

PATNA UNIVERSITY

UGC Centre of Vocational Education

In

BIOTECHNOLOGY



Syllabus

**Deptt. of Botany
B.N. College,
Patna- 800 004**

COURSE CONTENTS

UGC Vocational Programme in Biotechnology

B.Sc. (HON'S.) PART-I

Paper-I

BIOCHEMISTRY

Nature of biological material	01
General Properties of organic and inorganic compounds.	03
Suitability of organic compounds for generation of structure, storage of energy and information	02
Hydrophilic and hydrophobic groups in biological molecules	01
Classification of biomolecules based on their role in bioprocesses	05
I. Molecules involved in generation of mechanical stability-peptidoglycans, polysaccharides and membrane lipids	
II. Molecules involved in information storage and retrieval-the nucleic acids	
III. Molecules executing mediator and catalytic functions-the proteins	
IV. The signal molecules	
Perspective of biological macromolecules: the repeating units in nucleic acids and proteins. Helicity, bending, looping, pleats, salt bridges etc. and their determinants. The basis for intermolecular interaction e.g., enzyme – substrate and antigen-antibody recognition.	04
Nature of biochemical reactions	05

underlying biosynthesis and degradation. Role of enzymes in such reactions. Protein and non-protein enzymes. Kinetics of enzyme catalysed reactions.

In vitro activity of purified enzymes and their applications in industry. Various uses of enzymes – enzymes in food processing, medicine, diagnostics and production of new compounds.

Enzymes as research tools-ELISA methods, modification of biological compounds with the help of enzymes.

Carbohydrate chemistry, Glycolysis, Tricarboxylic Acid Cycle.

Mitochondrial electron transport chain & oxidative phosphorylation

Gluconeogenesis

Glycogen metabolism

B-oxidation

Paper – II

MATHS AND COMPUTERS

The set theory properties of subsets	02
Linear and geometric functions	01
Limits of functions, derivatives of functions	02
The binomial theorem	01
Logarithm	02
Solution of Linear Equations	05
Differentiation	05

Matrices	10	chromatin, nucleosome organization; eu-and heterochromatin;	
Integration	05	special chromosomes (e.g., polytene and lampbrush	
Determinants	10	chromosomes); banding patterns in human chromosomes.	
Probability calculations	02	Structural and numerical aberrations involving chromosomes,	04
Methods of sampling, confidence level	01	evolution of wheat, cotton and rice; Hereditary defects	
Measurements of central tendencies	02	Kleintelter, Turner, Cri-du-Chat and Down's syndromes.	
Measurements of deviations	02	Mutations-spontaneous and induced; chemical and physical	03
Computers: General introduction to computers, organization	06	mutagens; induced mutations in plants, animals and microbes	
of computers, digital and analogue computers, computer		for economic benefit of men.	
algorithm.		Basic microbial genetics, conjugation, transduction,	04
Computers in on line monitoring and automation	02	transformation; isolation of auxotrophs, replica plating	
Application of computers in co-ordination of solute	02	techniques, analysis of mutations in biochemical pathways,	
concentration, P ^H and temperature etc. of a fermenter in		one gene-one enzyme hypothesis.	
operation.		Extrachromosomal inheritance, mitochondrial and chloroplast	02
Demonstration of the above utilities (alongwith the above	6Pds.	genetic systems.	
lectures).		Population genetics: Hardy-weinberg equilibrium, gene and	
		genotypic frequencies.	

Paper-III GENETICS

Mendelian laws of inheritance, gene interactions	02
Sex determination in plants and animals; sex-linkage; non-disjunction as a proof of chromosomal theory of inheritance.	03
Linkage; mapping genes; interference; coincidence in pro-and eukaryotes	03
Chromosomes: Chemical compositions; structural organization of chromatids, centromeres, telomeres,	04

Paper- IV CELL BIOLOGY

Development of microscopy (optical, TEM and SEM	03
Cell as a basic unit of living systems. The cell theory	01
Procellular evolution: artificial creation of "cells"	01
Broad classification of cell types: PPLO, Bacteria, eukaryotic microbes, plant and animal cells. A detailed classification of cell types within an organism. Cell, tissue, organ and organism	02

as different levels of organization of otherwise genetically similar cells.

Ecological amplitude of cells in high attitude, sediments, arctic, hot spring, arid, brackish and freshwater environments.	02
Biochemical composition of cells (protein, lipid, carbohydrate, nucleic acid and the metabolic pool)	01
Ultrastructure and function of the cell membrane	02
Structure and function of cell organelles; Golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes; cytoskeletal structure (actin, microtubules etc.), Mitochondria, chloroplasts, lysosomes, peroxisomes, nucleus (nuclear membrane, nucleoplasm, nucleolus chromatin).	12
Organization of chromosomes.	
Cell division and cell cycle (incl. Cell synchrony and its applications)	03
Cell-cell interaction	01
Cell locomotion (amoeboid, flagellar and ciliar). Structure & function Muscle and nerve cells.	02
Cell senescence and death	01
Cell differentiation in plants and animals	02

Paper-V MICROBIOLOGY

History & development of microbiology; scope of Microbiology.	02
Pasteur's experiments disproving spontaneous generation.	01
The concept of sterilization. Methods of sterilization (Dry heat, Wet heat, radiation, chemical and filtration etc.)	04
Classification of microorganisms.	
Concept of microbial species and strains, Serotypes.	03
Characteristic features of eubacteria, archaebacteria, cyanobacteria, protozoa & viruses.	04
Various forms of microorganisms-PPLOs, cocci, bacilli and spirilla.	01
Microbial genetics.	04
Nature of the microbial cell surfaces (Gram positive and Gram negative) ultra structure of flagella.	04
Prokaryotic and eukaryotic microbial cells.	03
Nutritional classification of microorganisms.	02
Microbes in extreme environments- the thermophiles and alkalophiles, archaic & cryogenic.	02
Pathogenic microorganisms. Defence mechanism against microorganisms (Non specific defence only)	06
Symbiosis and antibiosis among microbial populations.	02
N ₂ – fixing microbes in agriculture.	03
Microbial metabolism. Fermentation products. A survey of products from microorganisms. Strain improvement by enrichment, selection and recombinant DNA methods.	07
Production of heterologous proteins of interest in microorganisms, Antibiotic production.	

Paper- VI
BIOCHEMICAL TECHNIQUES (PRACTICAL)

Quantitative estimation of the following in biological samples

Sugar in given solutions	1x3 hrs
Sugar in biological samples	1x3 hrs
Extraction and separation of Lipids	2x3 hrs
Estimation of proteins	2x3 hrs
Estimation of DNA/DNA	2x3 hrs
Isolation and purification of proteins	10x3 hrs
Assays of enzyme activity	2x3 hrs
Kinetic studies on enzymes	5x3 hrs
Chromatographic methods for separation of macromolecules	5x3 hrs

Paper- VII
MICROBIOLOGICAL TECHNIQUES (PRACTICAL)

Aseptic techniques:

Cleaning of glassware	2x3 hrs.
Preparation of media, cotton plugging and sterilization	2x3 hrs.
Personal hygiene-Microbes from hands, tooth-scum and other body parts	2x3 hrs.
Isolation of microorganisms from air, water and soil samples.	
Dilution and pour plating. Colony purification.	2x3 hrs.

Enumeration of microorganisms. Total vs viable counts.	2x3 hrs.
Identification of isolated bacteria. Gram staining, other staining methods, metabolic characterization (e.g. IMViC test)	2x3 hrs.
Growth curve of microorganisms.	3x3 hrs.
Antibiotic sensitivity of microbes, use of antibiotic discs.	2x3 hrs.
Testing of water quality.	4x3 hrs.
Test for antibodies against given bacteria.	3x3 hrs.
One step growth of bacteriophage.	3x3 hrs.
Culture from body fluids (Stool, Urine, Blood)	2x3 hrs.
Alcoholic and mixed-acid fermentation.	2x3 hrs.

Paper-VIII
ON THE JOB TRAINING-PROJECT

The students should be assigned to assist a clinic (in a hospital), a fermentation plant, brewery or bakery and watch the various stages in brewing and baking and post fermentation processing. Prior arrangement must be made of the mode of interaction of the educational institution with the clinic and the industry.

B.SC. SUBSIDIARY

BOTANY

Part-I

In all **ten** questions are to be set, **two** from section **A**, three from section **B** and **five** from section **C**. Five questions are to be answered, selecting at least one from each section.

Section – A : Microbiology

1. Viruses – A General account
2. Bacteria – Structure, growth and reproduction
3. Economic importance of viruses and bacteria

Section – B : Cryptogams

Structure, life history, diagnostic features and economic importance of algae, fungi, lichens, bryophytes and pteridophytes based on the types wherever mentioned.

1. **Algae:** *Nostoc*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus* and *Batrachospermum*
2. **Fungi:** *Albugo*, *Peziza* and *Puccinia*
3. **Lichens:** A general account
4. **Bryophytes:** *Marchantia*, *Anthoceros* and *Sphagnum*
5. **Pteridophyta:** *Selaginella*, *Equisetum* and *Marsilea*

Section – C : Phanerogams

1. **Gymnosperms:** Morphology, Anatomy, and Reproduction of *Cycas* and *Pinus*.

2. Angiosperms:

(i) Taxonomy:

- (a) Classification of Angiosperms with reference to the systems of classification George Bentham and J.D.Hooker; Adolf Engler and Karl Prantl and John Hutchinson

- (b) Important rules of plant nomenclature.

Study of the diagnostic features and evolutionary relationships of the following families of Angiosperms:

- (a) Ranunculaceae (b) Euphorbiaceae (c) Cucurbitaceae (d) Apocynaceae (e) Acanthaceae (f) Lamiaceae (g) Amaranthaceae (h) Cyperaceae and (i) Poaceae

(ii) Anatomy:

- (a) Meristem
- (b) Initiation, activity and function of cambium
- (c) Anomalous secondary growth in *Boerhaavia*, *Tinospora* and *Dracaena*
- (d) Root – stem transition

(iii) Embryology:

- (a) Structure and development of anther, pollen grain, embryo sac, endosperm and embryo.
- (b) A general account of the process of fertilization
- (c) An elementary study of Experimental Embryology.

Practicals

Cryptogams and Phanerogams

1. Study of structural details of algae, fungi, bryophytes, pteridophytes and gymnosperms included in the syllabus with the help of temporary slide preparation. 8 marks
2. Description of an angiospermic plant belonging to a family prescribed in the syllabus and identification up to family level. 4 marks
3. Study of the primary and secondary (both normal and abnormal) structure of roots and stems of flowering plants. 3 marks
4. Spots 1 -5 5 marks
5. Practical records 5 marks

B.SC. SUBSIDIARY

CHEMISTRY

Part-I

There shall be three group: A (Physical) Group B (Organic) Group C (Inorganic) each carrying 25 marks each group shall contain four questions out of which two are to be answered. Six questions to be answered in all.

Group – A (Physical Chemistry)

1. **Gaseous state:** Kinetic theory of Gases postulates. Kinetic Gas Equation. Deduction of Gas laws from Kinetic Gas Equation, R.M.S. velocity, average velocity and Kinetic Energy of gas molecules. Deviation from ideal behaviour, Van der Waal's Equation of, state and its validity.
2. **Chemical equilibrium;** Law of Mass Action and its Kinetic derivation, Equilibrium constant for both symmetric and unsymmetric reactions, relation between K_p , K_c , and K_x Le chatelier's principle.
3. **Dilute solution;** Colligative properties: Osmosis and Osmotic pressure, lowering of vapour pressure, Elevation of boiling point of solutions, depression of freezing point of solution, experimental determination of colligative properties, related laws and applications. Abnormal colligative properties of solutions.

4. **Thermodynamic terms;** Works, Heat and Energy. The First law of thermodynamics, Enthalpy, Heat capacity C_p , C_v , Relation between C_p and C_v Adiabatic Changes in state, relation between P-V, V-T and P-T for adiabatic changes for ideal gases, work done in isothermal processes.
5. **Thermochemistry;** Hess's law, Kirchoff's law, various types of heats for reactions and Bond energies and their calculation, Bomb calorimeters and relation between Q_v and Q_p .

Group – B (Organic Chemistry)

1. (a) Shape and structures of organic compound. Tetravalency of Carbon; Hybridisation (sp^3 , sp^2 & sp) (b) Classification and nomenclature of organic compounds.
2. Elementary idea of electron displacement effects, electromeric effect.
3. Alcohols: Classification nomenclature, distinction between different types of alcohols Trihydric alcohols: Glycerol.
4. Aldehydes and ketones; General method of Preparation, properties, and distinction between aldehyde and ketone.
5. Carboxylic acids General method of preparation properties of monocarboxylic acids, their derivatives (ester, acid chloride, anhydride, amide, origin of basic properties and electronic nature of COOH group and its derivatives.
6. Amines: (i) Classification, (ii) Preparation, (iii) Properties, (iv) Separation, (v) Distinction, (vi) Origin of basic properties and effect on substituents.

Group – C (Inorganic Chemistry)

1. Atomic Structure: The components of atoms determination of e/m for electrons: Positive ray analysis; Isotope (detection separation and concept of atomic mass; results of Rutherford's alpha particle scattering; Moseley's findings on the relationship of x-rays with atomic numbers; Atomic spectra of Hydrogen atom: Bohr's theory and interpretation of atomic Spectra, Limitations of Bohr's Sommerfeld's model meaning of wave function, (ψ and ψ^2) Hydrogen atom orbitals, shape of orbitals, quantum number energy level diagram, Electronic configuration of elements.
2. Consequences of Electronic Structure of Elements Periodic table (s,p,d,f, block), Periodicity atomic structure ionization energy electron affinity; electronegativity oxidation.
3. Chemical Bonding:
 - (a) Ionic Bond, lattice energy, Born-Haber cycle: factors favouring ionic bonds, variable valency, properties of ionic compounds.
 - (b) Covalent Bond, overlapping of orbitals, formation of sigma and pi-bonds, Hybridisations, directional bonding (VSEPR) theory, structure and shape of simple molecules, properties of covalent molecules.
 - (c) Miscellaneous Hydrogen bonding van der Waals forces.
4. The chemistry of individual elements and their compounds Apart from the aspects mentioned below the studies of the elements (in the groups and periods) be made with reference to (i) electronic configuration, (ii) oxidation states and their

stabilities, (iii) acid-base character, (iv) general chemical reactions of the elements and their compounds, tests for ions and radicals formed by the elements and (v) shapes (VSEPR-theory) and structure of the covalent compounds formed by the elements, Group Zero (Noble gases, except Radon) Discovery. Fractional distillation of liquid air separation, coconut charcoal monoatomicity, Application, Compounds of Xenon (non detailed).

Group – I – Silver and Gold, Occurrence, metallurgy, properties and important compounds; comparative study of coinage metals, Hydrogen peroxide, preparation, properties, uses, structure and strength.

Group – II – General group properties of Gr.II and IIB Radium: Occurrence Isolation, properties, and uses.

Group – III – Boron preparation, properties and uses of B, B₂O₃, BC₃, Boric acids and borex, Diagonal relationship with silicon; Hydrides of boron (Non detailed).

B.Sc. BIOTECHNOLOGY (Hons) PART- I

Hons	I	Biochemistry	80 (Theory)	20 (Int. Assessment)
	II	Maths & Computer	80 (Theory)	20 (Int. Assessment)
	III	Genetics	80 (Theory)	20 (Int. Assessment)
	IV	Cell Biology	80 (Theory)	20 (Int. Assessment)
	V	Microbiology	80 (Theory)	20 (Int. Assessment)
	VI	Biochemical Techniques	75 (Practical)	
	VII	Microbiological Techniques	75 (Practical)	
	VIII	On The Job Training	50 (Project + Viva)	

Subs.		Botany	75 (Theory)	25 (Practical)
		Chemistry	75 (Theory)	25 (Practical)

B.Sc. BIOTECHNOLOGY (Hons)**PART- I**

Hons	I	Biochemistry	80 (Theory)	20 (Int. Assessment)
	II	Maths & Computer	80 (Theory)	20 (Int. Assessment)
	III	Genetics	80 (Theory)	20 (Int. Assessment)
	IV	Cell Biology	80 (Theory)	20 (Int. Assessment)
	V	Microbiology	80 (Theory)	20 (Int. Assessment)
	VI	Biochemical Techniques	75 (Practical)	
	VII	Microbiological Techniques	75 (Practical)	
	VIII	On The Job Training	50 (Project + Viva)	

Subs.	Botany		75 (Theory)	25 (Int. Assessment)
	Chemistry		75 (Theory)	25 (Int. Assessment)

Paper- IX
BIOPHYSICS

Energetics of a living body. Sources of heat limits to temperature. Heat dissipation and conservation.	02
Lambert-Beer law. Spectrophotometry and colorimetry	02
Primary events in photosynthesis.	
Strategies of light reception in microbes, plants and animals.	01
Vision faults & correction.	01
Electrical properties of biological compartments.	
Electricity as potential signal.	01
Generation and reception of sonic vibrations. Hearing aides.	02
Intra-and intermolecular interactions in biological systems.	02
Spatial and charge compatibility as determinant of such interactions.	
Physical methods applied to find out molecular structure X-ray crystallography and NMR.	05
General spectroscopy: UV-vis, fluorescence, atomic absorption, IR, Raman spectra.	05
Physical methods of imaging intact biological structures:	10
- Ultrasound	
- Optical filters	
- X-ray	
- CT scan	
- ECG	
- EEG	
- NMR imaging	
Centrifugation- Principles, instrumentation & applications.	05
Electrophoresis- Principles, instrumentation & applications.	05

Paper- X
MOLECULAR BIOLOGY

Molecular basis of life	02
Structure of DNA	01
DNA replication in prokaryotes and eukaryotes.	04
DNA recombination molecular mechanisms in prokaryotic and eukaryotic.	02
Insertion elements and transposons.	03
Structure of prokaryotic genes.	01
Prokaryotic transcription.	03
Prokaryotic translation.	03
Prokaryotic gene expression (lac, his, tri, catabolic repression).	10
Structure of eukaryotic genes.	02
Eukaryotic transcription.	02
Eukaryotic translation.	02
Eukaryotic gene expression transcription factors etc.	10
Gene expression in yeast.	02
Gene expression in protozoan parasites.	02
Gene organization and expression in mitochondria chloroplasts.	06
Post translational regulation of gene expression.	02
Development and environment regulation of gene expression.	03

Paper- XI IMMUNOLOGY

The Immune system and Immunity along with historical perspective.	02
The organs and the cells of the immune system and their function	06
Antigen; antibody, types, structure, distribution & functions.	04
Origin of diversity in the immune system.	02
Humoral and cell mediated immunity (role of MHC and genetic restriction)	07
Effector mechanisms.	04
Antigen-antibody interaction	05
Immunity to infectious diseases, vaccines (Traditional & new generation)	05

Paper- XII ANIMAL CELL CULTURE

History of development of cell cultures.	01
The natural surroundings of animal cells.	01
Metabolic capabilities of animal cells.	02
Simulating natural condition for growing animal cells.	01
Importance of growth factors of the serum Primary cultures,	01
Anchorage dependence of growth.	

Non-anchorage dependent cells.	01
Secondary cultures. Transformed animal cells- Established/continuous cell lines.	02
Characterization of lines	01
Commonly used animal cell lines- their origin and characteristics	02
Growth kinetics of cells in culture.	01
Cryopreservation	01
Applications of animal cell culture for studies on gene expression	01
Organ culture.	02
Transfection of animal cells: Selectable markers, HAT selection, antibiotic resistance etc.	02
Cell fusion	02
Transplantation of cultured cells	01
Differentiation of cells	02

Paper- XIII RECOMBINANT DNA TECHNOLOGY

What is gene cloning and why do we need to clone a gene?	02
Tools and core techniques in gene-manipulation, Enzyme and other reagents, techniques, laboratory requirements.	05
Safety measures and regulations for recombinant DNA work	01
Vectors: Plasmids, bacteriophages, phagemids, cosmids, viruses	04
Purification of DNA from bacterial, plant and animal cells.	03

DNA amplification using PCR; DNA sequencing.	02
Cloning strategies- construction of genomic libraries and CDNA libraries. Probe construction, recombinant selection & screening.	05
Introduction of DNA into living cells.	02
Cloning vectors for <u>E.coli</u> .	02
Cloning vectors for organisms other than <u>E.coli</u> yeast, fungi, agrobact, erium, plant and animal viruses.	02
Application of rDNA technology	07
In studying gene structure & expression	
In medicine (insulin, recombinant vaccine diagnostic reagents and other pharmaceutical compounds)	
In agriculture	

Paper-XIV

METHODS IN MOLECULAR AND CELLULAR BIOLOGY (PRACTICAL)

Cytological preparations:	
- Fixation, dehydration and Staining	3x3 hrs.
- Squash in stain	2x3 hrs.
- Embedding and sectioning	3x3 hrs.
Cell counting methods:	
- The haemocytometer and other aides	2x3 hrs.
Measurements with the help of light microscope	1x3 hrs.
- Calibration of ocular micrometer	1x3 hrs.
- Finding out average cell size	

- Chromosome lengths	1x3 hrs.
- Separation of cell types (from blood)	1x3 hrs.
Separation of cell organelles:	
- Methods for cell lysis: rupture/Osmotic/Chemical/Enzymatic lysis of cells followed by centrifugation.	2x3 hrs.
Monitoring cell lysis by release of cellular material and by change in light scattering etc.	
- Mechanical rupture of cells: Ultrasonic vibrations; French pressure followed by centrifugation for cell organelles.	2x3 hrs.
Extraction cellular materials	
- Extraction in saline buffers	2x3 hrs.
- Extraction in solvents	2x3 hrs.
- Precipitation from extracts	2x3 hrs.
Separation of the constituent molecules of the extract in aqueoust buffer	3x3 hrs.
- Gel filtration	2x3 hrs.
- Ion exchange chromatography	
Thin layer chromatography of extracted material	2x3 hrs.
Isolation of chromosomal and plasmid DNA from bacteria.	4x3 hrs.
Restriction digestion of DNA and assigning restriction sites (may be done as demonstration)	2x3 hrs.
Making competent <u>E. coli</u>	2x3 hrs.
Transfection of plasmid DNA and selection for transformants.	3x3 hrs.

Paper- XV

IMMUNOLOGICAL METHODS (PRACTICAL)

Purification of antigens	4x3 hrs.
Raising polyclonal antibodies	Spread over 8 weeks
Purification of antibodies	4x3 hrs.
Conjugation and labeling antibodies	2x3 hrs.
Enzyme-linked immunoassay	3x3 hrs.
Radioimmunoassay	3x3 hrs.
Radial immunodiffusion analysis	2x3 hrs.
Generation of ascitic fluid	3x3 hrs.
Diagnosis of an infectious disease by an immunoassay	3x3 hrs.

Paper- XVI

ON THE JOB TRAINING- PROJECT

This should be taken up during summer over a period of one month preferably in an immunology/virology institute or a laboratory using recombinant DNA methods.

Paper- XVII

ANIMAL CELL BIOTECHNOLOGY

General metabolism	02
(Insulin, Growth hormone, Interferon, t-plasminogen activator, factor VIII etc.)	03
Expressing cloned proteins in animal cells. Over production and processing of chosen protein	02
The need to express in animal cells	01
Production of monoclonal antibodies	02
Production of vaccines	
Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin etc.)	04
Bioreactors for large scale culture of cells.	04
Transplanting cultural cells.	01

Paper- XVIII

PLANT BIOTECHNOLOGY

Introduction to in vitro methods. Terms and definitions. Use of growth regulators	02
Beginning of in vitro culture in our country (ovary and ovule culture, in vitro pollination and fertilization)	01
Embryo culture, embryo rescue after wide hybridization, and its applications	01
Introduction to the processes of embryogenesis and organogenesis and their practical applications.	02

Clonal multiplication of elite species (Micropropagation)	02
axillary bud, shoot-tip and meristem culture.	
Haploid and their applications. Somaclonal variations and applications (Treasure your exceptions)	02
Endosperm culture and production of triploids	01
Practical applications of tissue and organ culture	01
(summarizing the practical application of all the above mentioned techniques)	
Single-cell suspension cultures and their applications in selection of variants/mutants with or without mutagen treatment (of haploid cultures preferably)	02
Introduction of protoplast isolation; principles and applications	01
Testing of viability of isolated protoplasts	01
Various steps in the regeneration of protoplasts	01
Somatic hybridization-an introduction.	02
Various methods for fusing protoplasts. Chemical, electrical	01
Use of markers for selection of hybrid cells	01
Practical applications of somatic hybridization (hybrids vs cybrids)	01
Use of plant cell, protoplasts and tissue culture for genetic manipulation of plants. Introduction to <u>A. Tumefaciens</u> .	02
Tumor formation on plants using <u>A. tumefaciens</u> (Monocots vs Dictos)	
Root-formation using A.rhizogenes	01
Practical application of genetic transformation.	01

Paper-XIX ENVIRONMENTAL BIOTECHNOLOGY

Renewable and non-renewable resources	02
Conventional fuels and their environmental impacts:	03
- Firewood	
- Plant and animal wastes	
- Coal	
- Gas	
- Animal oils	
- Petroleum	
Modern fuels and their environmental impacts	08
- Methogenic bacteria and biogas	
- Microbial hydrogen production	
- Conversion of sugars to ethanol. The gasohol experiment.	
- Solar energy converters- Hopes from the photosynthetic pigments	
- Plant based petroleum industry?	
- Biomass production & Cellulose degradation for combustible fuel	
Microbiological quality of food and water, Environmental monitoring (Physical & Chemical), biological analysis; Biosensors.	06
Treatment of municipal waste (solid & liquid)	03
Treatment of industrial effluents	03

Degradation of pesticides and other toxic chemicals by microorganisms & plants.	04
Thuringiensis toxin as a natural pesticide	01
Biological control of insects & pathogens	02
Enrichment of ores by microorganisms	02
Nitrogen fixing microorganisms enrich the soil with assimilable nitrogen.	03
Biofertilizers- classification, production & applications.	

Paper- XXI

PROJECT WORK

The students will be assigned to generate data on certain research projects and/or compile available information from literature on a given topic of biotechnological relevants. The project work will span over a period one semester under the supervision of chosen faculty member.

Paper-XX

CULTURE METHODS (PRACTICAL)

Configuration of a good TC Lab, Good Lab Practice	
Initiating plant tissue, culture: (dedifferentiation of explants)	6x3 hrs.
Growth of plant cells into undifferentiated mass	6x3 hrs.
Large scale cultivation of plant cells in suspension	4x3 hrs.

Induction of differentiation by modulating the hormonal balance	6x3 hrs.
Culture of lymphocytes from blood samples. Preparation of media, Filter sterilization, monitoring microbial contamination (bacteria, fungi and mycoplasma)	4x3 hrs.
Cloning of animal cells by cell and colony purification.	
Fusion of cultured cells with myeloma cells	8x3 hrs.
Production of monoclonal antibodies at a large scale	6x3 hrs.
Demonstration/operation of large scale fermenters	6x3 hrs.

Paper- XXII

ENTREPRENEURSHIP

The students will be delivered lecture on how to select for a product line, design and develop processes, economies on material & energy requirement, stock the product and release the same for marketing etc. The basic regulations of excise also should be aprised to the candidates. In parallel the students will be asked to survey the demand for a given product, feasibility of its production under the given constraints of raw material energy input financial situations export potential etc. Procedural details on how to select process, how to move for loans, how to operate and how to repay the loans in a phasic manner should also be highlighted during the lectures. The semester should end with submission of a draft project by the students.