotechnology |