B.Sc. Bio - Technology (Hons.)

T. M. B. U. Bhagalpur

Syllabus

(UGC approved & sponsored vocational course)

Prepared by. Co-ordinators
Of. T.N.B & Marwari College Bhagalpur.

T.N.B. College, Bhagalpur

and approved by Academic Council Senate & Syndicate in 2007

(NAAC Accredited & Acclaimed as B^{++})

T.M.Bhagalpur University,

Bhagalpur - 812007

(Bihar)

Courses of Study
Part-I,

Paper-I
Bio-chemistry

General properties of Bio- Organic and In- Organic compounds.	03
Suitability of Bio-Organic Compounds for generation of structure, storage of energy and information.	02
Enzymes – Nature, Protein and Non- Protein enzymes, classification, properties. Factors mode of actions and kinetics. Co-enzymes and Isozymes, immobilisation of enzymes. use of enzymes in Industries. Food processing Medicines. Production of new compounds.	06
Classification of Biomolecule based on their role in Bio- Processes. Structure, Classification, important of carbohydrate Peptidoglycans and their role in basic metabolism, photosynthesis , photorespiration and respiration.	05
Lipid – structure and classification , Bio synthesis and Oxidation.	02
Protein- Structure and classification , Bio synthesis and degradation. The signal molecules.	02
Nucleic Acids- Structure , helicity , bendin, looping salt bridge etc. type of Nucleic acids, DNA repairing, DNA replication, transcription and translation.	06
Immuno Biotechnology Antigen- Antibody reaction ELISA method.	03

Paper-II
Cell Biology

Cell as a basic unit of living systems. The cell theory	02
Precellular evolution: artificial creation of "cells"	01
Broad classification of cell types: bacteria, eukaryotic microbes, plant and animal cells. A detailed classification of cell types within an organism. Cell, tissue, organ and organism as different levels of organization of otherwise genetically similar cells.	02
Ecological amplitude of cells in high altitude, sediments, arctic, hotspring, arid, brackish and freshwater environments	02
Biochemical composition of cells (Proteins, lipids, carbohydrates, nucleic acids and the metabolic pool)	01
Ultrastructure of the cell membrane Structure and function of cell organelles;	02
Ultrastructure of cell membrane, cytosol, Golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes; cytoskeletal structures (actin, mirotubules etc.). Mitchochondria, chloroplasts, lysosomes, peroxysomes, nucleus (nuclear membrane, nucleoplasm, nucleoulus chromatin).	12
Cell division and cell cycle (including, cell synchrony and its applications.)	03
Cell-cell interaction	01
Cell locomotion (amoeboid, flagellar and ciliar. Muscular and nerve cells.	02
Cell senescence and cell death	01
Cell differentiation in plants and animals	

MATHEMATICS

02

The Set Theory
Basic Definition of sets and its types , Union of sets and its properties. inter section of sets and its properties, compliment of sets and its properties. Construction of subsets and power of sets. Vann Diagram.

01

Linear and Quadratic functions.
Definition of linear and quadratic functions with suitable examples.

02

Limits of Function and derivatives of functions.
Limits of function in the form of (0/0) (∞/∞) ∞-∞ in a case of algebraic trigonometric and logarithmic function, Derivate at a point (i.e. left hand derivative and right hand derivative).

01

The Binomial Theorem.
Definition of binomial theorem (without proof) for positive integral index and its properties elementary problem based on its expansion.

02

Logarithm-
Definition of logarithm , log(m.n) = logm+ logn. Log(m/n) = log m – logn . $\log m^n = n \log m$. Change of base, concept of characteristic and mentria, sums based on logaritham calculation

05

Differentiation –
Definition of differentiation (i.e ab initio), fundamental rules of differentiation dy/dx of function, dy/dx of function of functions, logarithm, implicit and parametric function (applications of dy/dx).

05

Integration –
Integration is a inverse process of differntition and dedaction of formula of different types of functions, fundamental ruled of integration, integration by transformation integration by substitution, integration by parts.

Probability calculations –
Random experiment, Sample space & events Classical definition of probability, Probability of an event, Axioms of probability, Theorems on probability (without proof), Conditional probability, Independence of events.

Methods of sampling – Confidence level.

Measurement of central tendency, Requirements of a good statistical average. Arithmetic mean & its properties , Median & its properties , Mode & its properties. Harmonic mean, Geometric mean , Graphical representation of median & mode.

Measurement of deviation Concept of deviation, Requirements of a good measure of deviation Range, Mean deviation & its property, Standard deviation & its properties, Co-efficient of range. Co-efficient of mean deviation, Co-efficient of variation & its application.

COMPUTER

General Introduction to Computer. 01
Organization of computer using block diagram. 01
Digital and Analogue Computer 01
Computer Algorithm 01
Computer in Online Monitoring and Automation. 01
Application in solute concentration measurement, pH value calculation, variation with temperature in fermentation operation etc. 01
Demonstration of the above Utilities on Computer. 01

Energetics of a living body. Sources of heat limits to temperature. Heat dissipation and conservation.

Lambert-Beer Law. Spectrophotometry and colorimetry. Primary events in photosynthesis

Strategies of light reception in microbes, plants and animals

Correction of vision faults

Electrical properties of biological compartments. Electricity as a potential signal

Generation and reception of sonic vibrations. Hearing aides

Intra and intermolecular interactions in biological systems. Spatial and charge compatibility as determinant of such interactions

Physical methods applied to find out molecular structure

- X-ray crystallography and NMR

General spectroscopy – UV-*vis*, fluorescence, atomic absorption, IR, Raman spectra

Physical methods of imaging intact biological structures:

- Ultrasound
- Optical filters
- X-ray
- Cat Scan
- ECG
- EEG
- NMR imaging

Paper-V
Microbiology

Development of microscopy (optical, TEM and SEM).	01
Pasteur's experiments disproving spontaneous generation	01
The concept of sterilization. Methods of sterilization (Dry heat, wet heat, Radiation, Chemical and Filtration etc.)	02
Concept of microbial species and strains	01
The various forms of microorganisms – PPLOs, cocci, bacilli and spirilla	01
Genetic homogeneity in clonal populations	01
Spontaneous and induced variation arising in microbial population	04
Gene transfer in microorganisms	03
Nature of the microbial cell surface. Gram positive and gram negative bacteria. Kinds of flagella. Serotypes	02
Prokaryatic and eukaryotic microbial cells	02
Nutritional classification of microorganisms	01
Microbes in extreme environments – the thermophiles and alkalophiles	01
Pathogenic microorganisms. Defence mechanism against microorganism	02
Symbiosis and antibiosis among microbial populations	02
N_2 – fixing microbes in agriculture	02
Microbial metabolism.- Fermentation products, A survey of products from microorganisms. Strain improvement by enrichment, selection and recombinant DNA methods. Production of heterologous proteins of interest in microorganisms	04

Practical
Biochemical Techniques

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 pf proteins	2x3 hrs
Estimation of DNA/RNA	2x3 hrs
Isolation and purification of proteins	10x3 hrs
Assay of enzymes activity	2x3 hrs
Kinetic Studies on enzymes	5x3 hrs
Chromatographic methods for separation of macromolecules	5x3 hrs

Practical
Microbiological Techniques

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

On the Job Training

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

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Part-II,

Paper-VI
Molecular Biology

Molecular Basis of life	02
Structure of DNA	01
DNA replication both prokaryotes and eukaryotes	04
DNA recombination molecular mechanisms 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, trp, 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 on protozoan parasites	02
Gene organization and expression in mitochondria chloroplasts	06
Post translation regulation of gene expression	02
Development and environmental regulation of gene expression	03

Paper-VII
Recombinent DNA Technology

What is gene cloning and why do we need to clone a gene? 02

Tools and techniques plasmids and other vehicles genomic DNA, handling of DNA RNA CDNA, RT enzymes and other reagents techniques, laboratory requirement. Safety measures and regulations for recombinant DNA work

Choice and selection of the tools and the techniques (including Gel electrophoresis) 02

Vehicles: Plasmids and bacteriophages, available phagemids, cosmids, viruses 04

Purification of DNA from bacterial, plant and animal cells 02

Manipulation of purified DNA 03

Introduction of DNA intro living cells 02

Cloning vectors for *E. Coli* 02

Cloning vectors for organisms other than E. coli yeast, fungi, plants-agrobact, plantvirus animal viruses 02

Application of cloning in gene analysis 03

- How to obtain a clone of a specific gene
- Studying gene location and structure
- Studying gene expression

Gene cloning and expression of foreign genes in research and biotechnology 03

- Production of protein from cloned genes

Gene cloning in medicine

- Pharmaceutical compounds , Artificial insulin gene, Recombinant vaccine, Diagnostic reagents

Nature of genetic material: nucleic acids, DNA replication	0
Mendelian laws of inheritance, gene interactions	0
Sex determination in plants and animals; sex-linkage, non-disjunction as a proof of chromosomal theory of inheritance	0
Linkage, mapping genes; interference; coincidence in pro- and eukaryotes	0
Chromosomes: chemical composition; structural organization of chromatids, centromeres, telomeres, chromatin, nucleosome organization, eu- and heterochromatin; special chromosomes (e.g., polytene and lampbrush chromosomes); banding patterns in human chromosomes	0
Structural and numerical aberrations involving chromosomes; evolution of wheat, cotton and rice; Hereditary defects – Kleinefelter, Turner, Cri-du-chat and Down syndromes	0
Mutations – spontaneous and induced; chemical and physical mutagens, induced mutations in plants, animals and microbes for enonomic benefit of man	0
Basic microbial genetics, conjugation, transduction, transformation; isolation of auxotrophs, replicaplating techniques, analysis of mutations in biochemical pathways, one gene- one enzyme hypothesis	04
Extrachromosomal inheritance, mitochondrial and chloroplast genetic systems	02
Population genetics: Hardy-weinberg equilibrium, gene and genotypic frequencies	02

Paper-IX
Immunology

The Immune system and Immunity along with historical perspective	02
Antigen-antibody and their structure	03
The organs and the cells of the immune system their function	06
Antigen-antibody Interaction	03
Humoral and cell mediated immunity role of MHC and genetic restriction)	06
Origin of diversity in the immune system	02
Effector mechanisms	04
Immunity to infectious diseases, vaccines	04

Paper-X
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	01
Primary cultures. Anchorage dependence of growth Non-anchorage dependent cells	01
Secondary cultures. Transformed animal cells – Established/ continous cell lines	02
Commonly used animal cell lines – their origin and characteristics	02
Growth kinetics of cells in culture	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
Transplantation of cultured cells	01
Differentiation of cells	02
Cell fusion.	

Cytological preparations.	
• Fixation, dehydration and staining	3x3 hrs
• Squash in stain	2x3 hrs
• Embedding and sectioning	3x3 hrs
Cell Counting methods:	
• **The heamacytometer and other aides**	2x3 hrs
Measurements with the help of light microscope	
• **Calibration of ocular micrometer**	1x3 hrs
• **Finding out average cell size**	1x3 hrs
• **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 release of cellular material and by change in light scattering etc**	2x3 hrs
• **Mechanical rupture of cells: Ultrasonic vibrations; French pressure cell followed by centrifugation for cell organelles**	2x3 hrs
Extraction of 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 aqueous buffer	
• Gel filtration	3x3 hrs
• Ion filtration	2x3 hrs
Thin layer chromatography of extracted material	2x3 hrs
Isolation of chromosomal and plasmid DNA from bacteria	4x3 hrs
Restiction digestion of DNA and assigning restriction sites (may be done as a demonstration)	2x3 hrs
Making competent *E. coli*	2x3 hrs
Transfection of Plasmid DNA and selection for transformants	3x3 hrs

Practical
Immunological Methods

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

On the Job Training

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

Courses of Study
Part-III,

Paper-XI
Plant Biotechnology

Introduction to in Vitro methods. Terms and definitions. Use of growth regulators	02
Beginning of in vitro-cultures in our country (ovary and ovula 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 clite species (Micropropagation) exillary bud, shoot-tip and meristem culture	02
Haploids 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 (summarizing the practical applications of all the above mentioned techniques)	01
Single-cell suspension cultures and their applications in selection of variants / mutants with or without mutagen treatment (of haploid cultures preferably)	01
Introduction to 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 plansts.	
Introduction to *A. tumefacions*	02
Tumor formation of plants using *A. tumefaciens* (Monocots vs Dicots)	01
Root-formation using *A. rhizogenes*	01
Practical application of genetic transformation	01

Paper-XII
Animal Biotechnology

General metabolism	02
Special secondary metabolites / products (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 vaccines in animal cells	01
Production of monoclonal antibodies	02
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 cultured cells	01

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Renewable and non-renewable resources 02

What is renewable should be bioassimilable/biodegradable 02

Major consumer items: Food, fuel and fibres 01

Conventional fuels and their environmental impacts: 02
- Firewood
- Plant and animal wastes
- Coal
- Gas
- Animal oils

Modern fuels and their environmental impacts: 05
- Methogenic bacteria and biogas
- Microbial hydrogen production
- Conversion of sugars to ethanol. The gasohol experiment
- Solar energy converters – Hopes from the photosynthesis pigments
- Plants based petroleum for combustible fuel

Biojtechnological inputs in producing good quality natural fibres 03
- Transgenic sheep and transgenic plants

Microbiological quality of food and water 02

Treatment of municipal waste and industrial effluents 03

Degradation of pesticides and other toxic chemicals by microorganisms. 02

Thuringiensis toxin as a natural pesticide 01

Biological control of other insects swarming the agricultural fields 02

Enrichment of ores by microorganisms 02

Biofertilizers. Nitrogen fixing microorganisms enrich the soil with assimiable nitrogen 03

Practical
Culture Methods

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) 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

Project Work

The students will be assigned to generate data on certained 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.

Entrepreneurship

The students will be delivered lectures on how to select for a product line, design and develop processes economies on material and energy requirement, stock the product and release the same for marketing etc. The basic regulations of excise also should be aprise 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.

Coding Structure of B.Sc. Biotechnology (Hons.)

Part- I

		Marks.			
		Written	Internal Assessment	Total Marks	Duration o Examinati
Paper		**80**	**20**	**100**	**3 Hrs.**
Th-I	Bio- Chemistry	80	20	100	3 Hrs.
Th- II	Cell – Biology	80	20	100	3 Hrs.
Th- III	Math & Computer	80	20	100	3 Hrs.
Th- IV	Bio- Physics	80	20	100	3 Hrs.
Th- V	Microbiology	80	20	100	3 Hrs.
Practical	**Based on Th -I &V**			100	6 Hrs.
				Total 600	
On the Job Training (Reports to be compiled)					

Part- II

		Marks.			
		Written	Internal Assessment	Total Marks	Duration o Examinati
Paper		**80**	**20**	**100**	**3 Hrs.**
Th-VI	Molecular Biology	80	20	100	3 Hrs.
Th- VII	Recom DNA Tech.	80	20	100	3 Hrs.
Th- VIII	Genetics	80	20	100	3 Hrs.
Th- IX	Immunology	80	20	100	3 Hrs.
Th- X	Animal Cell Culture	80	20	100	3 Hrs.
Practical	**Based on Th- VI & IX**			100	6 Hrs.
				Total 600	
On the Job Training (Reports to be compiled)					

Part- III

		Marks.			
		Written	Internal Assessment	Total Marks	Duration o Examinati
Paper		**80**	**20**	**100**	**3 Hrs.**
Th-XI	Plant- Biotechnology	80	20	100	3 Hrs.
Th- XII	Animal Biotechnology	80	20	100	3 Hrs.
Th- XIII	Environmental Biotech.	80	20	100	3 Hrs.
Practical	**Culture methods**			100	6 Hrs.
Project work Under Supervision of Chosen Faculty				**100**	
Entrepreneurship Theory & Practice in project draft				**50**	
On the Job Training Report Part – I				**25**	
On the Job Training Report Part – II				**25**	
				Total 600	

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