RANCHI WOMEN'S COLLEGE
RANCHI
(AN AUTONOMOUS COLLEGE)
Constituent unit of Ranchi University, Ranchi

CHOICE BASED CREDIT SYSTEM
Course of Study
For
B. Sc. BIOTECHNOLOGY HONOURS

2021 onwards

Syllabus Revised by Board of Studies in Biotechnology
Ranchi Women's College, Ranchi
(w.e.f.2021 Onwards)

S.N.		Name of Members		Signature
1	Co-ordinator, Department of Biotechnology	Dr. Shalini Mehta	Chairperson Cum convener	
2	Faculty	Dr. Aruna Singh	Member	
		Dr. Supriya Shrivastava	Member	
		Dr. Soma Roy	Member	
		Mrs. Shalini Jane Mundu	Member	
3	Expert From Outside College	Dr. Biplab Sarkar, Scientist (Nanotechnology) ICAR-Indian Institute of Agriculture Biotechnology, Namkum, Ranchi	Subject Expert	
		Prof. Dr.Ramesh Chandra Department of Biotechnology BIT, Mesra	Subject Expert	
4	University Nominee	Dr. Madhulika Singh Associate Professor Department of Botany St-Xavier's College, Ranchi	Vice chancellor Nominee	
5	Representative from Industry/ Allied Field	Rajasekaran General Manager I/C, Environmental Engineering Section, Mecon Limited, Vivekanand Path, Doranda Ranchi	Member	
6	Meritorious Student	Gyanda Kumari	UG Topper (Session: 2018-2021)	

Dr. Shalini Mehta
Co-ordinator,
Department of Biotechnology

CHAIRPERSON
ACADEMIC COUNCIL
RANCHI WOMEN'S COLLEGE

Member Secretary
Academic Council
Ranchi Women's College

B.Sc. Biotechnology

Course Outcome

- The *First-year* of the course (two semesters) is the foundation year wherein interdisciplinary approach is implied to gain basic and applied knowledge. Courses like Fundamentals of Chemistry, Zoology/Botany, Cell biology, Biochemistry Microbiology, are included in curriculum for better co-relation of inter-disciplinary knowledge domain for enhanced adaptation to various basic courses.
- The *Second-year* course (two semesters) will help students to develop the ability to integrate the living system and indulge towards the study at Cellular, Molecular, Genetic and Metabolic levels. The students will learn integrating and correlating between the subjects.
- The *Third-year* course (two semesters) will help the students to develop the scientific knowledge in the area of Molecular and Cell biology to Recombinant Biotechnology, from Plant and Animal sciences to Plant and Animal Tissue Culture, from environmental biology to biodiversity, from microbiology to bioprocess engineering.
- The students will be familiar with handling of instrumentation, Good Laboratory Practices and biosafety.
- Theory supplemented with extensive practical skill will help the students to acquire a better knowledge related to subjects and prepare them for their Post graduations.
- Forms an interdisciplinary approach by combining basic sciences with the advanced technology.

Programme Specific Outcome

- Comprehend and integrate theoretical and practical skills in basic and applied disciplines of biotechnology.
- Developing a deep-rooted foundation at cellular, molecular, genetic and metabolic level.
- Making the agricultural practices easier through Plant tissue culture and Recombinant DNA technology.
- Knowledge of Biomolecules, their formation and interaction.
- Studying about Microorganisms, animal and plant strain improvement for industrial applications.
- Able to design new biotechnological products and processes by applying knowledge of different disciplines of biotechnology in an integrated manner.

Sem	Core course	AECC	SEC	DSE	GE
I	C1- Biochemistry and Metabolism C2- Cell Biology **Practical based on C1 & C2**	English / MIL			GE1- Chemistry(Compulsory) GE2- Zoology / Botany
II	C3- General Microbiology C4- Genetics Practical based on C3 & C4	Environmental Science			GE- Chemistry(Compulsory) GE-Zoology / Botany
III	C5- Plant Physiology **C6- Mammalian Physiology** **C7- IPR , Bioethics & Biosafety** Practical based on C5 , C6 & C7		SEC1- Enzymology		GE- Chemistry(Compulsory GE-Zoology / Botany
IV	C8- Molecular Biology C9- Immunology **C10- Entrepreneurship Development** Practical based on C8 , C9 & C10		SEC2- Molecular Diagnostics		GE- Chemistry(Compulsory GE-Zoology / Botany
V	C11- Bioanalytical Tools And Techniques C12- Recombinant DNA Technology Practical based on C11 & C12			DSE1- Animal Biotechnology DSE2- Plant Biotechnology	
VI	C13- Bioprocess Technology C14- Genomics and Proteomics Practical Based on C13 & C14			DSE3- Bioinformatics and Biostatistics DSE4- Environmental Biotechnology	

Abbreviations : CC- Core Course, AECC- Ability Enhancement Compulsory Course , Sec – Skill Enhancement Course , DSE- Discipline Specific Elective , GE- General Elective

Total Marks : 1400+ 1200 = 2600

COURSE INFORMATION SHEET

Sem	Core Course	AECC	SEC	DSE	GE
I	C1-[MT15+ET60=75] 4 credits C2--[MT15+ET60=75] 4 credits Practical on [C1 & C2=50] 4 credits	English/MIL =100 2 credits			GE-1- T 70+P30 GE 2- T70+P30
II	C3--[MT15+ET60=75] 4 credits C4- -[MT15+ET60=75] 4 credits Practical on[C3 & C4=50] 4 credits	Environmental Science =100 2 credits			GE-1- T 70+P30 GE 2- T70+P30
III	C5- [MT15+ET60=75] 4 credit C6--[MT15+ET60=75] 4 credits C7- -[MT15+ET60=75] 4 credits Practical on [C5+C6+C7=75] 6 credits		SEC1- Enzymology 100 = 75+25 2 credits		GE-1- T 70+P30 GE 2- T70+P30
IV	C8- -[MT15+ET60=75] 4 credits C9--[MT15+ET60=75] 4 credits C10--[MT15+ET60=75] 4 credits Practical on[C8+C9+C10=75] 6 credits		SEC2 Molecular Diagnostics 100=75+25 2 credits		GE-1- T 70+P30 GE 2- T70+P30
V	C11--[MT15+ET60=75] 4 credits C12--[MT15+ET60=75] 4 credits Practical on [C11 + C12-50] 4 credits			DSE1- Animal Biotechnology -[MT15+ET60=75] 4 credits DSE2- - Plant Biotechnology [MT15+ET60=75] 4 credits Practical on[DSE1+E2=50] 4 credits	
VI	C13--[MT15+ET60=75] 4 credits C14--[MT15+ET60=75] 4 credits Practical on [C13 + C14=50] 4 credits			DSE3 Bioinformatics and Biostatistics - [MT15+ET60=75] 4 credits DSE 4- IV - Environmental Biotechnology [MT15+ET60=75] 4 credits Practical on[DSE3+E4=50] 4 credits	

SEMESTER -1

Core-1 –Biochemistry and Metabolism
Credits-Theory-4, Practical-2
Theory –Lectures 60

Full Marks = 60 (ESE) **Pass Marks: 24**

Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section:A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section:B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section:C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

After the completion of this course, students should be able to:

- Explain the structure- function relationship of Biomolecules.
- Demonstrate an understanding of Carbohydrate, Protein, Lipid and Nucleic acid metabolism.
- Distinguish between different metabolic processes and their impact in metabolism of biomolecules.
- Select particular metabolic pathway involved in Carbohydrate, Protein & Fat related metabolic issues.

UNIT I **(10 Periods)**

Water: Structure and Properties. Water as a Biological Solvent
Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions
Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins. Denaturation and renaturation of proteins. Fibrous and globular proteins.

UNIT II **(10 Periods)**

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT III **(20 Periods)**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, Enzyme Catalysis, Enzyme Inhibition, Enzyme Kinetics. Factors Affecting Enzyme Action, Specific Activity, common features of active sites, enzyme specificity: types & theories.

Role of NAD, NADP, FMN/FAD, Coenzymes, Thiamine pyrophosphate, Pyridoxal phosphate, Lipoic acid, Biotin Vitamin B12, Tetrahydrofolate and metallic ion.

UNIT IV **(20 Periods)**

Metabolism: Carbohydrate Metabolism: Glycolysis, Fate of pyruvate under aerobic and anaerobic conditions. TCA Cycle, Electron transport Chain, Oxidative Phosphorylation. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and Glycogen synthesis.

Lipid metabolism: ß-oxidation of fatty acids.

Protein Metabolism Transamination, Deamination, Urea Cycle.

PRACTICALS

1. Preparation of buffers: Acetate and Phosphate Buffer
2. Principles of Colorimetry: Verification of Beer's law, To study relation between absorbance and % transmission
3. Estimation of Sugar, Protein and RNA
4. Estimation of blood glucose by glucose oxidase method.
5. Separation of Amino acids by paper chromatography.

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Satyanarayan, U , Biochemistry, Latest addition
5. Lippincott's Biochemistry 7th edition, ISBN- 9351297942

SEMESTER-1
Core -2- CELL BIOLOGY
Credits-Theory-4, Practical-2 Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers.
Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

At the end of course, the student should be able to,

- Comprehend the cellular architecture with the fine details of various intracellular organelles.
- Apply knowledge of cell biology in various cellular functions, the application and research involved in functioning of the different cell organelles.
- Interpret molecular mechanism involved at various stages of cell cycle and its regulation.
- To know various signal molecules & signaling pathways.
- Identify, formulate & solve problems arisen due to the insufficient functioning of the various life processes like cell-cell communication, cell cycle regulation, movement processes of a cell or system.
- Use the techniques, skills and modern tools necessary for imbalances in various life processes, design a molecular cell biology research project, collect and analyze data & interpret results.

UNIT I **(10 Periods)**

Cell: Introduction and classification of organisms by cell structure (Prokaryotic & Eukaryotic cell), cytosol, compartmentalization of Eukaryotic cells, cell fractionation.
Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell membrane transport.
Cell Cycle, Mitosis & Meiosis.

UNIT II. **(15 Periods)**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules. Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III **(20 Periods)**

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function ,Genome, biogenesis.

Chloroplasts: Structure and function, Genome, biogenesis

Nucleus: Structure and function, Chromosome and their structure.

UNIT IV **(15 Periods)**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix.

Cell Signaling: Endocrine, Paracrine, Autocrine, Neurotransmitters, Steroid Hormones, Thyroid Hormone and gases: CO and NO. Cellular responses to environmental signals in plants.

Receptors- Types of Cell surface receptors: Basic concept and mechanism of signal transduction: Bacterial and Plant two-component signaling system, G-Protein coupled receptor, Ras, Raf. Plant Hormone action

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics of Cancer cell. Molecular basis of cancer: Oncogenes, Tumor Suppressive Gene.

PRACTICALS

1. Study of structure of any Prokaryotic and Eukaryotic cell
2. Micrometry: Calibration of Microscope, Measurement of cell size
3. Cell division in onion root tip.
4. Preparation of Nuclear & cytoplasmic fractions.
5. Staining techniques : Staining blood cells.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Semester- II

Core 3-GENERAL MICROBIOLOGY

Credits-Theory-4, Practical-2 Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section:A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section:B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section:C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

At the end of the course, the student should be able to,

- Identify microbiological techniques, the defining characteristics
- of the major groups of microorganisms and apply to study microbial phylogeny.
- To apply various sterilization techniques in Microbiology Laboratory.
- Classify Viruses based on their characteristics and structure.
- Examine the general characteristics of Bacteria and their recombination.
- Apply knowledge of Microbial growth & different types of cultures.
- Develop understanding on the concept of microbial nutrition.
- Evaluate how microorganisms interact with the environment in beneficial or detrimental ways.

UNIT I **(10 Periods)**

Scope and Historical background of Microbiology. Major groups of Microorganisms: Morphology & Cell structure :Bacteria, Algae, Fungi, Protozoa .
Methods of Classifying bacteria--- On the basis of Taxonomy, Phylogeny and Molecular Approaches, Shape and arrangement of bacterial cells.
Typical structure of Bacterial cell.
General Account of viruses: Structure, reproduction and lifecycle: Lambda, M13 and TMV.

UNIT II **(10 Periods)**

The Cultivation of Bacteria- Nutritional Requirements, Nutritional types of Bacteria: Phototrophs, Chemotrophs, Autotrophs and Heterotrophs, Obligate parasites.

Bacteriological Media: Types of media, preparation of Media, Physical conditions required for growth-temperature, gaseous requirements, Acidity or Alkalinity (pH)

UNIT III **(20 Periods)**

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

The structure and biosynthesis of cell-wall Peptidoglycan.

Bacterial Reproduction: Transformation, Transduction, Conjugation, Endospore and sporulation.

UNIT IV **(20 Periods)**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: (Aquatic microbial) – Aquatic microorganism – Lakes & ponds, streams, Estuaries, sea, marine plankton, the benthic population.

Food Microbiology: Important microorganism in food Microbiology: Molds, bacteria. Major food borne infections and intoxications, Preservation of various types of foods.

PRACTICALS

1. Preparation of media & sterilization methods,
2. Methods of Isolation of bacteria from different sources (air, water and soil)
3. Obtaining pure Cultures of Bacteria.
4. Staining methods: simple staining, Gram staining.
5. Antibiotic –sensitivity test.
6. Growth Curve of Bacteria. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SEMESTER-II

Core-4 GENETICS

Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75

Full Marks = 60 (ESE) **Pass Marks: 24**

Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English

2. The setters are requested to take care and ensure that the questions are within the syllabus

3. The questions should be innovative, clear and understandable

4. Your co-operation is solicited and thankfully acknowledged by the College

5. The questions are to be set divided in three Sections

Section:A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section:B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.

Marks allotted: 5x4 = 20

Section:C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30.

Learning Outcomes:

At the end of the course, the student should be able to,

- Understand work of Mendel & laws of inheritance concept of loci and alleles & nonallelic interactions.
- Explain the detailed characteristics of prokaryotic & eukaryotic genes.
- To know the concepts of linkage, crossing over, chromosome mapping & recombination of genes.
- Comprehend the effect of structural & numerical chromosomal abnormalities.
- To apply knowledge of chromosome& gene mutation.
- To know about Hardy-Weinberg law in evolution & Population Genetics.

UNIT I **(15 Periods)**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Control points in cell-cycle progression in Yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

Nonallelic Interaction: Complementary genes, Epistasis (Dominant & recessive), Duplicate gene & Inhibitory gene.

UNIT II **(15 Periods)**

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences.

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, concept of cistron, genetic code.

UNIT III **(15 Periods)**

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination (Plant ,Animal& Human) Environmental factors and sex determination, sex differentiation, Barr bodies, Dosage compensation, Genic balance theory, Fragile-X syndrome and chromosome, sex influenced dominance, Sex limited gene expression, Sex linked inheritance.

Sex Determination & Sex linkage. Mechanism of Sex determination in human, Plant & Drosophila.

UNIT IV **(15 Periods)**

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes. Crossing over, Cytological basis of crossing over, Mechanism of crossing over, Crossing over at four strand stage.

Extra chromosomal inheritance: Rules of extra nuclear inheritance and cytoplasmic inheritance.

Evolution and population genetics: Hardy Weinberg law, allelic and genotype frequencies, changes in allelic frequencies.

PRACTICALS

1. Mendelian deviations in dihybrid crosses
2. Karyotyping with the help of photographs.
3. Study of polyploidy in onion root tip by colchicine treatment.
4. Temporary mount of Mitosis.

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic

Analysis, W. H. Freeman & Co.
6. Gupta, P.K., Genetics (Current edition)
7. Singh, B.D. Fundamentals of Genetics (Current Edition)
8. Tamarin—Principles of Genetics (Current edition)

SEMESTER –III
Core- 5 PLANT PHYSIOLOGY
Credits-Theory-4,Practical-2
Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section:A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Mark allotted: 1x10=10.

Section:B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20.

Section:C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30.

Learning Outcomes:

At the end of the course, the student should be able to

- Explain the mechanism of movement of water & solute within Plant.
- To know about micro & macronutrients in plants.
- Understand the detailed characteristics of chloroplast, photosynthetic pigments & mechanism of photosynthesis.
- Understand the mechanism of Respiration, Nitrogen metabolism, Growth & development in plants .
- Have introductory idea of Plant growth regulators & their role in plant growth.

UNIT I **(15 Periods)**

Plant water relations and micro & macronutrients

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: roles and deficiency symptoms of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT II **(20 Periods)**

Respiration & Photosynthesis

Aerobic & Anaerobic Respiration: Glycolysis, Krebs's cycle, Electron transport chain., Oxidative phosphorylation. Factors affecting respiration.

Importance of Photosynthesis, Photosynthetic pigments. Concept of two photosystems (PS I & PS II), Light reaction, Dark Reaction (C3 & C4 Cycle), CAM. Photorespiration, Compensation point. Factors affecting photosynthesis.

UNIT III **(10 Periods)**

Nitrogen metabolism

Inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV **(15 Periods)**

Growth and development: Definitions, phases of growth, growth curve.

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

Growth Hormones -brief idea & their functions in growth & development of plants (Auxin, Gibberellins, Cytokinin, Abscisic acid & Ethylene)

Physiological & chemical changes: seed dormancy, seed Germination, Concept of photoperiodism & vernalization.

PRACTICALS

1. Demonstration of plasmolysis by *Tradescantia* leaf peel.
2. Demonstration of opening & closing of stomata
3. Demonstration of guttation on leaf tips of grass and garden nasturtium.
4. Separation of photosynthetic pigments by paper chromatography.
5. To study the phenomenon of seed germination (Effect of light).

SUGGESTED READING

1. Hopkins, W.G. and Hunter, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
2. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
3. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
4. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

SEMESTER-III

Core-6 MAMMALIAN PHYSIOLOGY

Credits-Theory-4, Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. **Mark allotted: 1x10=10**

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

At the end of the course, the student should be able to

- Comprehensive understanding of all mammalian physiological system.
- Have detailed idea of hormonal & signal pathway.
- To apply knowledge of ECG.
- To know various blood components & groups as well as circulatory mechanism.

UNIT I **(15 Periods)**

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids.
BMR
Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

UNIT II **(15 Periods)**

Composition of blood, Plasma proteins & their role, blood cells, Haematopoiesis, Mechanism of coagulation of blood.
Mechanism of working of heart: cardiac cycle. ECG

UNIT III **(15 Periods)**

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.
Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV **(15 Periods)**

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Different endocrine glands– Hypothalamus, pituitary, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions. Basic mechanism of Hormone action.

PRACTICALS

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Determination of TLC.
4. Determination of Hemoglobin

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

SEMESTER-III
Core-7 I.P.R., BIOETIHCS & BIOSAFETY
Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

At the end of the course, the student should be able to,

- Understand how IPR affects the various areas of research work.
- Have detailed idea of PPVFR.
- To apply knowledge of IPR in Trademark, Copyright & patency.
- Understand and follow the regulatory framework important for product safety and benefit for the society.
- To know various Guidelines related to Bioethics & Biosafety and apply them in innovation.

UNIT-I **(15 Periods)**
Biotechnology and intellectual property rights. Patents, Trade secret, Copyright, Trademark, Plant Breeder's Right and farmer's Right (PPVFR).

UNIT II **(20 Periods)**
Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT III **(10 Periods)**
Bioethics – Necessity of Bioethics, Different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV **(15 Periods)**

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment. Biosafety Levels.

Cartagena protocol.

Good laboratory practices.

Good Manufacturing Practices.

PRACTICALS

1. Proxy filing of Indian Product patent
2. Planning of establishing a hypothetical biotechnology industry in India
3. A case study on clinical trials of drugs in India with emphasis on ethical issues.
4. Case study on women health ethics.
5. Case study on medical errors and negligence.

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers .

3.IPR, Biosafety and Bioethics by Deepa Goel and Parashar, Pearson Publications: ISBN 9788131774700 , ISBN 9789332514249

SEMESTER-IV

Core-8 MOLECULAR BIOLOGY

Credits-Theory-4, Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

After the completion of course, the student should be able to,

- Apply the principles of Molecular Biology techniques.
- Analyze architecture of genome, gene & the flow of genetic information through replication, transcription, & translation.
- Decipher regulation of gene expression & its influence on various stages of development.

UNIT I **(15 Periods)**

DNA structure and replication

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Theta model ,Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II **(15 Periods)**

DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III **(15 Periods)**

Transcription and RNA processing

Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV **(15 Periods)**

Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Post translational modifications of proteins.

PRACTICALS

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.
5. Molecular Biology of the Cell by Bruce Alberts; Fifth Edition, Garland Science Publications.

SEMESTER IV
Core -9 IMMUNOLOGY
Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

After the completion of course, the student should be able to

- To develop understanding of various immunology concept in study of cell biology and to study the different tools and techniques used to study the immunology at molecular level.
- To design and analyze the experiments related with the different molecules involved in immunology and use of the various techniques in the immunology to study the kinetics & rationale behind each phenomenon.
- To identify, formulate, and solve problems arisen due to inefficient functioning of the various immunological phenomenon leading to various immunological diseases.
- To use the techniques, skills and modern tools necessary for imbalances in various life processes.

UNIT I **(15 Periods)**

Immune Response - An overview of immune System: Innate and Adaptive Immunity. Cells and organs of immune system, Haematopoiesis. Humoral & Cellular immune responses, B-lymphocytes ,T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, Cytokines. Basic concepts of Plant Immunity.

UNIT II **(15 Periods)**

Immuno-globulins or Antibodies, Genome rearrangements during B-lymphocyte differentiation– clonal selection theory, Allotypes & Idiotypes, allelic exclusion, immunologic memory.

UNIT III **(15 Periods)**

Antigens – factors affecting antigenicity, Antigen processing & presentation. Major Histocompatibility complexes – class I & class II MHC antigens. Immunity to infection. Immunity against Bacterial and Viral diseases. Immunodeficiency -AIDS.

UNIT IV **(15 Periods)**

Hypersensitivity, compliment system, ADCC, Opsonization , effector mechanism , Vaccines & Vaccination – passive & active immunization, adjuvants, , DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, . Introduction to immunodiagnostics – Antigen-Antibody interaction. RIA, ELISA.

PRACTICALS

1. Differential leucocyte count
2. Haemagglutination assay
3. Separation of serum from blood
4. Double immunodiffusion test using specific antibody and antigen.
5. ELISA.

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Goldsby RA, Kindt TJ, Osborne BA. (2015). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
3. Goldsby A.R, Kindt, Osborne and Kuby Janis. Immunology (Current Edition)
4. How the Immune System Works, by Lauren Sompayrac; Wiley- Blackwell, 4th edition
5. Immunology by Klaus D. Elgert (2009) Wiley- Blackwell.

SEMESTER IV

Core -10 ENTERPRENEURSHIP DEVELOPMENT

Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions **for Paper Setter**

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 6 (six) Long Answer or Essay Type Questions. The examinee are required to answer any three Long Answer Questions Marks allotted: 15 x3= 45.

Learning Outcomes:

At the end of the course, the student should be able to,

- Prepare project report for Biotechnology entrepreneurship.
- Address the market challenges for the new enterprise.
- Setup enterprise for new biotechnology product.
- Assess the global market scenario of their product.

UNIT I **(10 Periods)**

INTRODUCTION

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II **(10 Periods)**

ESTABLISHING AN ENTERPRISE

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III **(15 Periods)**

FINANCING THE ENTERPRISE

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV **(15 Periods)**

MARKETING MANAGEMENT

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V **(10 Periods)**

ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

Project Report on a selected product should be prepared and submitted.

SUGGESTED READING

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.
4. Entrepreneurship: New Venture Creation : David H. Holt
5. Patterns of Entrepreneurship : Jack M. Kaplan
6. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.

SEMESTER –V

Core-11 BIO-ANALYTICAL TOOLS AND TECHNIQUES

Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections
Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. **Answer**
Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20
Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

At the end of the course, the student should be able to,

- Be familiar with working principles, tools & techniques of analytical techniques.
- Apprehend the functioning, maintenance & safety aspects of the apparatus used in biotechnology lab.
- Assimilate the principle & applications of centrifuge, electrophoresis, chromatography and spectroscopy in research & related experiments.
- Understand detailed interpretation of results of bioanalytical processes.

UNIT I **(10 Periods)**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), Confocal microscopy, pH meter, absorption and emission spectroscopy

UNIT II **(15 Periods)**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III **(15 Periods)**

Introduction to the principle of chromatography. Paper chromatography, Thin layer chromatography, Column chromatography: Silica and Gel filtration, affinity and Ion exchange chromatography, Gas chromatography, HPLC.

UNIT IV **(20 Periods)**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors. Nanotechnology and their applications.

PRACTICALS

1. SDS-polyacrylamide slab gel electrophoresis of proteins .
2. Preparation of protoplasts from leaves.
3. Separation of amino acids by paper chromatography.
4. To identify lipids in a given sample by TLC.

SUGGESTED READING

1. Karp, G. 2015. Cell and Molecular Biology: Concepts and Experiments. . John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 4.Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco
5. Principles and Techniques of Biochemistry and Molecular biology by Wilson and Walker, seventh edition, Cambridge University Press.

SEMESTER-V
Core-12 RECOMBINANT DNA TECHNOLOGY
Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

At the end of the course, the student should be able to,

- Apply the principles of molecular biology techniques.
- Analyze the experimental data to select a suitable PCR for a particular application.
- Evaluate selectivity & specificity of vectors for cloning genes and their expressions.
- Examine gene function, gene modulation and their effects on improvement of crop & animal.
- To know the various methodology of Protein Engineering.

UNIT I **(15 Periods)**

Molecular tools and applications- Restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors: pBR322, pUC 18, Bacteriophage-derived vectors/lambda phage vectors. Artificial chromosome. Microinjection, Electroporation, Ultrasonication. Principle and applications of Polymerase Chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II **(15 Periods)**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, Genome mapping, DNA fingerprinting, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each). Applications of Genetic Engineering, Genetic engineering in animals: Production and applications of transgenic mice , role of ES cells in gene targeting in mice,

UNIT III **(15 Periods)**

Protein Engineering: Basic concept, Example :Subtilisin, Random & site directed Mutagenesis. Primer extension and PCR based methods of site directed mutagenesis. Production of Chimeric proteins. Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of Chimeric proteins.

UNIT IV **(15 Periods)**

Genetic engineering in plants: Agrobacterium as Genetic Engineer. *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Direct DNA transfer to plants & Animals .

PRACTICALS

1. Isolation of chromosomal DNA from plant cells
2. Qualitative and quantitative analysis of DNA using spectrophotometer
3. Plasmid DNA isolation
4. Making competent cells
5. Transformation of competent cells.
6. Demonstration of PCR

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

SEMESTER-VI

Core-13 BIOPROCESS TECHNOLOGY

Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcomes:

At the end of the course, the student should be able to,

- Understand the scope, principle & components of Bioprocess Technology.
- Understand the growth kinetics & factors affect the microbial growth.
- Define the media for submerged & solid state fermentation process.
- Collect the proficient knowledge of design of fermenter and operation of fermentation process.
- Understand the different methods of product recovery and effluent treatment.

UNIT I **(15 Periods)**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principles & components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.

UNIT II **(15 Periods)**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing –Media preparation, Inocula development and sterilization.

UNIT III **(15 Periods)**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and Control system.

UNIT IV **(15 Periods)**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of Ethanol, Amylase, Lactic acid, Fermented food: Cheese, Single Cell Proteins, Biotransformation: (Products of Pharmacological intertest: Antibiotic & Steroid).

PRACTICALS

1. Bacterial growth curve.
2. Production and analysis of ethanol.
3. Production and analysis of lactic acid.
4. Purification of an industrial enzyme from any natural resource.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

SEMESTER-VI
Core-14 GENOMICS & PROTEOMICS
Credits-Theory-4,Practical-2

Theory --Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections
Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10
Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20
Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30.

Learning Outcomes:

At the end of the course, the student should be able to

- Apply structural and functional genomics approaches on newly sequenced genome for functional characterization of genes.
- Handle a protein and its characterization.
- Know the principles of proteome quantification.
- Demonstrate how various types of mass spectrometers can be used for proteome quantification, structure determination of proteins by various methods.
- Use software tools to analyze various quantitative proteomic data type, principles of statistical analysis of proteomic data, how quantitative proteomics can be applied in biology, clinical research , drug discovery and designing novel proteins.

UNIT I **(15 Periods)**
Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.
UNIT II **(10 Periods)**
Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.
UNIT III **(20 Periods)**
Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine

the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, Gel Filtration, SDS-PAGE); Native PAGE. Determination of covalent structures – Edman degradation.

UNIT IV **(15 Periods)**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

PRACTICALS

1. Use of SNP databases at NCBI .
2. Detection of Open Reading Frames using ORF Finder
3. Proteomics 2D PAGE database
4. Softwares for Protein localization.
5. Native PAGE
6. SDS-PAGE

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

SEC = Skill Enhancement Courses

SEC-1- Enzymology ---- SEM—III

SEC-2 Molecular Diagnostics--- SEM- IV

SEMESTER-III
SEC-1. ENZYMOLOGY
Credit 2 Full Marks 100

Instructions for Paper Setter

1.The questions should be only in English

2. The setters are requested to take care and ensure that the questions are within the syllabus

3. The questions should be innovative, clear and understandable

4. Your co-operation is solicited and thankfully acknowledged by the College

5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers.

Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 4 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.

Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 3 (six) Long Answer or Essay Type Questions. The examinee are required to answer any three Long Answer Questions Marks allotted: 15 x3= 45.

Learning Outcomes:

At the end of the course, the student should be able to,

- Identify enzymology techniques, the defining characteristics of the major groups of enzymes.
- Evaluate Enzyme action, substrate reaction and Allosteric mechanisms.
- Identify industrially important Enzymes.
- To apply various techniques in Enzymology laboratory.

UNIT – I **(15 Periods)**

Isolation, Crystallization and Purification of enzymes.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Chymotrypsin and Prothrombin).

Michaelis - Menten equation and its derivation,

Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Significance of activation energy and free energy.

UNIT – II **(15 Periods)**

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, Suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, Chemical modification of active site groups : Chymotrypsin, Lysozyme, RNase.

Enzyme regulation: Product inhibition, feedback control, covalent modification.

UNIT – III **(15 Periods)**

Allosteric enzymes with special reference to Aspartate Transcarbomylase and Phosphofructokinase.

Enzyme - Enzyme interaction, Protein ligand binding.

Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme- eg Fatty Acid synthase.

UNIT – IV **(15 Periods)**

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health , food and beverages industry.

PRACTICALS

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Demonstration of assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

SEMESTER –IV
SEC-2
Credit 2 Full Marks 100
MOLECULAR DIAGNOSTICS

Instructions for Paper Setter
1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections
Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers.
Marks allotted: 1x10=10
Section: B Question Number (2) covering the whole syllabus consisting of 4 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.

Marks allotted: 5x4 = 20
Section: C Question Number (3) covering the whole syllabus consisting of 3 (six) Long Answer or Essay Type Questions. The examinee are required to answer any three Long Answer Questions
allotted: 15 x3= 45. **Marks**

Learning Outcomes:

At the end of the course, the student should be able to,

- Understand the fundamentals of the concepts and design of biomedical equipment.
- Understand the importance of medical data transmission for better healthcare.
- Analyze the electrical hazards associated with medical equipment so that the safety equipment so that the safety equipment can be devised or suggested.
- Work in an interdisciplinary team.

UNIT I
Enzyme Immunoassays **(15 Periods)**
Comparison of enzymes available for enzyme immunoassays, Conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays.

UNIT II **(15 Periods)**
Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide and plasmid finger printing in clinical microbiology. Laboratory test in Chemotherapy (CBC & CTR).

UNIT III **(20 Periods)**
Molecular methods in clinical microbiology: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures., Tests for bactericidal activity. Automated procedures for antimicrobial activity.
Immunodiagnostic tests. FISH, Immunoaffinity Chromatography. Immunoblotting. Enzyme Immunohistochemical techniques. Use of monoclonal antibodies in enzyme immuno assays. FACS.

UNIT IV. **(10 Periods)**

GLC, HPLC, Electron Microscopy, Flowcytometry & Cell sorting.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. A kit-based detection of a microbial infection (Widal test)
3. Study of Electron micrographs (any four).
4. Demonstration of AMES TEST

SUGGESTED READING

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
4. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
5. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
7. Microscopic Techniques in Biotechnology, Michael Hoppert
8 Principles & Techniques of Biochemistry & Molecular Biology.

Discipline Specific Courses

1. Animal Biotechnology
2. Plant Biotechnology
3. Bioinformatics and Biostatistics
4. Environmental Biotechnology

SEMESTER –V
Discipline Specific Courses
DSE-1 ANIMAL BIOTECHNOLOGY
Credits-Theory-4,Practical-2
Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) Pass Marks: 24
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcome:

At the end of the course, the student should be able to,

- Demonstrate fundamental knowledge of Cell culture techniques and competence in laboratory techniques.
- Students can set up a tissue culture lab to carry out research.
- Acquire knowledge in animal cloning and its applications by various methods.
- Acquire adequate knowledge in the use of genetically modified organisms and its beneficial uses.

Unit I **(15 Periods)**
Scope of animal tissue culture. History of development of cell cultures. Basic equipments in Animal cell culture- CO2 Incubator, Laminar Air flow, Liquid Nitrogen Storage.

Unit II **(15 Periods)**
Culture media- natural media- plasma clot, embryo extract,
Importance of serum in media . Chemical defined media- MEM, Dulbecco and M199.

Unit III **(15 Periods)**

Primary culture: isolation of tissue, enzymatic disaggregation and mechanical disaggregation. Anchorage dependence of growth. Non anchorage dependent cells. Secondary culture: Transformed animal cells and animal cell lines. Monoclonal antibodies and HAT selection

Unit IV **(15 Periods)**

Gene transfer methods in Animals – Microinjection, Embryonic, and Retroviral transfer. Introduction to Transgenesis , Transgenic Animals – Mice and Sheep.
Introduction to Stem Cell Technology and its applications.

PRACTICALS

1. Sterilization technique: Glass ware sterilization, Media sterilization, Laboratory sterilization.
2. Basic equipments in Animal cell culture- CO2 Incubator, Laminar Air flow, Liquid Nitrogen Storage.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-genes and genomes- A short course. III Edition. Freeman and Co., N.Y.. USA.
6. Culture of Animal cell culture by R. Ian Freshney , Fifth Edition; Wiley: Liss publications

SEMESTER V
DSE-2 PLANT BIOTECHNOLOGY

Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcome:

After the completion of this course, the student will be able to,

- Develop their competency on different techniques of Plant tissue culture.
- Know the lab organization & measure adopted for aseptic manipulation and nutritional requirements of cultured tissues.
- Apply knowledge for large scale clonal propagation of plants through various micropropagation techniques and production of secondary metabolites.
- Develop skill in raising desired plants which have quality characteristics and their role in crop improvement.

UNIT I **(Periods 15)**

Introduction : Historical Background of Plant Tissue Culture. Media preparation, Plant Growth regulators.

Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation, Axillary bud proliferation, Meristem and shoot tip culture, Bud culture, Organogenesis, Embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II **(Periods 15)**

In vitro haploid production Androgenic methods: Anther culture, Microspore culture androgenesis Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, Factors effecting Gynogenesis, Chromosome elimination techniques for production of haploids in cereals.

UNIT – III **(Periods 15)**

Protoplast Isolation and fusion, Methods of Protoplast isolation, Protoplast development, Somatic hybridization, Identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization &limitations.
Somaclonal variation
Nomenclature, methods, applications basis and disadvantages.

UNIT – IV **(Periods 15)**

Single Cell Suspension Culture , Secondary metabolites ,
Cryopreservation, Artificial seeds.
Role of Plant tissue culture in Agriculture, Horticulture, Forestry & Pharmaceuticals.

PRACTICALS

1. Preparation of complex nutrient medium (Murashige & Skoog's medium)
2. To selection, Prune, sterilize and prepare an explant for culture.
3. Significance of growth hormones in culture medium.
4. To demonstrate various steps of Micropropagation.

SUGGESTED READING

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A, Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
4. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
5. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
6. K.K Dey, Plant Tissue Culture.
7. H . S Chawla, Introduction to Plant Biotechnology.
8. Plant tissue culture : Totiptogency to Transgenic _ Editor-in-chief Dr.H.P.Sharma. Agrobios(India) First edition-2012
9. Plant embryology : Classical to experimental by Dr.H.P.Sharma, Narosa Publication House Pvt. New Delhi -1 , 2009

SEMESTER-VI

DSE- 3. Bioinformatics and Biostatistics

Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcome:

At the end of the course, the student should be able to,

- Explain the theoretical knowledge of database system and algorithms.
- Apply key concepts of different bioinformatics tools.
- Apply the knowledge of bioinformatics in the biotechnology research and industry.
- Organize, summarize and display biological data.
- Apply concepts of statistics for analyzing biological data.

UNIT I **(10 Periods)**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. **(20 Periods)**

UNIT II

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction to BLAST, using it on the Web. Multiple Sequence Alignment,FASTA, Data Submission.Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Sequence alignment using BLAST

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

BIOSTATISTICS

UNIT III **(20 Periods)**

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency , Mean , Median , Mode ,Standard deviation and Dispersion.

Probability classical & axiomatic definition of probability, Theorems on total and compound probability, Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT IV **(10 Periods)**

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test , goodness of fit and analysis of variance (ANOVA)

PRACTICALS

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

SEMESTER VI
DSE-4 ENVIRONMENTAL BIOTECHNOLOGY

Credits-Theory-4,Practical-2

Theory –Lectures 60

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.
Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Learning Outcome:

At the end of the course, the student should be able to

- Identify and evaluate the importance of modern fuels.
- Apply advanced knowledge on environmental waste management (waste water & solid waste).
- Design techniques for bioremediation processes.
- Know the different types of ecofriendly biofertilizers.
- Know the environmental significance of GMOs.

UNIT I **(15 Periods)**

Conventional fuels and their environmental impact – Firewood, Plant &Animal Wastes, Coal and Natural oil & Gas. Difference between Conventional and Non- conventional fuels. Modern fuels and their environmental impact – Methanogenic bacteria. Biogas Technology, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol. Biodiesel

UNIT II **(15 Periods)**

Bioremediation of soil & water contaminated with oil spills, Heavy metals and detergents. Bioremediation- Types in situ & Ex situ. Advantages & Disadvantages. Factors affecting Bioremediation. Biodegradation of Xenobiotics. (Pesticides), & Petroleum products. Phytoremediation. Degradation of lignin and cellulose using microbes.

UNIT III **(15 Periods)**

Treatment of municipal waste (Preliminary, Primary, Secondary and Tertiary) Industrial effluents (Food industry, Pesticide Petrochemical).

Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM).

UNIT IV **(15 Periods)**

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

PRACTICALS

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Water Analysis by MPN Method.

SUGGESTED READING

1. Environmental Biotechnology, Pradipta Kumar Mohapatra
2. Environmental Biotechnology – Concepts and Applications. Hans-Joachim Jordening and Jesef Winter
3. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
4. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Principles of Environmental Engineering, Gilbert Masters
7. Wastewater Engineering – Metcalf & Eddy
8. Environmental Biotechnology- S. K. Agarwal
9. Environmental Biotechnology- Alan Scragg.

SEMESTER-I

AECC --- ENGLISH/MIL

Learning Outcome:

At the end of the course, the student should be able to,

- Student will achieve these outcomes through the development of the following skills: focused reading skills work and exam; discussions of longer articles; and summary writing including the drafting process.

SEMESTER-II

AECC ---ENVIRONMENTAL SCIENCE

Learning Outcomes:

At the end of the course, the student should be able to,

- Graduates will evolve into ecologically informed and socially responsible citizens who are empowered to protect the natural resources while ensuring sustainable lifestyle and developmental model.

Ranchi Women's College,Ranchi

Mid Sem No Exam Year

Subject Code/Biotech

F M = 15 Time: 1 Hour

General Instructions

i) Group A carries very short answer type compulsory questions

ii) Group B consist of short answer type descriptive questions, answer 2 out of 3

iii) Answer in your own words as far as practicable

iv) Numbers in right indicate full marks of the question

Group A

1. **(5x1=5)**
2.
3.
4.
5.

Group B

6. **(5)**
7. **(5)**
8. **(5)**

Soma Ru Almgb

Supriya Shrivastava

Ranchi Women's College,Ranchi

End Sem No Exam Year

Subject Code/Biotech

F M = 60/PM 24 Time: 3 Hours

General instructions :

1. Group A carries one compulsory question consisting of objective type MCQ/FIB/True or False of 10 marks 1x10=10
2. Group B consists of short answer type questions of 5 marks each/Answer any four out of eight 5x4=20
3. Group C consists of Long Answer Type questions of 15 marks each.Answer any two out of four 15x2=30
4. Answer all parts of a question in one place
5. Number in the right indicates full marks of the question

Group A

1. a)

b)

c)

d)

e)

f)

g)

h)

i)

j)

Group B

2.

a)

b)

c)

d)

e)

f)

g)

h)

Group C

3.

a)

b)

c)

d)