RADHA GOVIND UNIVERSITY
RAMGARH, JHARKHAND
DEPARTMENT OF BIOTECHNOLOGY

COURSE CURRICULUM FOR POSTGRADUATE COURSES
UNDER CHOICE BASE CREDIT SYSTEM
FACULTY OF SCIENCE

M.Sc. Biotechnology

(Effective from Session 2025-27)

9/5/2025

Dr. Aman Kumar Singh (Hq)

9/5/2025

Vision

To impart knowledge and envisages in learner for applying their minds to develop technologies, which will impact not only science but also for society in long run.

Mission

- To produce leadership in science and technology.
- Creating awareness about potential application in the field of Biotechnology and socio-ethical implications of the subject.
- To create a unique image of institution through large scale participation and contribution of students, expert faculties.
- To prepare responsible trained manpower in teaching and research.
- To publish high quality research papers in different fields
- The department will encourage young creative mind to enable them to tap their potential as emerging entrepreneurs in the field of Biotechnology.

Program Educational Objectives (PEO)

After the successful completion of M.Sc. Biotechnology program, thestudents will able to:

PEO-1: Have basic and advanced understanding of Biotechnology in its various domains including, health, nutrition, agriculture, biodiversity conservation, Biosafety etc.

PEO -2: Address research questions related to all the above mentioned domains through carrying out specific experiments.

PEO -3: Appear and successfully qualify the higher level examinations of various agencies like DBT(Department of Biotechnology), CSIR (Council ofScientific and Industrial Research), ARS (Agriculture Research Services), ICAR(Indian Council of Agriculture Research),and many more, so as to get chance to do research from reputed institutes within country and abroad withsound fellowships

PEO -4: Have enough subject knowledge to move ahead in entrepreneurship endeavors in biotechnology.

Programme Specific Outcome (PSO)

PSO-1: To enable graduates to pursue research career in industry and academia by providing fundamental and practical knowledge in the field of Biotechnology.

PSO-2: To empower the students with analytical and research skills, enable them to critically analyze existing literature in an area of specialization and to nurture entrepreneurial endeavors.

PSO-3: To develop biotechnologists with professional ethics in order to address global and societal issues for sustainable development.

Program outcome (PO)

PO 1: Master of Science knowledge: Apply the knowledge of biotechnology, microbiology, biochemistry fundamentals, and bioinformatics to the solution of complex biological problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex biological problems reaching substantiated conclusions using various principles of biotechnology, bioinformatics, microbiology, biochemistry, cell and molecular biology sciences.

PO 3: Design/development of solutions: Design solutions for complex biological problems and design protocols or processes that meet the specified needs with appropriate consideration for the public health and safety, conservation of biodiversity, better understanding of the microorganisms, and using bioinformatics tools for finding solutions of various crippling human/plant diseases with ethical, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use the various protocols developed through extensive research-based knowledge and methods including design of experiments, analysis and interpretation of data, and provide valid and reproducible conclusions.

PO 5: Modern Molecular Biology and Bioinformatics tools usage: Develop new technologies, protocols, resources, using modern molecular biology, biotechnology and bioinformatics tools and apply it to solve complex human health problems, plant stress tolerance and conserve floral biodiversity of Himalayan region focusing on medicinally important plants with an understanding of the limitations of this region.

PO 6: Post Graduate Student and society: Apply the classic and modern biological theoretical and practical knowledge gained to address societal, health, microbial and plant biodiversity studies, safety, ethical and cultural issues and the consequent responsibilities relevant to the professional up- gradation of the student and society as a whole.

PO-7: Environment and sustainability: Understand the impact of Himalayan hot spot of biodiversity. The professional PG students will have a better understanding of societal and environmental concerns, and demonstrate their knowledge, and need for sustainable development.

PO-8: Ethics: Apply ethical principles established by different government agencies and commit to research ethics, responsibilities and norms to undertake their current and future research and development.

PO-9: Individual and team work: Be an independent thinker and researcher effectively as an individual, and as a member or leader of different teams, and in multidisciplinary research Institutions and Universities.

PO-10: Communication: Communicate effectively on complex research activities with the scientific community and with society at large, as a scientist or a teacher, be well versed with scientific writing and write effective reports and design research projects, make effective presentations, and be able to defend it efficiently.

PO-11: Project management and finance: Write good research and development projects relevant to the needs of society and environment and attract extra mural funds for himself and his team in the Institute or University from various funding agencies and manage R&D projects effectively.

PO-12: Life-long learning: Apply the discipline, ethics and knowledge obtained to engage in independent and life-long learning in their respective fields of interest wherever they go for further higher studies or jobs.

Course Structure

The Course structure of Semester I-1V shall be as under.

(Total Credits: 74)

FIRST SEMESTER **(18 credits)**

Paper	Subject Code	No. of Credits per week	Teaching (in hours) per week	Minimum Teaching required in Hrs
I	BTM-101	3(3x1=3)	3	45
II	BTM-102	3(3x1=3)	3	45
III	BTM-103	3(3x1=3)	3	45
IV	BTM-104	3(3x1=3)	3	45
V	BTM-105	3(3x1=3)	3	45
VI	BTM-106	3(3x1=3)	3	45/90

SECOND SEMESTER **(18 credits)**

Paper	Subject Code	No. of Credits per week	Teaching (in hours) per week	Minimum Teaching required in Hrs
VII	BTM-201	3(3x1=3)	3	45
VIII	BTM-202	3(3x1=3)	3	45
IX	BTM-203	3(3x1=3)	3	45
X	BTM-204	3(3x1=3)	3	45
XI	BTM-205	3(3x1=3)	3	45
XII	BTM-206	3(3x1=3)	3	45/90

THIRD SEMESTER **(18 credits)**

Paper	Subject Code	No. of Credits per week	Teaching (in hours) per week	Minimum Teaching required in Hrs
XIII	BTM-301	3(3x1=3)	3	45
XIV	BTM-302	3(3x1=3)	3	45
XV	BTM-303	3(3x1=3)	3	45
XVI	BTM-304	3(3x1=3)	3	45
XVII	BTM-305	3(3x1=3)	3	45
XVIII	BTM-306	3(3x1=3)	3	45/90

FOURTH SEMESTER

Subject Code: BT-M-401 **Subject Code: BTM-402**

Paper: XIX **Paper: XX Dissertation/Project Work**

Fundamentals of Research Methodology (***Course based on project and its seminar)*. (=02 credits) (=20 credits)**

[Total=02+18=20 Credits]

Paper	Subject Code	No. of Credits	Teaching(in hours) per week	Minimum Teaching required in Hrs
XIX	**BTM-401**	2(2X1=2)	1	12
XX	**BTM-402**	18	1	12

Total = 1st +2nd + 3rd +4th Semesters] **[Total=18+18+18+20=74 Credits]**

Marking Scheme of the Examination

FIRST SEMESTER

Paper (Theory & Practical)	External Exam	Internal Exam	Pass Marks (External)	Pass Marks (Internal)	Total Marks	Pass Marks
I. Cell Biology	**70**	30	**28**	**12**	**100**	**40**
II. Microbial Physiology & Genetics	**70**	30	**28**	**12**	**100**	**40**
III. Biostatistics, & Computer Applications in Biology	**70**	30	**28**	**12**	**100**	**40**
IV. Biochemistry	**70**	30	28	**12**	**100**	**40**
V. Practical	**70**	30	28	**12**	**100**	**40**
VI. Communicative English (Elective from other Department)	**70**	30	28	**12**	**100**	**40**
TOTAL	**420**	180	**168**	72	**600**	**240**

SECOND SEMESTER

Paper (Theory & Practical)	External Exam	Internal Exam	Pass Marks (External)	Pass Marks (Internal)	Total Marks	Pass Marks
VII. Genetic Engineering	**70**	**30**	**28**	**12**	**100**	**40**
VIII. Methods in Molecular Diagnostics	**70**	**30**	**28**	**12**	**100**	**40**
IX. Molecular Biology & Biophysics	**70**	**30**	**28**	**12**	**100**	**40**
X. Biology of The Immune System	**70**	**30**	28	**12**	**100**	**40**
XI. Practical	**70**	**30**	28	**12**	**100**	**40**
XII Fundamentals of Economics (Elective from other Department)	**70**	**30**	28	**12**	**100**	**40**
TOTAL	**420**	**180**	168	**72**	**600**	**240**

THIRD SEMESTER

Paper (Theory & Practical)	External Exam	Internal Exam	Pass Marks (External)	Pass Marks (Internal)	Total Marks	Pass Marks
XIII. Animal Cell Sciences & Techniques	**70**	**30**	**28**	**12**	**100**	**40**
XIV Bioprocess Engineering & Technology (Elective)	**70**	30	**28**	**12**	**100**	**40**
XV. Plant Biotechnology	**70**	**30**	**28**	**12**	**100**	**40**
XVI. Environmental Biotechnology	**70**	**30**	28	**12**	**100**	**40**
XVII. Practical	**70**	**30**	28	**12**	**100**	**40**
XVIII. IPR &Patenting	**70**	**30**	28	**12**	**100**	**40**
TOTAL	**420**	**180**	**168**	**72**	**600**	**240**

FOURTH SEMESTER

XIX. RESEARCH METHODOLOGY	Max. Marks 100	**Min. Aggr. Marks for Passing = 40**
XX. DISSERTATION /PROJECT WORK (Six Months)	600	=240
TOTAL MARKS	**700**	**=280**

AGGREGATE OF 1st, 2nd,3rd & 4th Semesters

Total Marks =2500 **Pass**

Marks=(720+280)=1000

FIRST SEMESTER

Paper: BTM -101 : Cell Biology

Course Outcome

CO 1: Study of cell theory, Cell organelles, Ultrastructure, Roles of cell organelles.

CO 2: Exhaustive study of Cell Signaling pathways, secondary messengers etc.

CO 3: Understanding of Developmental biology: Stem cell and cancer, Differentiation in plant tissue

CO 4: Familiarization with methods of cell-study, various forms of Microscopy, staining for microscopy etc.

CO 5: Understand towards cell differentiation, malignancy and cell death. Compile the information on the structural aspect of cellular biology.

CO 6: Explain the organization of genes and chromosomes, chromosome morphology and its aberrations.

Unit I

Diversity of Cell size and shape, Cell theory, Structure of Prokaryotic and eukaryotic cells, Isolation of cells, Principles of microscopy, light microscopy, resolving power of a microscope, SEM and TEM, Freeze etch and image processing; Cellular organelles, Structural complexity of chromosomes.

Unit II

Plasma membrane structure, function and transport mechanisms, transport of nutrients, ions and macromolecules across membranes. Cellular energy transactions- role of mitochondria and chloroplast.

Unit III

Cell cycle- molecular events and model systems; Cell signaling in plants & animals, mechanisms of signal transduction, quorum sensing. Cilia and flagella of eukaryotes & prokaryotes; Biology of cancer; Cellular basis of differentiation and development: mitosis, meiosis, gametogenesis & fertilization.

Unit IV

Biosynthesis of proteins in eukaryotic cell, protein localization, synthesis and secretion of membrane proteins, intracellular protein trafficking. Cell Junctions, Development in *Drosophila* and *Arabidopsis*.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	3	1	1	3	3	1	3	3	1	1	2	2	3	2	2
CO2	2,3, 4	3	3	3	3	3	-	1	1	1	-	2	-	2	2	1
CO3	1,2, 4	3	-	3	3	2	2	1	2	2	1	3	2	2	1	2
CO4	1,2, 3	2	1	1	3	2	1	2	3	-	1	3	1	3	1	2
CO5	1,2	2	2	2	2	3	2	1	2	-	-	2	-	3	2	2
CO6	1,2, 6	-	2	3	-	3	2	2	3	3	-	2	3	3	3	3

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Molecular Biology of the Cell, B. Alberts, 6th Edition, Garland Science
2. Molecular Cell Biology, Lodish et al., 5th Edition, Free Man
3. Developmental Biology, SF Gilbert, Sinauer Associates Inc.,7th Edition
4. The Cell – A Molecular Approach, 6th Edition, Geoffrey M.Copper,Sinauer Asociates
5. Molecular Biology, Friedfelder D, Jones and Bartlett Publication, (1998).
6. Principles of Biochemistry,Lehninger, Freeman,5th Edition
7. Cell Biology: T.devasena

Paper: BTM-102 : Microbial Physiology & Genetics

Course Outcome

CO1: Experimental knowledge of Sterilization, disinfection, safety in microbiological laboratory. Preparation of media, Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods, Storage of microorganisms, Gram Staining and enumeration of microorganisms.

CO 2: Theoretical knowledge of microbial diversity & systematics, Microbial growth and physiology; Study of size, shape and growth pattern, nutrition type of microbes.

CO 3: Familiarization of assays related to antibiotics production and demonstration of antibiotic resistance.

CO 4: Understand the basic microbial genetics including prokaryotic gene expression and regulation.

CO 5: Understand the concept of gene in terms of recon, muton and cistron including both classical and modern concept.

CO 6: Understand the concept of classical genetics including Mendelian laws is easily grasped by students.

Unit I

History and scope of microbiology, Sterilization techniques, Pure culture methods enrichment culture technique, Isolation, staining techniques and preservation of microorganisms. Kinetics of growth, curve & mathematical expression of growth.

Unit II

Metabolic diversity among microorganisms, photosynthesis in microorganisms, chemolithotrophy; hydrogen-iron nitrite oxidizing bacteria; nitrate and sulfate reduction; Methane fermentation-diversity, syntrophy, role of anoxic decomposition, methanogenesis and acetogenesis; hydrocarbon transformation.

Unit III

Structural diversity of bacteria, purple and green bacteria, cyanobacteria, spirilla, spirocheaetes,lactic and propionic acid bacteria, rods and cocci, mycobacteria, rickettsias, chlamydias and mycoplasma methanogens.

Structural diversity of viruses; bacterial, plant, animal and tumor viruses, discovery, classification and structure of viruses, positive and negative strand viruses, lytic and lysogenic cycle, examples of herpes, pox, adenoviruses, retrovirus, Ø X 174,viroids and prions.

Unit IV

Procaryotic cells structure and functions, cell walls of eubacteria, peptidoglycan and related molecules, biosynthesis of cell wall; outer membrane of gram negative bacteria, cell membrane synthesis, gram +ve and gram –ve flagella, cell inclusions like endospores, gas vesicles. Host parasite relationship; entry of pathogens into host; toxins and their mode of action. Elementary idea of broad spectrum antibiotics

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	3	2	3	3	3	2	2	2	3	2	2	3	3	2	2
CO2	2,3, 4	1	2	2	1	2	-	3	2	1	2	2	3	3	3	2
CO3	1,2, 3	3	3	3	3	2	1	2	1	2	1	2	2	2	3	1
CO4	2,3,	2	2	2	2	-	2	2	1	2	3	3	1	1	1	2
CO5	1,3	1	2	3	1	2	3	1	3	1	2	1	2	3	2	3
CO6	1,2, 3,4	3	1	2	2	1	2	-	2	3	1	2	2	3	2	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. General Microbiology, Stanier, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan press Ltd.5th edition (2000).
2. Brock Biology of Microogranisms, Madigan M.T. Martinko, J.M. and Parker, J. Prentice- Hall NY, USA (6th edition).
3. Microbiology, Pelczar, M.J. Jr. Chan E.C.S. and Kreig , N.R. Tata McGraw Hill, NY, USA (5th edition).
5. Microbiology- A Laboratory Manual, Cappuccino, J.G. and Sherman N. Addison Wesley, UK,(10th edition).
6. Microbiological Application: A Laboratory Manual in General Microbiology Benson, H.J, Alfred Brown, McGraw Hill, NY, USA (10th edition).

Paper: BTM-103 : Biostatistics & Computer Applications in Biology

Course Outcome

CO 1: Comprehensive study of various topics including Data representation methods, measures of central tendency, variance

CO 2: Practical knowledge of application of correlation and regression analysis, test of significance: F and t tests, Chi square test etc.

CO 3: Study on sigma plotter, null hypothesis, Bioinformatic methods.

CO 4: Familiarization with biological databases, sequence, structure and strain database.

CO 5: Secondary and sequence analysis of DNA, RNA and proteins.

CO 6: Basic idea of computer languages.

Unit I

Importance and scope of statistics in biological experimentation; Elements of probability; Mathematical and statistical definitions; Addition and Multiplication theorems; Probability distribution functions-Binomial, Poisson and Normal; Area under normal distribution curve. Measures of central tendency: Arithmetic, geometric & harmonic means: Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean.

Unit II

Tests of significance, hypothesis and errors; student t statistics-population means equals a specified value; equality of 2 independent means (equal and unequal variance), equality of 2 means (paired samples). Analysis of variance: one way analysis (sample sizes equal and unequal), completely randomized design; two way analysis (one observation per cell).

Unit III

Linear regression: regression diagram and equation, regression coefficient, standard error, significance tests, prediction of dependent variable from the independent variable; linear correlation-scatter diagram , correlation coefficient, standard error, significance tests; relationship between regression and correlation coefficients, Non parametric tests: Chi square statistics, tests of goodness of fit, test of independence of attributes, standard line interpolation.

Unit IV

Introduction to computers: Basic Architecture, generations of computer hardware and software; operating systems-WINDOWS system and application software; introduction to internet-LAN, MAN,WAN, Programming language C (Introduction) and presentation software, Flow charts & Programming techniques.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2	3	2	2	3	2	3	2	1	2	3	3	2	2	2	3
CO2	1,2, 3	2	3	2	3	2	2	1	2	3	1	3	2	2	3	1
CO3	1,3	2	2	2	1	3	1	3	2	1	1	2	1	1	2	3
CO4	1,2, 3,4	1	2	1	2	1	-	3	1	2	2	2	3	2	3	1
CO5	1,2, 4	3	1	3	1	3	2	1	3	2	2	1	1	2	2	1
CO6	1,3	1	1	3	2	1	1	2	1	2	3	2	1	2	3	3

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books: -

1. Fundamentals of Biostatistics and Bioinformatics– B.L.Agarwal, New Age International Publishers, Daryaganj, New Delhi

2. Bioinformatics- Sharma, Shankar, Rastogi Publication,Merrut,

3. Principles of Bioinformatics- Shanmughawel, Pointer Publishers, Jaipur,

4. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (1983).

5. Statistical Methods, Medhi J, Willey Eastern Limited, (1992).

Paper: BTM-104: BIOCHEMISTRY

Course Outcome

CO 1: Theoretical knowledge of various topics as per the syllabus.

CO 2: Exhaustive study of enzyme kinetics and bio- molecules, different metabolic pathways.

CO 3: Familiarization with Bioenergetics concepts,generation of ATP

CO 4: Experimentation related to enzyme kinetics, c-protein/sugar/lipid estimation using different methods, titrations etc.

CO 5: Concept building in alternate energy sources.

CO 6: Study of role of biotechnological techniques in environment protection.

Unit I

Structure of water and its solvent properties, acid, base, pH and buffers, free energy and spontaneity of reactions; ATP and other phosphorylated compound with their free energy of hydrolysis, biological oxidation reduction reactions, coupled reactions and oxidative phosphorylation. Intra and inter molecular forces, electrostatic interactions, hydrogen bonding, weak interactions and Vander Waals forces, disulphide bridges.

Unit II

Enzyme classification, specificity, active site, Enzyme kinetics- Michaelis & Menton equation, determination of kinetic parameters, bi-substrate reactions and their kinetics, enzyme inhibition and kinetics, allosteric enzymes, ribozymes, isozymes. Enzyme catalysis in solutions, Applications of enzymes in industries.

Unit III

Structure and chemistry of macromolecules: Carbohydrates, Proteins, Lipids and Vitamins. Biochemical tests for carbohydrates, proteins & lipids. Kinetics of protein folding, protein sequencing & protein denaturation. Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

Unit IV

Chromatographic technique- paper and TLC, gel filtration, column chromatography, ion-exchange, affinity column, HPLC, GLC, SDS-PAGE, Agarose electrophoresis; isoelectric focusing & 2D-PAGE, Western blotting, Differential, density gradient, rate zonal & isopycnic centrifugation.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2,3	3	1	1	3	3	1	3	3	1	1	2	2	3	2	2
CO2	1.3.4	3	3	3	3	3	-	1	1	1	-	2	-	2	2	1
CO3	2,3	3	-	3	3	2	2	1	2	2	1	3	2	2	1	2
CO4	1,4	2	1	1	3	2	1	2	3	-	1	3	1	3	1	2
CO5	2,3,4	2	2	2	2	3	2	1	2	-	-	2	-	3	2	2
CO6	1,3	-	2	3	-	3	2	2	3	3	-	2	3	3	3	3

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books: -

1. Biochemical Calculations, Irwin H. Segal, John Wiley and Sons Inc, 2nd Edition.
2. Biochemistry, Stryer I., H.Freeman and Company, (2000).
3. Understanding Chemistry CNR Rao, Universities. Press Hyderabad (1999).
4. A Biologist's Guide to Principals and Techniques of Practical Biochemistry. K Wilson & KH Goulding, ELBS Edition, 1986.
5. Principles of Biochemistry,Lehninger, Freeman,5th Edition
6. Biochemistry,Jermey M. Berg,John L.Tymcozko.7th Edition
7. Harper's Biochemistry, Murray RK et al., Prentice Hall International (1999).

Paper: BTM-105 **Practical**

List of Practicals:

1. Microscopy : bright field
2. To study instrumental methods for cell biology
3. To study mitosis & meiosis
4. 'C' programming language
    a) if-else, nested if-else, ladder if-else related programs
    b) looping
    c) arrays
5. MS- Office

a. MS-Word

b. MS-Excel

c. MS-Power Point

6. MS-DOS
7. Basic Practicals of Bioinformatics
8. To prepare NA media for routine cultivation of bacteria.
9. To prepare Czapek-Dox Agar media for routine cultivation of fungi.
10. To prepare PDA media for routine cultivation of fungi.
11. To prepare LB broth for enteric bacteria culture
12. To study various methods of sterilization, Isolation and maintenance of micro-organisms by plating, streaking and serial dilution methods of slants and stab cultures, storage of micro-organisms.
13. To isolate pure cultures from soil and water.
14. To study growth curve, measurement of bacterial population by turbidometry and serial dilution methods; effects of temperature, pH, carbon and nitrogen sources on growth.
15. Microscopic examination of bacteria and yeast study of micro-organism by Gram's staining, and staining for spores.
16. Assay of antibiotics and demonstration of antibiotics resistance.
17. Titration of amino acids.
18. Colorimetric determination of pK.
19. Estimation of DNA by DPA method.
20. Estimation of RNA by Orcinol method.
21. Estimation of glucose by DNS method.
22. Estimation of protein by FC method.
23. To separate the plant pigments by paper chromatography.
24. To separate the lipids from doob grass by TLC

Paper: BTM-106: Communicative English

Course Outcome

CO1: Ability to comprehend both the written and spoken texts. Ability to frame questions and answer them. Ability to write/speak grammatically correct sentences.

CO2: Ability to write a paragraph around a topic sentence, write descriptions and dialogues. Use of telephone etiquettes with correct usage of tense and voice pattern.

CO3: Ability to write coherent paragraphs with wide range of vocabulary.

CO4: Awareness of the art of personal letter/email writing without grammatical errors.

CO5: Ability to participate in short group conversations. Ability to use collocations, fixed and semifixed expressions.

CO 6: Develop the basics of oral communication for academic, social and professional situations.

Unit-1

Introduction, Business Correspondence

Definition, Objectives, Stages of Communication, Essentials of Good/Effective Communication, Benefits of Good communication, Gaps in Communication, Communication and Information Technology. Structure of a Letter, Inquiry Letter, Sales Letter, Order Letter, Complaints, Complaint Handling, Telemarketing.

Unit-2

Government Correspondence, Writing Skills

Noting, Routine Letter, Official Letter, Memorandum, Circular, Telegrams, Newsletter, Report Writing, Scientific Paper Writing, Writing small Paragraphs & Essays, Composition.

Unit-3

Grammar

Sentence Structure, Idiomatic Usages of Language, Tense, Direct and Indirect Speech, Active and Passive Voice, Vocabulary

Unit-4

Short Stories

The following short stories are prescribed for study:

R K Narayan - The Axe

Maugham - The Necklace

Khuswant Singh - The Portrait of a Lady

O'Henry - The Gift of the magi

Leo Tolstoy - Three Questions

Unit- 5

Preparation for Job

Writing Applications for Jobs, Preparing Curriculum Vitae, Preparing for Interviews, Preparing for Group Discussions.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	3	2	2	3	2	2	3	2	2	3	3	2	2	1	3
CO2	1,2, 3	3	3	1	2	3	3	1	2	3	2	2	2	3	3	1
CO3	1,3, 4	2	1	3	2	1	3	2	1	3	1	2	1	3	2	3
CO4	1,2, 3,4	1	2	1	3	2	2	1	2	1	2	1	3	1	2	2
CO5	1,2	2	3	1	2	1	1	2	3	2	2	1	2	1	3	3
CO6	1,2, 4	2	2	1	1	2	2	3	3	1	3	2	1	3	3	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. A Practical English Grammar – A.J. Thomson, A.V. Martinet – OUP
2. Word Power Made Easy- Norman Lewis- Penguin
3. A Textbook of English Phonetics for Indian Students – T. Balasubhramanian Macmillan Publications
4. The Phonetics and Phonology of English: A Handbook – D Thakur – BharatiBhawan Publication
5. Better English Pronunciation – J.D. O'Connor – Cambridge University Press
6. English Phonetics and Phonology – Peter Roach – Cambridge University Press
7. Pronunciation Practice Activities – Martin Hewings – Cambridge University Press

SECOND SEMESTER

Paper: BTM-201: Genetic Engineering

COURSE OUTCOMES

CO 1: Elaborated structure and properties of genetic material.

CO 2: Theoretical knowledge of advance techniques like, FISH, EMSA, CHIP etc.

CO 3: Introduction to Cloning vectors, cloning methodologies, PCR and its applications; DNA sequencing.

CO 4: Hands-on experience in genomic DNA isolation, Restriction digestion, gel-purification, ligation, etc.

CO 5: Theoretical and practical knowledge transformation, induction of recombinant protein synthesis, protein purification etc.

CO 6: Restriction enzymes and other enzymes related to genetic manipulation.

Unit I

Scope of genetic engineering, milestones in genetic engineering; genetic engineering guidelines, DNA- synthesis and mutation, sequencing, Gene cloning and patenting; Molecular tools and their applications: restriction enzymes, modification enzymes, nucleic acid purification. PCR, its types and applications. Vectors- plasmids, bacteriophage, phagemids, cosmids, artificial chromosomes (YAC & BAC). Restriction digestion & Restriction mapping cDNA synthesis and cloning; mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis; library construction and screening**.**

Unit II

Alternative strategies of gene cloning; Cloning interacting genes-Two and Three hybrid systems, Cloning differentially expressed genes, DNA micro array; Site Directed Mutagenesis and Protein Engineering ; How to study gene regulation- DNA transfection, northern blot, primer extension, SI mapping , RNase protection assay, reporter assays.

Unit III

Expression strategies for heterologous genes: vector engineering and codon optimization, host engineering; in vitro transcription and translation, expression in bacteria, yeast, insect cells, mammalian cells, and plants.

Unit IV

T-DNA and transposon tagging; role of gene tagging in gene analysis, identification and isolation of genes through T-DNA or transposon; Transgenic and Gene Knockout

technologies–Targeted gene transfer, Chromosome Engineering; Gene Therapy- Strategies of gene delivery, Gene replacement/ augmentation, Gene correction, Gene editing.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,3	3	2	3	2	3	2	3	2	2	1	2	3	3	2	3
CO2	1,3, 4	2	3	2	3	2	2	-	2	3	-	2	3	3	2	1
CO3	2,3	2	1	-	1	2	3	2	1	3	3	1	2	2	1	2
CO4	1,2, 3,	2	2	1	1	2	-	2	3	-	2	-	2	2	3	3
CO5	1,4	1	1	2	2	2	3	1	1	2	3	1	1	3	1	2
CO6	1,2, 4	3	1	2	3	3	2	2	1	-	1	3	-	1	2	1

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Molecular cloning: A Laboratory Manual, J. Sambrook , E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.

2. DNA Cloning: A practical Approach, D.M. Glover and B.D. Hames, IRL Press,Oxford, 1995.

3. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, S.L.Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998.

4. Molecular Biotechnology (2nd Edn.) S.B. Primrose, Blackwell Scientific Publishers,Oxford, 1994.

Paper: BTM-202: Methods in Molecular Diagnostics

COURSE OUTCOMES

CO 1: Concept building in various topics including: Spectroscopy, chromatography, electrophoresis.

CO 2: Practical knowledge of Chromatographic techniques, Spectroscopy techniques

CO 3: Development of understanding on Radioactivity, Radioisotopes and their uses in biology, measurement of radioactivity etc.

CO 4: Theoretical basic concept building in Protein crystallization; Enzyme and cell immobilization techniques.

CO 5: Protein isolation/purification using different techniques, quantitative and qualitative estimations of biomolecules.

CO 6: Concepts of centrifugation and their different variants.

UNIT-I

Isolation and Purification of Nucleic acids- Principles and Methods. Molecular cloning, labeling of nucleic acids, hybridization. Protein- protein and protein- ligand interactions, physical and chemical methods for their study.Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, *In situ* PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction.

UNIT-II

Applications of PCR- PCR based microbial typing: Eubacterial identification based on 16S rRNA sequences- Amplified Ribosomal DNA Restriction analysis (ARDRA). Culture independent analysis of bacteria- DGGE and TRFLP. Molecular diagnosis of fungal pathogens based on 18S RNA sequences-Detection of viral pathogens through PCR. RAPD for animal and plants- PCR in forensic science- AmpFLP, STR, Multiplex PCR- Determination of Paternity- Human identification and sex determination.

UNIT-III

Automated DNA sequencing- Principles, Methods and Instrumentation- Advances in DNA sequencing- Pyrosequencing- Microarrays- Personalized Medicine Pharmacogenomics**.**

UNIT-IV

Proteomics- Clinical Proteomics, Good Laboratory Practices. Different Levels of Biosafety, Containment Levels for rDNA experiments. Biosafety aspects of transgenic plants and germplasm.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1,3	3	2	2	3	2	2	3	2	2	3	3	2	2	1	3
CO 2	1,2,3	3	3	1	2	3	3	1	2	3	2	2	2	3	3	1
CO 3	1,3,4	2	1	3	2	1	3	2	1	3	1	2	1	3	2	3
CO 4	1,2,3 ,4	1	2	1	3	2	2	1	2	1	2	1	3	1	2	2
CO 5	1,2	2	3	1	2	1	1	2	3	2	2	1	2	1	3	3
CO 6	1,2,4	2	2	1	1	2	2	3	3	1	3	2	1	3	3	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books-

1. Clinical Chemistry and Molecular diagnostic- Carl A Burtis, Edward R. Ashwood David E. Boons, Elsivier publication, USA, 5th edition (2012).

2. Molecular Diagnostic for the clinical laboratorian, William B. Coleman, Gregory J. Tsongalis, Humana Press,USA, 2nd edition,.

Paper: BTM-203 : Molecular Biology & Biophysics

COURSE OUTCOMES

CO 1: Understanding of Genome organization, Development of basic concepts in DNA/RNA structure, Replication, Repair & Recombination.

CO 2: Knowledge of transcription and translation in prokaryotic and eukaryotic system.

CO 3: Development of concepts of Oncogenesis, oncogenes and tumor suppressor genes.

CO 4: Hands on training on DNA & RNA isolation by different techniques; plasmid isolation, transformation, Electrophoresis, quality check of Nucleic acids, restriction digestion, PCR, RFLP etc.

CO 5: Development of concepts of NMR, CD, Spectroscopy.

CO 6: Understand of concepts of GC-MS, Cromatography.

Unit I

Introduction to Molecular Biology and Genetics; Double helix: Physico-chemical considerations**.** DNA replication, mechanism of DNA replication in prokaryotes and eukaryotes, enzymes and accessory proteins involved in DNA replication. DNA repair and recombination- methyl directed mismatch repair, very short patch repair, nucleotide and base excision repair, SOS system, Holliday junction, FLP/FRT CrE/Lox recombination, RecA and other recombinases. Antisense: Molecular mechanism of anti- sense molecules, disruption of RNA structure; applications of antisense.

Unit II

Transcription and modifications in RNA/protein; prokaryotic and eukaryotic transcription, RNA polymerases, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, 5-Cap formation, transcription termination, 3' end processing and polyadenylation, splicing, editing, stability and nuclear export of mRNA; post transcriptional gene silencing. Translation in prokaryotes and eucaryotes, machinery, mechanism and regulation of translation

Unit III

Physical techniques in protein, nucleic acids and polysaccharide: structural analysis X-ray crystallography, UV-Vis, Fluorescence, IR, CD, NMR, ESR and Raman spectroscopy; Differential colorimetry, Scanning Tunneling microscopy, MALDI –TOF-MS, Atomic Absorption Sepctroscopy & Flame Photometry.

Unit IV

Radiolabeling techniques, properties of different types of radioisotopes normally used in biology, their detection and measurement, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1,2,3	3	2	2	1	3	2	3	2	1	3	2	1	1	2	3
CO 2	1,2,3 ,4	2	3	-	2	2	2	1	2	-	2	3	2	3	1	1
CO 3	1,3	2	3	2	3	2	3	3	1	3	2	-	2	2	1	2
CO 4	1,2,4	2	2	3	2	-	1	1	3	2	1	2	2	1	2	2
CO 5	1,2,4	1	2	1	3	1	2	-	1	2	3	1	1	3	2	3
CO 6	1,4	2	-	2	1	3	1	1	1	3	2	-	3	3	2	3

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books-

1. Molecular cloning : A Laboratory Manual , J. Sambrook & Russeel, 3rd Edition, CSHL Press
2. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
3. Molecular Biology of the Gene (6th edition), J.D. Watson, Pearson
4. Molecular Cell Biology 5th Edition) J. Darnell, H. Lodish and D. Baltimore, , Freeman American Books, Inc., USA, 1994.
5. Molecular Biology of the Cell (4th Edition) B. Alberts, Garland Science
6. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
7. Molecular Biology- David Freifelder, 2nd Edition, Narosa Publishing House.

Paper: BTM-204: Biology of the immune system

Course Outcome

CO 1: Theoretical knowledge of various topics including, antigens, antibodies.

CO 2: Hands on training on advanced immunological techniques viz., ELISA and its variants, western blotting, immunodiffusion methods, immunoelectrophoresis, determination of blood groups etc.

CO3: Idea of Immune responses generated by Lymphocytes, Antigen-Antibody interactions.

CO 4: Vaccine technology and Clinical immunology: Immunity against Bacteria, viral, fungal and parasitic infections; Tumor immunology; DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Hybridoma etc.

CO 5: Understand adaptive and innate immunity, organs and cells of immune system etc.

CO 6: Able to explain the basic principles of immunology relating to host resistance.

Unit I

Introduction: innate and acquired immunity, organization and structure of lymphoid organs, nature and biology of antigens and super antigens. Antibody structure and function; antigen antibody interactions; major histocompatibility complex, BCR & TCR; Generation of diversity, complement system.

Unit II

Cells of the immune system; haematopoiesis and differentiation, lymphocyte trafficking; B-lymphocytes,T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophil, neutrophils and mast cells.

Unit III

Antigen processing and presentation, Generation of humoral and cell mediated immune responses; activation of B and T –lymphocytes; cytokines and their role in immune regulation; MHC restriction; Immunological tolerance.

Unit IV

Cell-mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity, autoimmunity; AIDS and other immunodeficiences, Vaccines-different types.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2	2	3	2	2	2	1	3	2	-	3	3	2	3	3	2
CO2	1,2, 3,4	2	3	1	3	1	-	2	1	2	2	2	3	1	2	1
CO3	2,3	3	2	1	1	3	2	3	1	2	1	3	-	2	2	3
CO4	1,4	1	1	2	2	3	2	-	2	3	3	1	2	1	2	2
CO5	2,3, 4	2	3	3	2	2	1	3	2	1	-	2	1	2	3	3
CO6	1,2, 3	2	3	2	3	1	3	2	-	1	2	1	2	2	3	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A. Osbarne. (Freedom)

2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).

3. Fundamentals of immunology, William Paul, 7th edition, Lippincotts Williams and wilkins (2012).

4. Roitt's essential Immunology, Roitt I.M. and Delves P.J., Blackwell Science Ltd., (2001).

Paper: BTM-205: Practical

List of Practicals:

1. To preparation competent cells.
2. To isolate plasmid DNA.
3. To quantitate nucleic acids.
4. To study agarose gel electrophoresis and restriction mapping of DNA.
5. To construct restriction map of plasmid DNA.
6. To perform PCR
7. To perform Restriction Digestion
8. To perform Southern blotting.
9. To isolate genomic DNA from moong seeds.
10. To isolate genomic DNA from *E-coli.*
11. To isolate DNA from germinating gram seeds.
12. To determine molecular weight of given DNA sample by agarose gel electrophoresis.
13. To isolate DNA from cauliflower and show the bands.
14. Blood film preparation and identification of cells.
15. Immunization, collection of serum.
16. Double diffusion and immuno-eletrophoresis.
17. Western –blotting.
18. ELISA
19. To assay T3 in a given serum sample.
20. To assay T4 in a given serum sample
21. To assay TSH in a given sample.
22. To perform affinity chromatography.
23. To. perform SDS-PAGE of protein
24. To perform Gel Filtration chromatography using kit

Paper: BTM-206: Fundamentals of Economics

Course Outcome

CO 1: To comprehend the evolution of the concept of economic development and economic growth.

CO 2: To understand macroeconomic theoretical structure for the proper comprehension of different issued and policies.

CO 3: To get familiarize with new developments in the theory of markets and economics of information.

CO 4: Understand, explain and constructively criticise well-known macroeconomic models.

CO5: Use well-known macroeconomic models to illuminate current debates about macroeconomic policy.

CO 6: To introduce students to various theories of distribution, welfare economics, general equilibrium in closed systems.

Micro Economics

Unit 1- Consumer Behaviour

Consumer's Behaviour-Law of Demand. Marshallian and Hicksian theory of consumer's equilibrium. Elasticity of Demand- Kinds and measurement of elasticity of demand. Marhallian theory of consumer's surplus.

Unit II- Production Function

Law of variable proportions. Returns to scale. Least cost combination of factors. Different concepts of costs: Short run and long run cost curves.

Unit III-Market

Market- Meaning and classification. Relationship between average revenue, marginal revenue and elasticity of demand. Relationship between average cost and marginal cost. Pricing under perfect competition and monopoly.

Unit IV-Distribution

Marginal productivity theory of distribution. Ricardian theory of rent, Liquidity preference theory of interest. Knight's and Schumpeters theory of profit.

Macro Economics

Unit V- National income- concepts and methods of measurement. Fisharian version of quantity theory of money. Central and commercial banks: Credit creation and methods of credit control.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1,2	3	3	2	3	3	2	3	2	1	3	2	1	1	2	3
CO2	1,2,3	2	3	-	2	2	2	1	2	-	2	3	2	2	3	1
CO3	1,3	2	1	2	3	2	3	2	1	3	2	-	2	2	1	2
CO4	1,2,3,4	2	2	3	2	-	1	1	3	2	1	2	2	1	3	2
CO5	1,2,4	1	2	1	3	1	2	-	1	2	3	1	1	3	2	3
CO6	1,3	2	-	2	1	3	2	2	1	3	2	-	3	3	2	3

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Kreps, D M, A Course in Microeconomic Theory, Harvester Wheatsheaf; H R Varian, Microeconomic Analysis (3rd edn), Norton
2. Osbourne, M J & A Rubinstein, A Course in Game Theory, MIT Press
3. Acemoglu, D., Introduction to Modern Economic Growth, Princeton University Press, 2009
4. Dornbush, R and F. Stanley (1997), Macroeconomics, McGraw Hill, Inc. New York
5. Hall, R.E. and J.B. Taylor (1986), Macro economics, W.W. Norton, New Delhi

THIRD SEMESTER

Paper: BTM-301 Animal Cell Science and Techniques

Course Outcome

CO 1: Theoretical knowledge of various topics as per the syllabus including basic cell culture techniques.

CO 2: Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Transfection, pleuripotency, stem cells etc.

CO 3: Study of various approaches related to vaccine production, disease diagnostic assays and many other assays involved in animal health management.

CO 4: Concept building in animal reproductive biology, Animal genomics and DNA forensics: Embryo transfer; Micromanipulation of animal embryos.

CO 5: Transgenic animal technology; RFLP, RAPD, proteomics, metobolomics; DNA Barcoding.

CO 6: Detection of adulteration in meat using DNA basedmethods; microbial forensics etc.

Unit I

Structure and organization of animal cell, equipments and materials for animal cell culture technology; primary and established cell line cultures, introduction to the balance salt solutions and simple growth medium, brief account of chemical, physical and metabolic functions of different constituents of culture medium, role of carbon di-oxide, serum and supplements.

Unit II

Serum and protein free defined media and their application, measurement of viability and cytotoxicity, biology and characterization of the cultured cells, measuring parameters of growth, basic techniques of mammalian cell culture *in vitro;* disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.

Unit III

Cell synchronization, cell cloning and micro-manipulation, cell transformation. Applications of animal cell cultures, stem cell cultures, embryonic stem cells and their applications.

Unit IV

Cell culture based vaccines, somatic cell genetics, hybridoma technology and production of monoclonal antibodies. Organ and histotypic culture, measurement of cell death, apoptosis, three dimensional culture and tissue engineering.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2,3	3	3	2	3	2	2	3	2	2	1	3	3	3	2	3
CO2	1,2, 3,4	2	3	1	-	1	3	2	3	3	2	1	1	1	2	2
CO3	3,4	2	1	3	2	3	-	1	3	2	3	2	3	1	2	1
CO4	2,4	1	3	2	1	-	3	1	2	1	3	1	2	3	2	3
CO5	1,2, 3,4	2	3	1	3	2	2	2	1	2	1	2	1	3	2	2
CO6	1,4	3	2	1	2	3	1	3	-	3	2	3	2	1	3	1

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Culture of Animal Cells (3rd Edition), R. lan Freshmney. Wiley-Liss.

2. Animal Cell Culture – Practical Approach, Ed . John R W Masters. Oxford Univ Press. 2000

3. Animal Cell Culture Techniques, Ed Martin Clynes, Springer. 1998

4. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods, (Ed.) Jenni P.Mather and David Barnes, Academic Press

Paper: BTM-302: Bioprocess Engineering and Technology

Course Outcome

CO 1: Basic concept building in Basic principle of Biochemical engineering, including, Isolation, screening and maintenance of industrially important microbes. Various topics as per the syllabus and isolation, screening and maintenance of microbes important for industries.

CO 2: Application of microbes in waste management and food industry.

CO 3: Study of downstream processing techniques: filtration, centrifugation, sedimentation, flocculation; Cell disruption; Storage and packaging.

CO 4: Understand principles underlying design of fermentor, fermentation Process and downstream processing.

CO 5: Gain understanding of production of secondary metabolites and antibiotics.

CO 6: Know the advantages of biochemical processes and its conventions.

Unit I

Bio fermentation: designing and application, principles of bio fermentation, monitoring and control parameters (pH, oxygen, agitation, temperature, foam, etc), batch and continuous; production medium, raw materials, isolation, maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

Unit II

Downstream processing: Filtration of fermentation broths, ultra centrifugation, recovery of biological products by distillation, superficial fluid extraction. Removal of microbial cells and solid matter, foam separation, centrifugation, cell disruption, liquid-liquid extraction, chromatography, drying and crystallization, D.O.C. and C.O.D. treatment and disposal of effluents.

Unit III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamin B12, vitamin C, antibiotics (penicillin, streptomycin,). Microbes in mineral beneficiation & petroleum industry (MEOR). Immobilization.

Unit IV

Elementary idea of Diary & Food Microbiology, bread, cheees, idli & yoghurt. Canning and packing, technology of typical food products.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	2	3	1	3	3	2	1	2	3	3	-	3	3	2	2
CO2	1,3	2	3	2	2	-	2	3	2	-	2	3	2	2	3	1
CO3	1,2, 4	3	1	3	1	2	1	2	3	2	3	2	2	2	2	3
CO4	3,4	1	3	1	1	2	3		-	3	1	2	1	2	3	2
CO5	1,3	1	2	3	2	3	1	3	2	1	2	1	2	3	3	2
CO6	1,3	2	1	3	2	2	2	1	1	2	-	2	3	2	1	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Biochemical Engineering, S Aiba, AE Humphrey and NF Millis, Academic Press. New York 1973

2. Biochemical Reactors, B Atkinson, Pion Ltd., London. 1974

3. Biochemical Engineering Fundamentals (2nd edition), JE Baily and DF Ollis, McGraw Hill BookCo. New York. 1986

4. Bioprocess Engineering: Basic Concepts (2nd edition), ML Shuler, and F Kargi, Prentice Hall,Engelwood Cliffs. 2003

5. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hall,Pergamon Press, Oxford. 1995

6. Chemical Engineering Problems in Biotechnology, M L Shuler, (Ed) AICE. 1989

7. Biochemical Engineering, J M Lee, Prentice Hall Inc. 1991

Paper: BTM-303 : Plant Biotechnology

Course Outcome

CO 1: Knowledge of various topics including Organogenesis; Somatic embryogenesis; Regulation and applications.

CO 2: Artificial seed production; Micropropagation;Somaclonal variation; Androgenesis, somaclonal variation etc.

CO 3: Development of concepts in Agrobiology, Genetic transformation: its various methods and applications.

CO 4: Hands on training on Plant Tissue Culture, artificial seed production, cell suspension cultures, fermentation, secondary metabolite production and plant transgenics.

CO 5: To understand the importance of Plant Tissue Culture is an essential requirement for genetic improvement, conservation.

CO 6: Mass propagation and maintenance of uniformity of traits through generations.

Unit I

Introduction of plant cell and tissue culture: tissue culture media Single and suspension culture, Organogenesis & Embryogenesis, embryo culture and embryo rescue; haploid production and homozygous diploid lines; cryopreservation and germplasm conservation; protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plant; symmetric and asymmetric cybrids, production of virus free plants.

Unit II

Cloning vector for higher plant transformation: *Agrobacterium tumefaciens* Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes. Viral vectors. Direct gene transfer. Transformation of monocots; transgene stability and gene silencing, selection of clones. Expression of cloned genes: genetic markers, reporter genes, Gus assay

Unit III

Application of plant transformation for productivity and performance: herbicide resistance, insect resistance, virus resistance, disease resistance, nematode resistance, abiotic stress post harvest losses, long shelf life of fruits and flowers, carbohydrate composition and concentration during storage.

Unit IV

Chloroplast transformation: vectors, mechanisms, advantages and limitations, homoplastomic line development. Metabolic engineering and industrial products; plant secondary metabolites, control mechanisms and applications of industrially important secondary metabolites. Marker-

aided breeding RFLP maps; Linkage analysis; RAPD markers; STS, SSCP, SCAR, AFLP, QTL and microsatellites; Molecular assisted selection.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2,3	3	3	2	3	2	2	3	2	2	1	3	3	3	2	3
CO2	1,2, 3,4	2	3	1	-	1	3	2	3	3	2	1	1	1	2	2
CO3	3,4	2	1	3	2	3	-	1	3	2	3	2	3	1	2	1
CO4	2,4	1	3	2	1	-	3	1	2	1	3	1	2	3	2	3
CO5	1,2, 3,4	2	3	1	3	2	2	2	1	2	1	2	1	3	2	2
CO6	1,4	3	2	1	2	3	1	3	-	3	2	3	2	1	3	1

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.

2.H.S. Chawla: Plant Biotechnology,2nd Edition, Oxford & IBH publishing co.pvt.ltd

3. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.

4. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996

5. Plant Biotechnology,M.K.Razdan,2nd Edition,Oxford & IBH publishing co.pvt.ltd

Paper: BTM-304: Environmental Biotechnology

Course Outcome

CO 1: Theoretical knowledge of Environment; Basic concepts; Resources; Eco system: plants, animals, microbes.

CO 2: Ecosystem management; Pollution, Renewable resources; Sustainability; Microbiology of degradation and decay.

CO 3: Study of role of biotechnological techniques in environment protection. Waste water collection; control and management.

CO 4: Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques.

CO 5: Concept building in alternate energy sources: Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers.

CO 6: Vermiculture; Organic farming; Bio-mineralization; Biofuel etc.

Unit -I

Environment: Basic concepts and issues. Global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management. Air pollution and its control through biotechnology, *Biodiversity*: conservation and management

Unit II

Water pollution and its control through biotechnology. Waste water treatment- physical, chemical and biological treatment processes; algal blooms and human health. Microbiology of waste water treatment: Aerobic processes & Anaerobic processes.

Unit III

Treatment schemes for waste waters of diary, distillery & tannery industries; extremophiles. Xenobiotics & Bioremediation.

Unit IV

Biological N2 fixation, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production); Single cell protein (*Spirulina*, yeast, mushroom); Biosensors, Biomass Energy, Biofuels.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	3	2	3	2	1	3	2	2	3	2	2	2	2	2	3
CO2	1,2, 4	3	2	2	-	2	2	3	3	2	2	3	3	3	1	2
CO3	2,4	2	2	1	3	2	2	1	1	-	3	1	3	3	3	2
CO4	1,4	1	3	3	2	1	2	1	2	2	1	3	1	1	2	2
CO5	1,2, 4	1	2	2	2	1	3	2	1	3	2	2	3	3	2	3
CO6	1,3	3	1	2	1	1	3	2	2	3	2	1	2	1	3	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Wastewater Engineering – Treatment, Disposal and Reuse, Metcalf and Eddy. Inc. Tata McGrawHill, New Delhi. 1991

2. Environmental Science (5th Edition) by WP Cunninghum & BW Saigo., Mc Graw Hill. 1999.

3. Environmental Chemistry, A.K. De. Wiley Eastern Ltd. New Delhi(1996).+

4. Introduction to Biodeterioration , D Allsopp and K J Seal, ELBS/Edward Arnold. Cambridge UnivPress. 2004.

5. Ecology & Environment,P.D.Sharma,,11th edition, Rastogi publicxation.

6.Microbial Ecology,Ronald M. Atlas & Richarad Bartha, Pearson publication,4th edition

Paper: BTM-305 : Practical

1. To prepare tissue culture medium, and membrane filtration
2. To prepare single cell suspension from spleen and thymus.
3. To study cell counting and cell viability.
4. Trypsinization of monolayer and sub-culturing
5. Cryopreservation and thawing
6. Measurement of doubling time
7. Role of serum in cell culture
8. Cell fusion with PEG.
9. To determine dissolved oxygen (DO) concentration of water sample.
10. To determine biological oxygen demand (BOD) of a sewage sample.
11. To estimate nitrate, nitrite and chlorine in drinking water sample.
12. To determine the Chemical Oxygen Demand (COD) of water sample.
13. To determine the Total Dissolved Solids (TDS) of water sample
14. To prepare MS media.
15. To study the effect of solidification on media.
16. To study Surface sterilization & Seed Inoculation
17. To develop RFLP and RAPD maps
18. To isolate industrially important microorganisms for microbial processes.
19. To determine thermal death point (TDP) and thermal death time (TDT) of microorganisms.
20. To immobilize the seeds.
21. Microbial production of citric acid using *Aspergillus niger.*
22. Microbial production of antibiotic (penicillin).

Paper: BTM-306: **IPR & Patenting**

Course Outcome

CO 1: Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.

CO 2: Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development.

CO 3: Identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development.

CO 4: Be familiar with the processes of Intellectual Property Management (IPM) and various approaches for IPM and conducting IP and IPM auditing and explain how IP can be managed as a strategic resource and suggest IPM strategy.

CO 5: Be able to anticipate and subject to critical analysis arguments relating to the development and reform of intellectual property right institutions and their likely impact on creativity and innovation.

CO 6: Be able to demonstrate a capacity to identify, apply and assess ownership rights and marketing protection under intellectual property law as applicable to information, ideas, new products and product marketing.

UNIT I

Introduction to IPR & Patents: Understanding of Intellectual Property Rights, Introduction of IPR, History of Patent Protection, Rationale behind Patent System, WTO, TRIPS and WIPO

UNIT II

Overview of Biotechnology and Intellectual Property, Biotechnology Research and Intellectual Property Rights, Management, Licensing and Enforcing Intellectual Property, Commercializing Biotechnology Invention, Case studies of Biotechnology

UNIT III

Patents, Copyrights and Trademark: Economic impact of the patent system, Patent and kind of inventions protected by a patent, Granting of patent, Rights of a patent, Searching a patent, Drafting of a patent, Filing of a patent, The different layers of the international patent system (National, and International options), Copyright and related rights, trademark, Rights of

trademark, types of trademark, function does a trademark perform, protection, trademark registration,

UNIT IV

Legislations and Salient Features of Patent Act: History of Indian Patent Act, Indian Patents Act 1970, Patent Amendment Act 2005, WTO-TRIPS – Key effect on Indian Legislation, Organization of Patent System in India.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2	3	2	3	2	3	2	1	3	2	1	2	2	1	3	3
CO2	1,2, 3,4	1	2	1	-	1	3	2	2	3	2	3	-	3	1	1
CO3	2,4	3	3	1	3	2	1	2	1	3	2	1	2	2		3
CO4	1,2, 4	2	2	2	2	2	2	-	1	2	3	2	3	3	3	2
CO5	2,3	1	2	1	3	3	2	1	3	2	3	-	1	2	1	3
CO6	3,4	1	3	2	1	1	2	3	2	1	2	3	1	1	2	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

1. Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy

2. Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra

3. IPR by P. Narayanan

4. Law of Intellectual Property, Asian Law House, Dr.S.R. Myneni.

FOURTH SEMESTER

Paper: BTM-401: RESEARCH METHODOLOGY

Course Outcome

CO 1: Search for, select and critically analyse research articles and papers.
CO 2: Prepare a literature review.
CO 3: Formulate and evaluate research questions.
CO 4: Develop a research proposal or industry project plan.
CO 5: Gain experience with instrument development and data collection methods.
CO 6: Gain experience with ethics proposals.

Unit I

Research- Purpose, Types & Characteristics. Process of Research. Formulation of objectives, Hypothesis- Types of Hypothesis. Methods of testing Hypothesis. Research plan and its components. Survey, Observation, Case Study.

Unit II

Research problem: Identification and formation of research problem. Elements in research methodology. Research Design, components of research.

Unit III

Role of IPR and patenting in Research and Development. Ethical, legal, social and scientific issues in research.

Unit IV

Data Collection, Sources of Data, Primary Data, Secondary Data. Procedure Questionnaire. Sampling, merits & demerits. Experiments; kinds and procedure. Control Observation- Merits & Demerits. Kinds. Procedure, Brief idea of Sampling errors.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

CO	BL	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1,2, 3	2	3	1	3	3	2	1	2	3	3	-	3	3	2	2
CO2	1,2	2	3	2	2	-	2	3	2	-	2	3	2	2	3	1
CO3	1,2, 3,4	3	1	3	1	2	1	2	3	2	3	2	2	2	2	3
CO4	3,4	1	3	1	1	2	3		-	3	1	2	1	2	3	2
CO5	1,3	1	2	3	2	3	1	3	2	1	2	1	2	3	3	2
CO6	1,3, 4	2	1	3	2	2	2	1	1	2	-	2	3	2	1	2

3-High, 2- Moderate, 1- Low, '-' for No correlation

Recommended Books

Cooper, D.R., Schindler, P.S. and Sun, J., 2006. Business research methods (Vol. 9). New York: McGraw-Hill Irwin.

Creswell, J.W. and Creswell, J.D., 2017. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Kothari, C.R., 2004. Research methodology: Methods and techniques. New Age International.

Krishnaswamy, K.N., 2006. Management Research Methodlogy: Integration of Principles, Medthods and Techniques. Pearson Education India.

Sekaran, U. and Bougie, R., 2016. Research methods for business: A skill building

approach. John Wiley &Sons.

Paper: BTM-402 **DISSERTATION/PROJECT VIVA**

Course based on project and its seminar.

DISSERTATION/PROJECT WORK
a) Objective b) Review of Literature c) Methodology d) Analysis & Interpretation of Result e) Language & Presentation f) Viva voce