SHIVAJI UNIVERSITY, KOLHAPUR.

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CHOICE BASED CREDIT SYSTEM

Syllabus For

Bachelor of Science Part - II

BIOTECHNOLOGY (ENTIRE)

SEMESTER III AND IV

(Syllabus to be implemented from June, 2019 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.

- Preamble :

  This syllabus is framed to give sound knowledge with understanding of Biotechnology to undergraduate students of B. Sc. Biotechnology Entire Program. Students learn Biotechnology as a separate course (subject) from B. Sc. II.

  The goal of the syllabus is to make the study of Biotechnology popular, interesting and encouraging students for higher studies including research.

- Structure of Program and List of Courses are as follows:

B.Sc Part II (Sem III and IV)

Course code	Name of Course	Course code	Name of course
Semester III		**Semester IV**	
DSC BT17	Genetics	**DSC BT23**	Immunology
DSC BT18	Fundamentals of Biophysics	**DSC BT24**	Advances in Cell Biology
DSC BT19	Metabolic Pathways	**DSC BT25**	Plant Biochemistry
DSC BT20	Ecology	**DSC BT26**	Environmental Biotechnology
DSC BT21	Molecular Biology-I	**DSC BT27**	Molecular Biology-II
DSC BT22	Plant Tissue Culture	**DSC BT28**	Animal Tissue Culture
AECC-C	Environmental Studies (Theory)	**AECC-D**	Environmental Studies (Project)

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

DSC BTP5	Techniques in Genetics, Immunology and Cell Biology	**DSC BTP7**	Techniques in Plant Tissue Culture and Environmental Biotechnology
DSC BTP6	Techniques in Molecular Biology and Metabolic Pathways		

DSC BT17- 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**

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 BT18- 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. **Atomic Absorption Spectroscopy:** Introduction, Principle, Instrumentation, Applications. **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. **Chromatography:** Introduction, Theory, Principle and applications of column chromatography, size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, HPLC, GLC. **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 BT19 - 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. **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. **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**.**	

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 BT20 - Ecology

Topic No.		Lectures 30
	Credit- I	
1.	**Ecosystem-** Concept, structure, function. **Productivity-** Kinds of productivity. **Food chain-** types of food chain, food web, concept of tropic level, **Ecological pyramids-** concepts and types. **Energy flow in ecosystem** –concept of energy, unit of energy, ecological energetics, laws governing energy transformation, ecological efficiency, Lindeman's atrophic dynamic concept. **Biogeochemical cycle** Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle **Biodiversity** Types of biodiversity, causes of loss of biodiversity, conservation of biodiversity, importance of biodiversity, Hot Spots.	**15**
	Credit-II	
2.	**Population Ecology-** Introduction, population characteristics, Natality, Mortality, survivor ship curves, age structure, age pyramid. **Population growth-** Exponential and logistic, r and k strategists. **Evolution :-** Theories of evolution-Lamarckism, Darwinism, Modern synthetic theory & mutational theory. Evidences of evolution and Adaptive radiation. Concept of species and speciation. Hardy-Weinberg law.	**15**

References:

1. Fundamentals of ecology ; E.P Odum.
2. Concept of ecology ; Dash.
3. Enviornmental Biology,Verma & Agarwal
4. Enviornmental Science., Saigo, Canninhham
5. General ecology., H.D.Kumar

DSC BT21 - Molecular Biology- 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., RNA As 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:-** De novo 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), Packaging of DNA (Nuclesome, Solenoid Model).	**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, hydroxyl amine, 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**

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 BT22 - Plant Tissue Culture

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

DSC BT23-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**

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 BT24- 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**

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 BT25 -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. **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. **Introduction to Plant Hormones** Biosynthesis of plant hormones- Auxin, Cytokinin, Gibberellin. **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 BT26 Environmental Biotechnology

Topic No.		Lectures 30
	Credit I	
1.	**Water Pollution** -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) **Air Pollution** -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. **Soil Pollution** -Definition, Sources, Role of pesticide in soil pollution, control Measures. **Environmental Toxicology** 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** 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. **Bioremediation Techniques** -Definition, Principle, *Insitu and Exsitu* Bioremediation, Bioremediation of waste waters (MSW, BSW and ISW), Activated Sludge Process, Lagoons, Oxidation ponds, Trickling filter. 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 BT27 - Molecular Biology-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.	**15**
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.	**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 BT28 Animal Tissue Culture

Topic No.		Lectures 30
	Credit I	
1.	**History and Introduction of Animal Cell culture**- History of animal cell culture **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) **Culture media-** Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of media). **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). **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. **Characterization of cultured cells-** Morphology of cells, species of origin of cells, Identification of tissue of origin, transformed cells, Identification of specific cell lines. **Measurement of growth parameters of cultured cells-** Growth cycle of cultured cells, plating efficiency of cultured cells **Cell synchronization-** Cell separation by physical means, cell separation by chemical blockade **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 **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. **Contamination-** Concept and Sources of contamination, types of microbial contamination, eradication of contamination. **Applications of cell culture-**In transplantation, and tissue engineering, monoclonal antibodies, culture based vaccine, valuable recombinant product, cloning, ethics and morality. **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 Genetics, Immunology and Cell Biology

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.
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 P6 Techniques in Molecular Biology and Metabolic Pathways

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.
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 and Environmental Biotechnology

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
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 (four options for each question be given)**	**10 Marks**
Q. No. 2	**Attempt any two of the following (out of three)**	**20 Marks**
Q. No. 3	**Attempt any four of the following (out of six)**	**20 Marks**
Total		**50 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.

DSC BT P5 (Techniques in Genetics, Immunology and Cell Biology) and DSC BT P6 (Techniques in Molecular Biology and Metabolic Pathways)

Q.1 Major Experiment 20 Marks
Q.2 Minor Experiment 10 Marks
Q.3 Spotting 10 Marks (5 spots- each carry two marks)
Based on Genetics, immunology (DSC BT P5)/ Molecular Biology (DSC BT P6)
Q.4 Major Experiment 20 Marks
Q.5 Minor Experiment 10 Marks
Q.6 Spotting 10 Marks (5 spots- each carry two marks)
Based on Cell Biology (DSC BT P5)/ Metabolic Pathways (DSC BT P6)
Q.7 Journal 10 Marks
Q.8 Viva-voce 10 Marks

DSC BT P7 Techniques in Plant Tissue Culture and Environmental Biotechnology

Q.1 Major Experiment 20 Marks
Q.2 Minor Experiment 10 Marks
Q.3 Spotting 10 Marks (5 spots- each carry two marks)
Based on Plant tissue culture
Q.4 Major Experiment 20 Marks
Q.5 Minor Experiment 10 Marks
Q.6 Spotting 10 Marks (5 spots- each carry two marks)
Based on Environmental Biotechnology
Q.7 Tour Report 10 Marks
Q.8 Journal 10 Marks