CBCS CURRICULUM OF

M.Sc. BIOTECHNOLOGY PROGRAMME


SUBJECT CODE = BTC

FOR POST GRADUATE COURSES UNDER RANCHI UNIVERSITY

Implemented from
Academic Session 2018-2020

UNIVERSITY DEPARTMENT OF BOTANY
RANCHI UNIVERSITY, RANCHI
M.Sc. BIOTECHNOLOGY

Ref. No. R.U./PG/Bot./Voc M.Sc. Biotech _____

Ranchi
Date: 27/09/2018

NOTIFICATION

Board of Courses and Studies for implementation of Choice Based Credit System of M.Sc. Biotechnology, University Department of Botany, Ranchi University as per University guidelines which is as follows:

Sl. No.	Name	
1	Dr. Ashok Kumar Choudhary HOD University Department of Botany Ranchi University, Ranchi	Chairman
2	Prof. Jyoti Kumar University Professor University Department of Botany Ranchi University, Ranchi	Internal Member
3	Dr. (Mrs.) Latika Sharan Associate Professor University Department of Botany Ranchi University, Ranchi	Internal Member
4	Mrs. Ladly Rani Course Co-ordinator M.Sc. Biotechnology University Department of Botany Ranchi University, Ranchi	Internal Member
5	Prof. Hanuman Prasad Sharma Pro Vice Chancellor S.K.M.U., Dumka	External Expert
6	Dr. Shalini Lal Course Coordinator Microbiology S.P.M.U., Ranchi	External Expert
7	Dr. Amit Patnaik Assit. Professor Biotechnology University Department of Botany Ranchi University, Ranchi	~~Special invitee~~ Internal Member

27-9-18

Jyoti Kumar 27/9/18

Sharan 27.9.18

Rani 27.9.2018

H.P. Sharma 27/9/2018

Shalini Lal 27.9.18

Amit Patnaik 27-09-2018

Professor & Head
Univ. Dept. of Botany
RANCHI UNIVERSITY, RANCHI

27.9.18

(A. K. Choudhary)
University Professor & Head
University Department of Botany
Ranchi University, Ranchi

Director
Vocational Courses
Dept. of Botany
Ranchi Univ., Ranchi

Contents

COURSE STUCTURE FOR M.Sc. BIOTECHNOLOGY PROGRAMME

Table AI-1: Distribution of 80 Credits for Subjects having Practical Papers

[*wherever there is a practical examination there will be no tutorial and vice –versa.]

Course	Papers	Credits Theory + Practical	Credits Theory + Tutorial
I. Foundation Course (FC)			
1. Foundation Course Compulsory Foundation/ Elective Foundation	**(FC)** 1 Paper	1X5=5	1X5=5
II. Core Course (CC)	**(CC 1 to 10/11)**		
Theory	7 Papers/11 Papers	7X5=35	11X5=55
Practical/ Tutorial*	3 Papers/----------	3X5=15	
Project	1 Paper	1X5=5	1X5=5
III. Elective Course (EC)			
A. Ability Enhancement Course of the Core Course opted	**(AE/EC 1)** 1 Paper	1X5=5	1X5=5
B. Discipline Centric Elective	**(DC/EC 2&3)**		
Theory +	2 Papers	2X5=10	
Practical	1 Paper	1x5=5	
OR Theory/Practical/Tutorial*	1Paper + 1 Practical/Dissertation		2X5=10
OR Generic Elective/ Interdisciplinary	**(GE/EC 2&3)**		
Theory OR	2 Papers		
Theory/Practical/Tutorial*	1 Paper + 1 Practical/Dissertation		
	Total Credit = 80		**= 80**

Table AI-1.1: Course structure for M.Sc Programme with Practical Papers

Semester	Subject (Core Courses) 11 Papers	Allied (Elective Courses) 4 Papers	Foundation Course (Compulsory Course) 1 Paper	Total Credits
Sem-I	C-1, C-2, C-3 (5+5+5=15 Credits)		Foundation Course FC (05 Credits)	**20 Credits**
Sem-II	C-4, C-5, C-6, C-7 (5+5+5+5=20 Credits)			**20 Credits**
Sem-III	C-8, C-9, C-10 (5+5+5=15 Credits)	EC1 (05 Credits)		**20 Credits**
Sem-IV	C-11 (Project) (05 Credits)	EC2, EC3, EP (5+5+5=15Credits)		**20 Credits**

Total = 80 Credits

COURSES OF STUDY FOR POSTGRADUATE M.Sc. BIOTECHNOLOGY PROGRAMME

Table AI-2 Subject Combinations allowed for M. Sc. Programme (80 Credits)

Foundation Course **FC** **1 Paper**	Core Subject **CC** **11 Papers**	Ability Enhancement Course **AE** **1 Paper**	Discipline Centric Elective/ Generic Elective Course **DC/ GE/ EC** **3 Papers**

Table AI-2.1 Semester wise Examination Structure for Mid Sem. & End Sem. Examinations:

Sem.	Core, AE/ GE/ DC/ EC & Compulsory FC Courses				Examination Structure		
	Paper	Paper Code	Credit	Name of Paper	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical/ Viva (F.M.)
I	Foundation Course	FCBTC101	5	Molecular Biology and Genomics	30	70	----
	Core Course	CCBTC102	5	Cell Biology	30	70	----
	Core Course	CCBTC103	5	Microbiology	30	70	----
	Practical's on Core	CPBTC104	5	Practical Paper I	----	----	70 + 30
II	Core Course	CCBTC201	5	Genetic Engineering	30	70	
	Core Course	CCBTC202	5	Biochemistry and Biophysics	30	70	----
	Core Course	CCBTC203	5	Immunology	30	70	----
	Practical's on Core	CPBTC204	5	Practical Paper II	----	----	70 + 30
III	Ability Enhancement Course	ECBTC301	5	Biostatistics, Computer Application and Bio-informatics	30	70	----
	Core Course	CCBTC302	5	Plant Biotechnology	30	70	----
	Core Course	CCBTC303	5	Animal Biotechnology	30	70	----
	Practical's on Core	CPBTC304	5	Practical Paper III	----	----	70 + 30
IV	Elective	ECBTC401	5	Industrial Biotechnology	30	70	----
	Elective	ECBTC402	5	Environmental Biotechnology	30	70	----
	Practical's on Elective	EPBTC403	5	Practical Paper IV	----	----	70 + 30
	PROJECT	PRCHE404	5	Project/Dissertation	----	----	70 + 30

SEMESTER I 4 Papers

Total 100 x 4 = 400 Marks

I. COMPULSORY FOUNDATION COURSE [FCBTC101]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

MOLECULAR BIOLOGY & GENOMICS

Theory: 60 Lectures; Tutorial: 15 Hrs

Course Objective:

The course aims at giving a wide exposure to the students on Molecular Biology and Genomics so that students will understand the basic metabolism of living entities.

Group – A

1. Introduction to Molecular Biology and Genetics.
2. **Genome organization** Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA;DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.
3. DNA Structure; Replication; Repair & Recombination
   Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.
6. Insertion elements & Transposons.
7. Gene, mutation and mutagenesis: UV and chemical mutagens; types of mutation; Ames test for mutagenesis; Methods of genetic analysis, Strain improvement and Mutator gene.

Group - B

1. Transcription: Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones;

Protein stability; Protein turnover and degradation Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing.

2. Modifications in RNA: 5- Cap formation, Transcription termination, 3- end processing and polyadenylation, splicing, Editing, Nuclear export of m RNA, m RNA stability.
3. Translation: Prokaryotic and eukaryotic translation, co- and post- translation modifications of proteins.

Group - C

1. Bacterial genetic system: Transformation, Conjugation, Transduction, Bacterial genetics map with reference to *E. coli*.
2. Biology for Cancer: Oncogenes and tumour suppressor genes; Viral and cellular oncogenes, tumour suppressor genes from humans.
3. Antisense and Ribozyme technology: Molecular mechanism of antisense molecules, applications of antisense and ribozyme technologies.
4. Holiday junction, gene targeting gene disruption, Rec A and other recombinases.

Group - D

1. Mapping of Genome: Genetic and physical maps, Physical mapping and map- based cloning, Southern and florescence *in situ* hybridization (FISH) for genome analysis microarray analysis.
2. Genome sequencing: Genome sizes, organelle genomics, Genomic libraries YAC, BNC, libraries, Strategies for sequencing genome.
3. Mendelian Genetics

   Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases.

   Non Mendelian inheritance patterns Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits.

Essential Readings

- Garder, Principles of genetics, Wiley Publications, 8th edition
- Levin, Gene VI to Gene VIII, Oxford Pub.
- Friefelder, Essentials of Molecular Biology, Panima Pub
- T. A. Brown ,Genome-2 2nd Edition
- Old & primrose, Principle of Gene Manipulation, Blackwell Pub.
- Weaver Molecular Biology, Mc Graw Hill
- Brown, Gene Cloning and DNA analysis, Blackwell Pub.
- Winnacker, From genes to clones , Panima Pub.
- P.C. Tumer, Instant notes in Immunology, Viva books Pub.
- Griffith, Introduction to genetic analysis, Freeman publication, 8th edition
- Robert Broker, Genetics, Mc Graw Hill
- Strickberger, Genetics, Prentice Hall Pub.
- T. A. Brown, Gene Cloning DNA analysis- Blackwell Pub.
- Stephen Hunt, Functional Genomics Oxford, Tokyo

II. CORE COURSE [CCBTC102]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:
Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations (Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).*

CELL BIOLOGY **Theory: 60 Lectures; Tutorial: 15 Hrs**

Course Objective:

The course aims at giving a wide exposure to the students on theoretical, conceptual, historical, aspects as well as the applied aspects of Biotechnology.

Group - A

1. Molecular logic of living organism, cell and its biochemical organization. Cell theory.
2. Membrane Structure and Function Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.
3. Cellular organelles-plasma membrane, cell wall, their structural organization; Mitochondria, chloroplast, nucleus and other organelles and their organization. Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution. Cellular energy transaction-role of mitochondria and chloroplast.

Group - B

1. Transport of nutrients, ions and macromolecules across membranes.
2. Cell motility-Cilia, flagella of Eukaryotes and Prokaryotes.
3. Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and theirsignificance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals

Group - C

1. Cellular responses to environmental signals in plants and animals; mechanisms of signal transduction.
2. Chromatin organization and packaging; Cell cycle and control mechanisms;
3. Cellular basis of differentiation and development - mitosis, meiosis gametogenesis and fertilization.

Group – D

1. Microscope and its applications – Light, phase contrast and interference, Fluorescence, Confocal.
2. Electron microscopy (TEM and SEM),
3. Electron tunnelling and Atomic Force Microscopy, etc.

Essential Readings

- Alberts. Molecular Biology of cell. Garland Pub
- Verma,Cell biology ,Genetics ,Molecular Biology, Evolution & Ecology.2006
- Karp,Cell & Molecular Biology: concepts & Experiments.4th Edition.
- Lodish,Cell & Molecular Biology,W.H.Freeman.5th Edn.
- Watson, Molecular Biology of the Genes. Pearson Publication.
- Wilson, & Walker. 1995. Principles and techniques of practical Biochemistry.
- Becker. 1996. Biotechnology: A laboratory course. Alp
- Lenhinger. Principles of biochemistry, 2nd Edn.
- Glick, Molecular Biotechnology, ASM Publication.
- Becker & Hardin, The world of the Cell, Pearson Pub.
- C.B. Powar, Cell Biology ,Himalaya Press.
- Nelson & Cox, Lehninger Principle Biochemistry, Freeman Pub.
- Desiker, Cell & Development Biology, Dominant Pub.
- Albert, Essential Cell Biology, Garland Science.
- Geoffrey Cooper, The- Cell Molecular Approach, ASM Pub.
- Ben Hui Liu, Statistical Genomics : Linkage, mapping & QTL Analysis, CRC press

---

III. CORE COURSE [CCBTC103]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

MICROBIOLOGY **Theory: 60 Lectures; Tutorial: 15 Hrs**

Course Objective:

The focus of this paper is to aware students about the origin of life and the evolution of living organisms.

Group - A

1. History of microbiology; Development of pure culture methods; Enrichment culture methods; Development of microbiology in the twentieth century.
2. Methods of Microbiology: Isolation, pure culture techniques, staining of bacterial cells and its organelles, methods of sterilization-physical and chemical, selection and construction of culture media, enrichment culture technique, assay of amino acids and antibiosis.
3. Microbial evolution, Systematics and Taxonomy: Evolution of earliest life forms, bacterial identification, nomenclature and classification, new approach to bacterial taxonomy / classification including ribotyping and ribosomal **RNA** sequencing.

Group - B

1. Prokaryotic cells: structure function: General structure and feature; cell wall of eubacteria, flagella, cell inclusions-endospore and gas vesicles.
2. Prokaryotic diversity: **Bacteria**; Brief account of all groups of bacteria and cyanobacteria, Rickettsias, Ohlamydias, and mycoplasma.
3. **Archae:** Archaebacteria extremophilic microbes - their biotechnological potentials.
4. **Viruses:** Classification, morphology and composition of virus in general.
5. **Bacteriophage:** phi X174 cyanophage and retroviruses, viroids and prions.

Group - C

1. Microbial growth and Physiology: The definition of the growth, growth curve, measurement of growth and growth yields, synchronous and continuous growth. culture collection and maintenance of culture. Life style of Prokaryotes, Unicellular Eukaryotes
2. Overview of microbial nutrition: Types and mode of nutrition in bacteria.
3. Metabolic diversity among microorganisms: Photosynthesis in microorganisms, chemolithotrophy, sulphate reduction.

4. Nitrogen metabolism- nitrate reduction, nitrifying and denitrifying bacteria nitrogen fixation nitrogen cycle.

Group - D

1. Secondary metabolites/ Bioactive substances
2. Brief account of toxins of bacteria and cyanobacteria
3. Microbes used as bio-fertilizer

Essential Readings

- Pelczar M.J.Chan, 5th Edition, Microbiology
- Roger Y.Stanier, 5th Edition General microbiology
- Powar & Daginawala Vol I & Vol II,General Microbiology
- Prescott L. M. Microbiology, 6th Edition
- Atlas R.M. Microbiology
- Jhonson ,Laboratory Experiments in Microbiology,6th Edition, Pearson Education
- Harold J.Benson, Microbiological applications, 6th Edition
- Singleton Sainsbury, Dictionary of Microbiology & Molecular Biology, John Wiley
- R.C. Dubey& Maheshwari,A Textbook of Microbiology,1st Edn,2005.
- 10.Medical Microbiology, Anantnarayan
- 11.Nicklin, Instant Notes in Microbiology,2nd Edn.
- Stanier,General Microbiology, 5th Edn.
- Ingraham,Introduction to microbiology,3rd Edn
- 14.Moat, Microbial Physiology,4th Edn.
- 15. Ignacimuthu,Methods in Microbiology
- 16. Black, Microbiology Principle & Exploration,6th Edition.
- 17. Torotora , Microbiology: An Introduction 8th Edition.
- 18. Cuppuccino,Microbiology : A Laboratory Manual,8th Edition
- 19. White, Physiology & Biochemistry of Prokaryotes
- 20. Alexopoulos, Introductory Mycology
- 21. Rajvaidya, Applied Microbiology Vol.I to V, APH Pub.

IV. CORE COURSE PRACTICAL [CPBTC104]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100 **Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL PAPER I **Practical: 60 Lectures; Tutorial:15 Hrs**

Course Objective:

This course is focused on practical aspects and Experimentation of Biotechnology.

I Cell Biology and Microbiology

1. Method of Protein Estimation
   i) Estimation of Protein by Biuret methods
   ii) Estimation of Protein by Folin Lowry methods
   iii) Estimation of Protein by Bradford method
   iv) Estimation of Protein by UV Absorption.
2. Method of Carbohydrate Estimation
   i) Estimation of reducing sugar by DNSA method.
   ii) Estimation of Carbohydrate by Nelson-somogys method
   iii) Estimation of Carbohydrate by GOD/POD method.
   iv) Estimation of Carbohydrate by Phenol Sulphuric acid Method.
3. Nucleic acid Estimation
   i) Estimation of DNA by DPA method
   ii) Estimation of RNA by orcinol method /modified orcinol
   iii) Estimation of total lipids in seeds
4. Analysis of oils, iodine numbers, saponification value, acid number
5. Enzyme assay, Enzyme Kinetics, specific activity, Determination of Km & Vmax, Optimum pH, Optimum Temperature of Amylase/Alkaline phosphatase /protease/cellulase
6. Studying comparative effect of Inhibitors on enzyme activity of Amylase/Alkaline phosphatase/protease/cellulose.
   Alkaline Phosphatase i.e., a) Competitive Inhibition (NaH_2PO_4, PNP)
   b) Uncompetitive Inhibition (L – Phenylalanine)
7. Separation of plant pigments by paper chromatography
8. Separation of Amino acids by thin layer chromatography
9. Cell motility and flagella staining
10. Isolation of chlorophyll and xanthophyll from spinach leaves

II Microbiology

1. Isolation & maintenance of organism by plating, streaking & serial isolation methods slants & stab culture, storage of microorganism
2. Microscopic observation - Gram staining, Capsule & Spore Staining
3. Growth cure – Diauxic
4. Effect of Environmental Factors on Growth of Bacteria: Salt, Temp, pH.
5. Viable count of bacteria from soil sample (Dilution Plating Method)
6. Biochemical characterization of selected Microbes
7. Isolation of bacteriophages from sewage sample
8. Enrichment and Isolation of:
   a) Halophiles b) Acidophiles c) Phenol Degraders
   d) Nitrogen Fixers e) Antibiotic Producers f) Kojic Acid Producers
9. Alcohol Fermentation
10. Comparative studies of ethanol production using different substrates
11. Immobilization of Whole Cells
12. Effect of Antibiotics on various Gram Positive and Gram Negative bacteria
13. Determination of Minimum Inhibitory Concentration (MIC) and Minimum
14. Bactericidal Concentration (MBC) of various Antibiotics on different Organisms
15. Biochemical tests for identification of Bacteria- Oxidase, Catalase, IMVIC test, TSI Test etc.
16. Growth curve, measure of bacterial population by turbidometry and studying the effect of temp., pH Carbon and Nitrogen
17. Isolation of Rhizobium sp. From Root nodules of legumes.

III Molecular Biology

1. Isolation of Genomic DNA from bacterial cell / plant cell
2. Isolation of RNA from Yeast cells
3. Determination of Tm values of DNA
4. Isolation of Temperature sensitive conditional Mutant
5. Isolation of auxotrophic mutant by 5 BrU mutagenesis
6. Bacterial Conjunction
7. Physical mapping with interrupted conjugation techniques (By Problem solving approach)
8. Bacterial Transformation

IV Molecular Techniques

1. Isolation & Characterization of plasmid DNA
2. Isolation of Lambda phage DNA
3. Quantification of nucleic acid
4. Cloning in Plasmid or Phage vectors
5. Southern Blotting
6. Development of RFLP & RAPD Map
7. Access of population diversity by 16S rRNA sequence.

SEMESTER II 4 Papers

Total 100 x 4 = 400 Marks

I. CORE COURSE [CCBTC201]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations (Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).*

GENETIC ENGINEERING **Theory: 60 Lectures; Tutorial: 15 Hrs**

Course Objective:

This course is focused on the basic research methods in Biotechnology research and it's also gives basic knowledge of research.

Group - A

1. Scope of genetic engineering.
2. Milestone in genetic engineering: DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression, cloning and patenting of life forms, genetic engineering guidelines.
3. Molecular tools and their applications: Restriction enzymes, modification enzymes, DNA and RNA markers. Molecular Markers- RFLP maps, RAPD, STS, microsatellites SCAR (sequence characterized Amplified Regions) SSCP (single stranded conformational polymorphism), AFLP, QTL, application of molecular marker.
4. Isolation of genomic and plasmid DNA and their purification.
5. PCR and Its Applications: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Group - B

1. Gene cloning vectors: Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes.
2. Restriction mapping of DNA fragment and map construction, nucleic acid sequencing.
3. cDNA synthesis and cloning ; reverse transcription, linkers, adaptor and their chemical

synthesis, probes, library construction and screening.

4. Alternative strategies of gene cloning: cloning interacting genes - two-and-three hybrid systems, cloning differentially expressed genes, nucleic acid microarray.

Group - C

1. Site-directed mutagenesis and protein engineering. Proteomics Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.
2. How to study gene regulation? DNA transaction, Northern blot, primer extension, SI mapping, RNase protection assay, Reporter assays.
3. Expression strategies for herterologous genes: expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants.

Group - D

1. T- DNA and transposon tagging: Role of gene tagging in gene analysis, T-DNA and transposon tagging, Identification and isolation of genes through T-DNA or transposon.
2. Transgenic and gene knockout technologies: Targeted gene replacement chromosome engineering. Gene therapy.
3. Pharmacogenetics: High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

Essential Readings

- Nicholl, An Introduction to Genetic Engg. - 2 ed, Cambridge
- Primrose, Principles of Gene Manipulation - 6 ed, Blackwell
- Winnacker, From Genes to Clones, Panima
- Primrose, Principle of Gene Manipulation, Blackwell
- Griffiths, Intro. to Genetic Analysis - 8 ed, Freeman Pub.
- Maxine singer-berg, Genes – Genomes, Uni. Sci. Book
- T.A.Brown, Gene Clonning - DNA Analysis, Blackwell
- John Witkowski, Recombinant DNA, Scientific American
- Piramal, Molecular Biotechnology, Dominant Pub.
- Maxine singer & Paul Berg, Exploring Genetic Mechanism, Uni.science Books
- Bruce K. Patterson, Techniques in Quantification and Localization of Gene Expression, Birkhaus Pub.
- Reed , Holmes,Jonathan Weyers, Practical Skills in Bimolecular Sciences
- Anthony, Griffiths,William M, Modern Genetic Analysis :Integrating Genes & Genomes, W.H.Freeman and Company

---

II. CORE COURSE [CCBTC202]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

BIOCHEMISTRY AND BIOPHYSICS **Theory: 60 Lectures; Tutorial: 15 Hrs**

***Course Objectives:** This course is focused on the interdisciplinary application of Biotechnology.*

Group - A

1. Polysaccharides- Types, structural features, methods for compositional, analysis.
2. Carbohydrates: Metabolism of carbohydrates, Glycolysis, Krebs cycle, hexose Monophosphate Pathway, Glycogenesis, Gluconeogenesis, Uronic Acid Pathway, Glyoxylate Cycle, Calvin Cycle, hatch-Slack Pathway, Light reaction and formation of high energy bonds.
3. Sugars- Classification and reactions.
4. Lipids- Classification, structure and functions.
5. Lipid/ fat metabolism: Occurrence of various fatty acids in nature; biosynthesis of saturated and unsaturated fatty acids, sterols, sterols, phospholipids, triglycerides; biodegradation of saturated and unsaturated fatty acids.

Group - B

1. Amino acids and peptides- Classification, chemical reaction and physical properties.
2. Proteins- Classification and separation, purification and criteria of homogeneity, Ramachandran map; Primary and secondary structure, alpha -helix, beta -sheet structure etc. tertiary and quaternary structure, structural features of membrane proteins, secondary and tertiary structure prediction of protein conformation, sequencing of proteins.
3. Glyco- and lipoprotein- Structure and function.

Group - C

1. Enzymes: IUB classification, Steady state kinetics of enzyme catalyzed single substrate reaction, factors affecting enzymes activity, Introduction to allosteric enzymes.Enzymes in food processing, medicines and diagnostics; enzyme immobilization (method of immobilization industrial and therapeutically uses immobilized enzymes); role of enzyme in ELISA.
2. Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.

Group - D

1. Bio-techniques Basic Techniques
   Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques
2. Spectroscopy Techniques: UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy
3. Chromatography Techniques: TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity
4. Electrophoretic techniques: Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.
5. Centrifugation: Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods
6. Radioactivity Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay
7. Advanced Techniques: Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

Essential Readings

- Lenhinger. Principles of Biochemistry, Nelson & Cox, 4th Edition.
- Stryer – Biochemistry. W.H.Freeman & Co.
- Plumner. An introduction to practical Biochemistry,3rd Edition
- J.Jayraman. Lab Manual in Biochemistry.
- Cohn and Stumph. Outline of Biochemistry. Wiley eastern.
- Zube's Biochemistry.4th Edition Macmillan.
- Switzer and Garrity. Experimental Biochemistry WH Freeman.2nd Edition
- Voet & Voet Donald. 3rd Edition. Fundamentals of Biochemistry, J/W.
- Hames and Hooper. 2000. Instant notes in Biochemistry. BIOS Sci. Publ.
- Smith G. 1996. Biotechnology. Cambeidge Univ. Press.
- Geoffrey Cooper. 2000. The cell with CD- Rom. Sinauer Asso. Incorp.
- Elliott & Elliot.3rd Edition Biochemistry and molecular bilogy.
- Seidman and Moore. 2000. Basic laboratory methods for biotechnology. Longman
- Boyer. 1999. Concepts in biochemistry. Thomson
- Das and Mookerijee. Outline of biology.
- Biotechnology, Demystifying the concepts. By David Bourgaize. Alp 2000
- Wilson, & Walker. 1995. Principles and techniques of practical Biochemistry.
- Boyer. 2001. Concepts in Biochemistry. 2nd Edition
- Hames, Instant Notes in biochemistry, 2nd Edition.
- Garrett, Biochemistry,2nd Edition.
- Price & Steven, Fundamentals of Enzymology,3rd Edition
- Creigntion, proteins: Structure & Molecular Properties, Freeman Pub.+
- Stephen Neidle, Nucleic acid Structure and Recognition, Oxford University Press
- Rob Reed , David Holmes, Practical Skills in Bimolecular Sciences, LONGMAN Pub.

III. CORE COURSE [CCBTC203]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

IMMUNOLOGY **Theory: 60 Lectures; Tutorial: 15 Hrs**

Course Objective:

This course is focused on the immune system of vertebrates.

Group - A

1. Introduction
   - Phylogeny of immune System
   - Innate and acquired immunity
   - Clonal nature and immune response
2. Organization and structure of lymphoid organs.
3. Nature and biology of antigens and super - antigens.
4. Antibody structure and function.
5. Antigen- antibody interactions.
6. BCR & TCR generation of diversity.
7. Cells of the Immune System: Haematopoesis and differentiation, Lymphocytes trafficking, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, natural killer and Lymphokine activated killer cells, Eosinophil, Neutrophils and Mast cells.
8. Regulation of immune response: Antigen processing and presentation, generation of humoral and cell mediated immune responses; Activated B and T-lymphocytes; cytokine and their role in immune regulation; T-cell regulation, MHC-restriction.
9. Cell-mediated cytotoxicity: Mechanism of T - cell and NK cell mediated lysis Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity.

Group - B

1. Major histocompatibility complex.
2. Complement system.
3. Immunological tolerance.
4. Hypersensitivity.
5. Auotoimmunity.
2. Transplantation.

Essential Readings

- Janis Kuby, Immunology, 5th Edition
- Ivan Roitt, Essential Immunology, 9th Edn.
- Ananthnarayan , Medical microbiology,
- Mary S. Leffell,& Noel R. Rose, Handbook of Human Immunology, CRC press
- Tizzard, Immunology
- Elgert Immunology
- Lidyard, Instant notes in Immunology, 2nd Edition.
- Darla J wise, Immunology-A comprehensive review : A Blackwell science Pub.
- Todd & Spickett, Immunology
- Delves & Roitte Encyclopedia of Immunology- Vol-1 to Vol.-4, 2nd Edition

---

IV. CORE COURSE PRACTICAL [CPBTC204]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100 Pass Marks =45

Instruction to Question Setter: -

Mid Semester Examination (MSE):

*There will be **two** groups of questions in 20 marks written examinations. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type** five questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to be answered.**Note:** There may be subdivisions in each question asked in Theory Examinations*

PRACTICAL PAPER II **Practical: 60 Lectures; Tutorial: 15 Hrs**

Course Objective:

This course is focused on practical applications and Experimentation of Biotechnology.

I. Biochemistry and Biophysics

1. Protein Purification Studies of different proteins/enzymes.
2. SDS PAGE and Native Gel
    a. CBB – R250 staining technique
    b. Silver staining technique
2. Gel Filtration Chromatography
3. Ion Exchange Chromatography: Purification of proteins/enzymes using CM
    a. Cellulose / DEAE Cellulose.
    b. Induction of Protein synthesis in *E.coli* cells.
    c. Determination of Tm value of nucleic acid
4. Determination of % G+C content
5. The ultraviolet absorption of proteins and amino acids
6. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis- spectrophotometer and validating the Beer-Lambert's law
7. Protein Folding Studies.

II. Genetic Engineering

1. Plasmid Curing by Acridine Orange
2. Restriction Digestion of λ DNA using three Restriction Endonuclease enzymes:
a) EcoR V b) Hind III c) BamH I
3. Replica plating techniques
4. Agarose gel electrophoresis and restriction mapping of DNA
5. Demonstration of techniques of PCR

III. Immunology

1. ELISA
2. Generation of primary antibody by using mice as model organism.
3. Separation of serum and plasma from whole blood.
4. Single Radial Immunology
5. Octerlony Double diffusion.

SEMESTER III 4 Papers

Total 100 x 4 = 400 Marks

I. ABILITY ENHANCEMENT COURSE [ECBTC301]: (Credits: Theory-05)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

BIOSTATISTICS, COMPUTER APPLICATIONS & BIOINFORMATICS

Theory: 60 Lectures; Tutorial: 15 Hrs

Course Objective:

This course is focused on the basic knowledge of computer and use of computers in Biotechnology and its tools.

Group - A

1. Brief description and tabulation of data and its graphical representation.
2. Measure of central tendency and dispersion: mean, median, mode, range, standard deviation, and variance. Idea of two types of errors and level of significance, tests of significance (F & t test); chi - square tests.
3. Simple linear regression and correlation.

Group - B

1. Introduction of digital computers: Organization; low-level and high-level languages, binary number system.
2. Flow charts and programming techniques.

Group - C

1. Introduction to data structures and database concepts, introduction to Internet and its applications.
2. Introduction to MS-Office software, covering Word Processing, Spreadsheets and Presentation software, Introduction to Hardware graphics/ Corel draw.

Group - D

1. Computer- Oriented Statistical Techniques: Frequency table of single discrete variable, Bubble sort, Computation of mean variance and standard deviation: t- test, correlation coefficient.
2. Introduction to Bioinformatics: Definition and aims; fundamental of data base searching (BLAST and FASTA); computational gene finding-multiple alignment and sequence search; molecular evolution and phylogenetic trees.

Essential Readings

- Gary B.Fogel & David Corne, Evolutionary Computation in Bioinformatics, Morgan Kaufmann Publishers,
- Christoph W. Sensen , Essentials Of Genomics and Bioinformatics, Wiley-VCH.
- David Bowtell and Joseph Sambrook, DNA Microarrays, CSHL Press
- Murray R. Selwyn, Principles of Experimental Design for the Life Sciences, CRC Press
- Warren J. Ewens,Gregory R. Grant, Statistical Methods in Bioinformatics : An Introduction, Springer.
- Hugh G. Griffin,Annette M. Griffin, PCR Technology:current innovation.
- Ben Hui Liu, Statistical Genomics : Linkage, mapping and QTL Analysis, CRC Press
- Westhead, Instant Notes on Bioinformatics,1st Edn.
- Baxevanis & Francis, Bioinformatics,2nd Edn.Wiley.
- T.K.Attwood,An Introduction to Bioinformatics ,Pearson Pub.
- Higgs & Attwood, Bioinformatics & Molecular Evolution
- David W. Mount, Bioinformatics : Sequence and Genome Analysis,Cold Spring Harbor Laboratory Press

---

II. CORE COURSE [CCBTC302]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:
Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PLANT BIOTECHNOLOGY **Theory: 60 Lectures; Tutorial: 15 Hrs**

Course Objective: *This course is focused on the practical application of Biotechnology.*

Group - A

1. History of plant tissue culture and its present status.
2. Introduction to Cell and tissue culture technique to produce novel plant and hybrids.
3. Tissue culture media (composition and preparation)
4. Phytohormones a) Chemical nature, biosynthesis, physiological roles and mode of action of Auxins, Gibberellins and Cytokinnins b) Chemical nature and physiological roles of Morphactin, Abscisic acid and Ethylene.

Group – B

1. Initiation and maintenance of callus and suspension culture; singe cell clones.
2. Organogenesis, somatic embryogenesis; transfer and establishment of whole plants in soil.
3. Shoot- tip culture: Rapid clonal propagation and production of virus -free plants.
4. *In vitro* pollution, Embryo culture, embryo rescue and synthetic seeds.

Group - C

1. Anther, Pollen and Ovary culture for production of haploid plants and homozygous lines; endosperm culture.
2. Protoplast isolation, culture and fusion: selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
3. Nuclear cytology of cultured plant cells and somaclonal variation.
4. Cryopreservation, slow growth and DNA banking for germplasm conservation.

Group - D

1. Plant transformation technology; basis of tumor formation, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri plasmids as vectors, co-integrative and binary vectors, use of reporter genes, particle bombardment, electroporation, microinjection transformation of monocots.
2. Transgenic plants: insect resistance, virus resistance, resistance to fungal and bacterial diseases, longer shelf life, male sterility.
3. Metabolic engineering and industrial products: Important plant secondary metabolites, control mechanisms and manipulation.
4. Concept of Phytoimmunity.

III. CORE COURSE [CCBTC303]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ANIMAL BIOTECHNOLOGY **Theory: 60 Lectures; Tutorial: 15 Hrs**

Course Objective:

This course is focused on the application part of Biotechnology.

Group - A

1. Structure and organization of animal cell
2. Equipment and materials for animal cell culture technology
3. Primary and established cell line culture
4. Introduction to the balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of carbon dioxide, role of serum and supplements.
5. Serum and protein free defined media and r their application.
6. Biology and characterization of the cultured cell, measuring parameters of growth.
7. Basic techniques of mammalian cell culture *in vitro*; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.
8. Scaling - up of Animal cell culture.
9. Cell synchronization.

Group - B

1. Cell cloning and micromanipulation.
2. Cell transformation.
3. Application of animal cell culture - special secondary metabolites/products (insulin, Human Growth Hormones, Interferons, t-plasminogen activator, Factor VIII etc.), Hybridoma technology.
4. Stem cell cultures, embryonic stem cells and their applications
5. Cell culture based vaccines
6. Transgenic animal

Essential Readings

- Freshney, Culture of animal Cells, Sixth Edition

IV. CORE COURSE PRACTICAL [CPBTC304]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100 Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto60%, 1mark; 60<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL PAPER III Theory: 60 Lectures; Tutorial: 15 Hrs

Course Objective:

This course is focused on practical applications and Experimentation of Biotechnology.

I. Bioinformatics

1. Use of NCBI Bioinformatics Tools:
a) Pubmed b) OMIM c) Taxonomy
d) Protein analysis e) Genes and Disease
2. Use of Expasy Tools
3. FASTA and sequence formats
4. BLAST
5. Alignments – Pair wise & global
6. Construction of Dendrogram
7. Prediction of ORF/ gene Prediction
8. Protein Visualization (RASMOL, SPDB VIEWER, PROTEIN EXPLORER)
9. Protein Modeling-Homology modeling & Active site Prediction
10. Primer Designing
11. Biostatistics: Mean, Median, Mode, Standard Deviation, Chi square test, Student's t- test

II. Plant Biotechnology

1. Isolation of chloroplast & estimation of chlorophyll
2. Preparation of media & Surface sterilization of Explant
3. Selection, preparation and inoculation of explant for callusing
4. Study of callus characteristics
5. Sub-culturing of callus in differentiation media
6. Sub-culturing callus for Suspension culture
7. Extraction of secondary metabolites from callus culture
8. Protoplast Isolation & Culture
9. Production of Haploids by anther culture
10. Agrobacterium mediated gene transfer and reporter gene assay
11. *In vitro* evaluation of Medicinal plants against pathogenic microbes
12. Role of Microorganisms in elevation of heavy metal induced stress in plants

III. Animal Biotechnology

1. Total count of RBC & WBC differential count & Blood grouping
2. Western Blotting
3. Isolation & staining of Mitochondria
4. Blood film preparation and identification of cells.
5. Demonstration of Immunological reaction (WIDAL, VDRL Pregnancy, Hepatitis)

SEMESTER IV 4 Papers

Total 100 x 4 = 400 Marks

I. GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECBTC401]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations (Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).*

INDUSTRIAL BIOTECHNOLOGY

Theory: 60 Lectures; Tutorial: 15 Hrs

Course Objective:

This paper comprises four groups, encompassing industrial application, technological advancements and manufacturing perspectives, status of Biotechnology.

Group - A

1. Introduction to Bioprocess Engineering.
2. Bioreactors.
3. Isolation, preservation and maintenance of industrial microorganisms.
4. Kinetic of microbial growth and death.
5. Air and media sterilization.

Group - B

1. Media of industrial Fermentation.
2. Types of fermentation process: Analysis of batch, Fed-batch and continuous bioreactors, solid state fermentation, biotransformation.
3. Stability of microbial reactors, analysis of mixed microbial population, specialized bioreactors (pulsed, fluidized, photo-bioreactor etc.).
4. Measurement and control of bioprocess parameters.

Group - C

1. Downstream processing: Introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation.
2. Cell disruption, liquid extraction, Chromatography, membrane process, drying and crystallization.
3. Enzyme and whole cell immobilization and their industrial applications.

Group - D

1. Industrial production of - alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol).
2. Industrial production of - Antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine, glutamic acid), single cell protein.
3. Introduction to food technology
    - Elementary idea of canning and packing.
    - Sterilization and pasteurization of food products.
    - Technology of typical food / food products (bread, cheese, idli)
    - Food preservation.

Essential Readings

- Pappler, Microbial technology, Volume 1,2 7 3 Academic press
- E.L. Mansi, Fermentation, Microbiology & Biotechnology, Taylor Pub.
- Murray Moo & Young, Comprehensive Biotechnology, Vol-1 to 4.
- Tripathi, Food Biotechnology, Dominant Publication
- Mukhopadhyay. Process Biotechnology Fundamental. Viva book
- Shuler and Kargi, Bioprocess engineering. Prentice-Hall.
- Schugerl. 1987. Bioreaction engineering. J/W.
- Stanbury and Whitaker. Principles of fermentation technology.
- Sikyta, Methods in Industrial microbiology. Ellis Hardwood Ltd.
- T.K.Ghose. Bioprocess computation in biotechnology. Ellis Hardwood Ltd.
- Murray Joh. 1997. Microorganisms and Biotechnology.
- Bioprocess Engineering Principles by Doran (D); Academic Press, 1998
- Cooney, A.E. Humphrey, Comprehensive Biotechnology: The principles & Regulation of Biotechnology in Industry, Agriculture and Medicine, Vol.2, Pergamon Press.
- Doran. Bioprocess Engineering Principles - Academic Press - 2001

II. GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECBTC402]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations (Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).*

ENVIRONMENTAL BIOTECHNOLOGY

Theory: 60 Lectures; Tutorial: 15 Hrs

Course Objective:

This paper comprises four groups, encompassing application of Biotechnology for the protection and safety of the environment.

Group - A

1. Environment: basic concepts and issues.
2. Environmental pollution
3. Global environmental problems; ozone depletion, UV-B, green house effect and acid rain their impact and biotechnological approaches for management.
4. Air pollution and its control through biotechnology.

Group - B

1. Water pollution and its control: water as a scarce natural resource, need for water management, measurement of water pollution, sources of water pollution, waste water collection, waste water treatment- physical, chemical and biological treatment processes.
2. Microbiology of water treatment, aerobic process: activated sludge, oxidation ditches, trickling filter, towers, rotating disc, rotating drums and oxidation ponds.
3. Anaerobic process: anaerobic digestion, anaerobic filters, upflow anaerobic sludge.
4. Treatment schemes for waste water of dairy, distillery, tannery, sugar and antibiotic industries.

Group - C

1. Microbiology of degradation of xenobiotics in environment- ecological consideration, decay behaviour and degradative plasmids, hydrocarbons, substituted hydrocarbons, hydrocarbon transformation, oil pollution, surfactants, pesticides.
2. Bioremediation of contaminated soil and waste land.
3. Biopesticides in integrated pest management.
4. Solid wastes sources and management (Composting, vermiculture and methane production)

Group - D

1. Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge,
   Geographical Indications, Protection of New GMOs; International framework for the protection of IP
2. IPR Patent application-; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs
   Patent infringement- meaning, scope, litigation, case studies and examples
3. Bio-safety: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels Biosafety guidelines - Government of India;
4. Definition of GMOs & LMOs Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Cartagena Protocol., Bio-piracy.

Essential Readings

- Rajvaidhya, Environmental Biochemistry, APH Pub
- Ahmed, Industrial & Envi. Biotech, Horizon
- Bitton, Wastewater Microbiology - 2 ed, Wiley
- D.P.Singh, Environmental Microbiotech, New Age
- Pratham Vashisth, Environmental Biotechnology, Dominant Pub.
- Arihat Parulkar, Environmental Biotechnology, Dominant Pub
- Purohit Shammi, Environmental Sciences, Student Edi
- Eugene Odum, Ecology, Oxford
- B.K.Singh, Biodiversity, Mangal Deep
- 10.Vashishtha, Environmental Biotechnology, Dominant Pub.
- 11.Gerba & Pepler, Environment Microbiology
- H. D. Kumar, Textbook of Microbiology

Important Links

- http://www.w3.org/IPR/
- http://www.wipo.int/portal/index.html.en
- http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html www.patentoffice.nic.in
- www.iprlawindia.org/ - 31k - Cached - Similar page
- http://www.cbd.int/biosafety/background.shtml
- http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
- http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

---

III. ELECTIVE COURSE PRACTICAL [EPBTC403]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL PAPER IV PRACTICAL: 60 Lectures; Tutorial:15 Hrs

Course Objective:

This course is focused on practical applications and Experimentation of Biotechnology.

1. Analysis of potable Water for determining its Quality
   - 1a. Detection of Coliforms (MPN)
   - 1b**.** Determination of Total Dissolved Solids
   - 2. Chemical Analysis of Sewage / effluent sample
   - 2a. Determination of Solids (TS, TSS, TDS)
   - 2b. Determination of Dissolved oxygen content
   - 2c. Determination of BOD
   - 2d. Determination of COD
   - 2e. Determination of Nitrogen (NH_4 – N, NO_3 – N, NO_2 – N, Total Organic N)
   - 2f. Determination of Phosphorus (Total, Dissolved, Portico late P)
3. Isolation, Identification and Characterization of Polyhydrocarbon Degrading Organisms.
4. Isolation, Identification and Characterization of Dye Degrading Organisms
5. Microbial production of Citric acid/Alcohol/Antibiotics
6. Estimation of heavy metals in water/soil by atomic absorption spectrophotometer

---

IV. CORE COURSE (PROJECT) [PRBTC404]: (Credits: 05)

Marks : 100 (ESE: 3Hrs)=100	Pass Marks =45

Guidelines to Examiners for

End Semester Examination (ESE):

Evaluation of project dissertation work may be as per the following guidelines:

Project model (if any) and the Project record notebook = 70 marks
Project presentation and viva-voce = 30 marks

Overall project dissertation may be evaluated under the following heads:

- *Motivation for the choice of topic*
- *Project dissertation design*
- *Methodology and Content depth*
- *Results and Discussion*
- *Future Scope & References*
- *Presentation style*
- *Viva-voce*

PROJECT WORK/ DISSRERTATION/ PAPER PRESENTATION

Each student has to submit two copies of the dissertation work duly forwarded by the HOD of Department concerned. The forwarded copies will be submitted in the Department of Botany, Ranchi University, for evaluation (Seven days before the seminar).

The paper will consist of

(a) Field work/Lab work related to the project.
(b) Preparation of dissertation based on the work undertaken.
(c) Presentation of project work in the seminar on the assigned topic in the P.G. Department of Botany, Ranchi University, Ranchi & open viva there on.

- Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular intervals.

OR

- Paper presentation on 'Topic Provided' and group discussion

NB:- Students will select topics for the project work in consultation with a teacher of the department. The Seminar will be held in the Department of Botany, Ranchi University, Ranchi.

DISTRIBUTION OF CREDITS FOR P.G. PROGRAMME (SEMESTER-WISE) FOR POSTGRADUATE **'P.G. Voc./M.Sc./M.A./M.Com'** PROGRAMME

Table B-1: Semester wise distribution of 80 Credits for Subjects with Practical Papers.

Semester	CC	FC	GE/DC	AE	Total credits
Semester I	15	05			20
Semester II	20				20
Semester III	15			05	20
Semester IV	5		15		20
	55	**05**	**15**	**05**	**80**

Table B-1: Semester wise distribution of 80 Credits for Subjects without Practical Papers.

Semester	CC	FC	GE/DC	AE	Total credits
Semester I	15	05			20
Semester II	20				20
Semester III	15			05	20
Semester IV	10		10		20
	60	**05**	**10**	**05**	**80**

CC=Core Course; FC=Foundation Compulsory/Elective Course; GE=Generic Elective; SE=Skill Enhancement Course; DC=Discipline Centric Elective

SAMPLE CALCULATION FOR SGPA & CGPA FOR POSTGRADUATE **'P.G. Voc./M.Sc./M.A./M.Com'** PROGRAMME

Table B-2: Sample calculation for SGPA for M.Sc./M.A./M.Com Programme

Course	**Credit**	**Grade Letter**	**Grade Point**	**Credit Point (Credit X Grade)**	**SGPA (Credit Point/Credit)**
Semester I					
FC	05	A	8	40	
C-1	05	B+	7	35	
C-2	05	B	6	30	
C-3/CP	05	B	6	30	
Total	**20**			**135**	**6.60 (135/20)**
Semester II					
C-4	05	B	6	30	
C-5	05	C	5	25	
C-6	05	B+	7	35	
C-7/CP	05	A+	9	45	
Total	**20**			**135**	**6.60 (135/20)**
Semester III					
EC-1	05	A+	9	45	
C-8	05	0	10	50	
C-9	05	A	8	40	
C-10/CP	05	A	8	40	
Total	**20**			**175**	**8.75 (175/20)**
Semester IV					
EC-2/EC-2	05	B	6	30	
EC-3/EC-3	05	A+	9	45	
C11/EP	05	B	6	30	
Project	05	A+	9	45	
Total	**20**			**150**	**7.50 (150/20)**
CGPA					
Grand Total	**80**			**595**	**7.44 (595/80)**

Table B-3: Sample calculation for CGPA for P.G. Vocational M.Sc./M.A./M.Com Programme

Semester I	**Semester II**	**Semester III**	**Semester IV**
Credit:20; SGPA:6.60	Credit:20; SGPA: 6.60	Credit:20; SGPA: 8.75	Credit:20; SGPA: 7.50

Thus CGPA= (20x6.60+20x6.60+20x8.75+20x7.50) /80**=7.36**

DISTRIBUTION OF MARKS FOR EXAMINATIONS AND FORMAT OF QUESTION PAPERS

Distribution of Marks for Mid Semester Evaluation:

Table No. 15: Distribution of marks of Theory Examinations of Mid Semester

Topic	Code	Full Marks	Pass Marks	Time	Group-A (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M.	Group-B (Descriptive Questions) No. of Questions x Marks = F.M.	Total No. of Questions to Set	
							Group A	Group B
Mid Sem*	T30*	30 (20 +5 +5)	17	1 Hr	5 x1 =5	3 (out of 5) x5 =15	05	5

***There shall be 20 marks theory examination for mid sem, 05 marks for attendance/ regular interactions & 05 marks for seminar/ assignment/ term paper given by faculty concerned in classrooms.**

Distribution of Marks for End Semester Theory Examinations:

Table No. 16: Marks distribution of Theory Examinations of End Semester

Topic	Code	Full Marks	Pass Marks	Time	Group-A# (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M.	Group-B (Descriptive Questions) No. of Questions x Marks = F.M.	Total No. of Questions to Set	
							Group A#	Group B
End Sem	T50	50	--	3 Hrs	2 x5 =10	2 (out of 3) x20 =40	2	3
	T70	70	28	3 Hrs	Q.No.1 (5x1) + 1x5 =10	4 (out of 6) x15 =60	2	6

 # Question No.1 in Group-A carries very short answer type questions of 1 Mark

Note : There may be subdivisions in each question asked in Theory Examinations.

FORMAT OF QUESTION PAPER FOR MID SEM EXAMINATION

20 MARKS

Ranchi University, Ranchi

Mid Sem No. Exam Year

Subject/ Code

F.M. =20 **Time**=1Hr.

General Instructions:
समान्य निर्देश :

i. **Group A** carries very short answer type compulsory questions.
(खंड 'A' में अत्यंत लघु उत्तरीय अनिवार्य प्रश्न हैं।)
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के पाँच में से किन्हीं तीन विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. ..... [5x1=5]
2. .....
3. .....
4. .....
5. .....

Group B

6. ..... [5]
7. ..... [5]
8. ..... [5]
9. ..... [5]
10. ..... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

50 MARKS

Ranchi University, Ranchi

End Sem No. Exam Year

Subject/ Code

F.M. =50

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 2 out of 3** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के तीन में से किन्हीं दो विषयनिष्ठ / वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. ..... [5]
2. ..... [5]

Group B

3. ..... [20]
4. ..... [20]
5. ..... [20]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

70 MARKS

Ranchi University, Ranchi

End Sem No. Exam Year

Subject/ Code

F.M. =70 **P.M.**=28 **Time**=3Hrs.

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के छः में से किन्हीं चार विषयनिष्ठ / वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. [5x1=5]

i. .....
ii. .....
iii. .....
iv. .....
v. .....

2. ..... [5]

Group B

3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.