GONDWANA UNIVERSITY
GADCHIROLI

SYLLABI AND COURSE OF STUDY IN BIOTECHNOLOGY

BIOTECHNOLOGY COURSE

PG SEMESTER I
UNDER NEP-2020

From Session 2023 Onwards

GONDWANA UNIVERSITY, GADCHIROLI

FACULTY OF SCIENCE AND TECHNOLOGY

Master of Science in Biotechnology

Program Information

On completion of the course, the students are expected to be proficient in the fundamental, applied and modern areas of Biotechnology. They are expected to have acquired the skills of theoretical and practical aspects of different branches of biotechnology; to be able to develop rationale thinking skills, logical interpretation and analytical skills. Effective communication of scientific developments to the society at large is very critical attribute expected from the students of this course.

The outcomes expected **(PO)** from the post-graduates of M.Sc. Biotechnology programme are:

PO1- Fundamental and advanced knowledge of biotechnology and its different branches

PO2- Orientation and specialization in at least one specific branch of biotechnology and related fields

PO3- Proficiency in theoretical and practical aspects of traditional as well as modern tools and techniques in the fields of biotechnology

PO4- Awareness and sensitization about various societal problems related to biotechnology

PO-5- Effective communication of scientific knowledge and recent developments with the society

PO-6-Acquiring skills of writing, editing and publication of research findings in reputed journals and magazines.

PO-7- Acquire skills and training in scientific communications and presentation

PO-8- Ability to design and undertake research projects to solve societal problems

Aims of Master Degree Program in Biotechnology

The objective of this course is to provide fundamental and advanced knowledge of biotechnology and its related subjects.

- To generate competent human resources skilled to contribute towards the sustainable development of industry, teaching, and research in different areas of Biotechnology.
- To develop a set of interdisciplinary professional skills that will enable the students in research and development in Biotechnology.
- To bring social, ethical, and professional awareness among the students about various issues of contemporary practices in biotechnology and related fields.

Qualification Descriptors

Upon successful completion of the course, the students receive a M.Sc. degree in Biotechnology. Biotechnology postgraduates are expected to branch out into different paths of seeking advanced research based knowledge, professional employment, or entrepreneurship that they find fulfilling. They will be able to demonstrate knowledge as well as skills in diverse fields of Biotechnology. This will provide a foundation, which shall help them to embark on research careers by attaining doctoral positions in coveted institutions, as well as securing employment in research projects in industry or institutes. Besides research, they can get suitable teaching positions in Colleges and Universities as an Assistant Professor after qualifying National Eligibility Test (NET). It is expected that besides the skills specific to the discipline, the wider life skills of analysis, logical reasoning, scientific aptitude, communication skills, research and life ethics, and moral values will be inculcated in the students.

The list below provides a synoptic overview of possible career paths provided by a postgraduate training in Biotechnology:

1. Research
2. Industry
3. Teaching
4. Biotechnology entrepreneurship
5. Administration and Policy Making
6. Scientific Communication
7. Patents and Law
8. Scientific Writing and Editing
9. Document preparation and publication

M. Sc. Biotechnology Program Specific Outcomes (PSO)

After completion of M.Sc. Biotechnology, the students will be able:

PSO –1 :To understand the basic principles and applications of biotechnology.

PSO– 2: To understand the principles of microbiology, cell biology, biochemistry, molecular biology, genetics, and molecular biology involved in biotechnology to identify crucial biological problems.

PSO–3 :To realize the importance of laws and ethics in biotechnological practices and be able to practice good laboratory practices.

PSO–4: To handle basic, sophisticated advanced instruments needed in a research laboratory with ability to design and execute experiments with precision in a logical manner.

PSO–5: To understand theoretical as well as practical aspects of gene cloning, expression of recombinant proteins, tissue culture, and transgenic development.

PSO–6: To understand the basics of statistics and computational methods used in biological processes.

PSO–7:To understand the principles and applications of genomics, transcriptomics, and proteomics, and integrate the knowledge of omics and genetic engineering to address problems of healthcare, crop improvement, energy and environment.

PSO–8: To understand the principles and applications of bioprocess designing, pharmaceutical biotechnology, and nanotechnology for solving problems of biology and other related sciences.

PSO-9: To launch start-ups and become entrepreneurs for novel biotechnology products and processes in various industries.

PSO-10: To understand Bio safety measures, Ethical issues and regulatory compliances in the field of Biotechnology and effective scientific communication

NEP 2020

SEMESTER PATTERN

M.Sc. Biotechnology (PG) Program

Faculty of Science and Technology

(Affiliated Colleges)

(W.e.f. Academic Year 2023-24)

Scheme of teaching and examination under semester pattern for M.Sc. Program in Biotechnology

	Major Course	Elective	Minor
SEMI	**Major1- 01MSCBT01** (3Credits) (4Hours/Week)	**Elective Course – 01MSCBT04** Student shall select any one course. (3Credits) (4Hours/Week)	**01MSCBT09 Research Methodology** (3Credits) (4Hours/Week)
	Major2 – 01MSCBT02 (3Credits)(4Hours/Week)		
	Major 3 – 01MSCBT03 (3Credits) (4 Hours/Week)		
	Practical (Lab 1 & 2) Based on Major Course (3-8 Hour/Week) (4 Credit)		Seminar 1 Credit

Total 20 Credits

Teaching and Examination Scheme
M.Sc. Semester I
Master of Science
(Biotechnology)

<table>
<tr><th colspan="7">Gondwana University, Gadchiroli</th></tr>
<tr><th colspan="7">Faculty Name : Science and Technology Name P.G.: BIOTECHNOLOGY</th></tr>
<tr><th colspan="7">Two Years Regular Post Graduate Program</th></tr>
<tr><th colspan="7">SEM – I</th></tr>
<tr><th>Major (Mandatory)</th><th>Credit</th><th>Elective</th><th>Credit</th><th>Research Methodology</th><th>Credit</th><th>Total Credit</th></tr>
<tr>
<td>1.Cell Biology,Paper - I
Theory = 03 Credit
Theory = 100 (80 + 20)</td>
<td rowspan="4">(3x3)
9</td>
<td>1. Molecular Biology, Paper - IV
Theory = 03 credit
Theory = 75 (80 + 20)</td>
<td rowspan="4">3</td>
<td rowspan="4">1
Research Methodology</td>
<td rowspan="4">3</td>
<td rowspan="4">20</td>
</tr>
<tr>
<td>2. Advanced Environmental Biotechnology ,Paper - IV
Theory = 03 credit
Theory = 100 (80 + 20)</td>
</tr>
<tr>
<td>2. Microbiology,
Paper - II Theory = 03 credit
Theory = 100 (80 + 20)</td>
<td>3. Environmental Microbiology & Waste Management, Paper - IV Theory = 03 credit
Theory = 100 (80 + 20)</td>
</tr>
<tr>
<td>4. Microbial Technology, Paper - IV
Theory = 03 Practical = 01
Theory = 100 (80 + 20)</td>
</tr>
<tr>
<td rowspan="2">3. Biophysical Techniques – Paper - III
Theory = 03 credit
Theory = 100 (80 + 20)</td>
<td>5. Virology , Paper - IV
Theory = 03 credit
Theory = 100 (80 + 20)</td>
<td>4</td>
<td>Practical
Seminar</td>
<td>1</td>
</tr>
<tr>
<td colspan="2">Note:- Student shall select any one from above group</td>
</tr>
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Scheme of teaching and examination under semester pattern for M.Sc. Program in Biotechnology (M.Sc. Semester I Biotechnology)

MARKING SCHEME Semester I													
Code	Theory / Practical	Teaching Scheme					Credit	Examination Scheme					
								Duration in hrs.	Max. Marks		Total	Minimum Marks	
		Theory		Practical		Total			External	Internal		Theory	Practical
		UA	CA	UA	CA								
Major - 01MSCBT01	Theory	80	20	**LAB-1 75**	25	300	3	3	80	20	100	40	40
Major - 01MSCBT02	Theory	80	20				3	3	80	20	100	40	40
Major - 01MSCBT03	Theory	80	20	**LAB-2 75**	25	300	3	3	80	20	100	40	40
Elective – 01MSCBT04	Theory	80	20				3	3	80	20	100	40	40
Minor - 01MSCBT09	Theory	80	20	-	-	100	3	3	80	20	100	40	40
SEMINAR	-	-	50			50	1	-	-	50	50	-	-
TOTAL		**400**	**150**	**150**	**50**	**750**	**20**						

COURSE OUTCOMES AND COURSE CONTENT

Semester	**I**

Paper Code	**01MSCBT01**
Paper Title	**Cell Biology**
Number of teaching hours per week	**4 period per week**
Total number of teaching hours per semester	**60**
Number of credits	**3**

Course Outcomes:

After successful completion of this Course, students will be able to:

CO1. Describe the ultrastructure of cells, structure and function of organelles, cytosol and cytoskeleton

CO2. Understand phases of cell cycle, cell division, molecular mechanisms that regulate life and death of a cell including programmed cell death or apoptosis and differentiation in plants

Unit I: Ultrastructure and function of cell and cell organelles	15Hrs
A. Discovery of cell B. General structure of plant cell C. Structure of animal cell and types D. Plasma membrane: fluid mosaic model E. Cell walls: archae, bacteria, plant cell. F. Mitochondria G. Chloroplasts H. Golgi complex, endoplasmic reticulum, lysosomes, plastids	
Unit II: Cell cycle and Cell signaling	15Hrs
A. Cell cycle: cytological events in mitosis and meiosis, Go-G1 transition. chromosome condensation, regulation of cell division B. Cell signaling: signal transduction in animal and plant cell (tyrosine kinase, light induced signaling, programmed cell death-apoptosis C. Cytoskeleton and Cell locomotion	
Unit III: Plant and Animal Tissue	15Hrs
A. Structure and function of i. Meristematic tissue and permanent tissue. ii. Parenchyma, collenchyma, sclerenchyma iii. Stomata, xylem, phloem B. Structure and function of muscle tissue, nervous tissue, connective tissue C. Cell junction (gap junction), cell adhesion, cell-cell interaction	
Unit IV: Chemistry of Cell	15Hrs
A. Chemistry of carbohydrates: energy storage molecules –starch, glycogen. Building blocks–cellulose, chitin. B. Chemistry of lipids : triglycerides, phospholipids, glycolipids, sphingolipids, sterols, lipoproteins C. Proteins: amino acids and peptides. primary, secondary, and tertiary structures. collagen structure. Ramachandran plot. Models of protein folding, roles of chaperones and chaperonins. D. Nucleic acids: structure of DNA and RNA: A, B, and Z forms of DNA, Topological structure of DNA.	

Reference Books:

1. Cell Biology Genetics Mole Biology Evolution And Ecology, P. S. Verma, 2005, S. Chand
2. Biotechnology (E.H.),B.D.Singh,2008,Kalyani Publication

3. Cell And Molecular Biology Gerald Karp, 2007.John Willey And Son Pvt. Ltd.
4. Cell Biology, C.B. Powar, 2005,Himalaya Publishing House.
5. Cell, B. Lewin, 2007, Jones And Bartlett Publisher, London.
6. Cytology, Verma And Argawal, 2005, S.Chand, New Delhi

Semester	**I**
Paper Code	**01MSCBT02**
Paper Title	**Microbiology**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**3**

COURSE OBJECTIVES:

After successful completion of this Course, students will be able to:

CO1: Understand the contribution of eminent scientist in the development of microbiology

CO2: Distinguish between gram positive and gram-negative bacterial cell and its cell wall.

CO3: Perform staining techniques for the identification of the gram positive/gram negative bacterial type.

CO4: Understand the microbial growth and its control processes.

Unit I : History and Development of Microbiology	15 Hrs
A. Contribution of Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister B. Classification of microorganism, Whittaker classification, Bergey's System of bacterial classification (2^{nd} and 9^{th} edition). C. Concept of prokaryotes and eukaryotes, comparison i. Structure of typical bacterial cell ii. Structure and function of bacterial cell organelles – Capsule, Slime layer, Flagella, Pili, Endospore, Nucleoid	
Unit II : Microscopy and Staining	15 Hrs
A. Compound microscopy- numerical aperture and its importance, resolving power, oil immersion objective and their significance. i. Principles and application of dark field, phase contrast, fluorescent microscopy ii. Electron microscopy- principle, working, application (TEM and SEM) iii. Atomic force microscopy, confocal microscopy B. Basic concept of dye and stain i. Types of stains-acidic, basic and neutral Stains ii. Differential staining- Gram staining iii.Procedure and mechanism of endospore staining, capsule and negative staining	
Unit III : Microbial Physiology	15 Hrs
A. Nutrition: basic nutritional requirements, nutritional classification, types of biological complex media B. Reproduction and growth: concept of growth and reproduction, binary fission, growth curve, measurement of growth C. Microbial control: definition of sterilization, disinfection, antiseptics, germicides D. Methods of sterilization physical and chemical methods, dynamics of sterilization	
Unit IV : Microbial Diversity	15 Hrs
A. Algae: general characteristics, reproduction and Applications in biotechnology. B. Fungi (yeast and mould): General characteristics, reproduction and applications in biotechnology. C. Viruses: General characters and structure D. Life cycles of virus: lytic and lysogeny (Lambda phage) E. Viroids and prions	

Reference Books:

1. An Introduction to Microbiology (2019), 3rded.,Tauro P, Kapoor KK, Yadav KS, and Sequeira MG. New Age International Publishers. ISBN: 0852268785.
2. Brock Biology of Microorganisms (2018), 15thed., Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA Pearson Education, ISBN 9781292235103.
3. Prescott's Microbiology (2017). 10th ed. Sherwood LM, Woolverton C.J McGraw-Hill Education. ISBN 9781259281594.
4. A text book of Microbiology (2013), 3rd ed. Dubey, R.C. and Maheswari, D.K. Revised S. Chand and Company Ltd, New Delhi. ISBN: 9788121926201.
5. Microbiology (2001) 5th ed., Pelczar Jr. M, McGraw Hill Education ISBN: 9780074623206.
6. Microbial Physiology and Metabolism by Caldwell D.R.1995 Brown Publishers.
7. Microbial Physiology by Moat A.G. and Foster J.W.1999. Wiley.
8. Prokaryotic Development by Brun.Y.V.and Shimkets L.J.2000. ASM Press.
9. Advances in Microbial Physiology.Volumes. Edited by By A. H. Rose. Academic Press, New York.
10. Applied Microbial Physiology by Rhodes.
11. Biosynthesis by Smith.
12. The Bacteria.Volumes by I.C. Gunsalus and Rogery Stanier, Acadenic Press.
13. Microbial Physiology by Benjam.
14. Metabolic Pathways By:- David M. Greenberg.
15. Dawes,E.A. Microbial Energetics, NewYork: Chapman.
16. White ,D. The Physiology and Biochemistry of Prokaryotes, Oxford University Press

Semester	**I**
Paper Code	**01MSCBT03**
Paper Title	**Biophysical Techniques**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**3**

COURSE OBJECTIVES : By the end of this course, the students will be able to:
CO1. Identify the factors affecting the electrophoretic mobility
CO2. Evaluate beer-lambert law.
CO3. Describe instrumentation of spectroscopy
CO4. Discuss the applications of various spectrophotometer
CO5. Inspect the physical basis of centrifugation

Unit I : Biophysical Technique I	15Hrs
A. Chromatography: types and principles of partition, adsorption, gel filtration, affinity, ion exchange, paper chromatography. brief concept of GLC and HPLC. B. Electrophoresis: concept and principles of electrophoresis, gel electrophoresis (agarose, PAGE, SDS-PAGE), basic principles of disc gel electrophoresis, gradient electrophoresis, pulsed field gel electrophoresis, paper electrophoresis. C.Viscosity: basic principle, determination of molecular weight of biopolymer through viscosity	
Unit II : Biophysical Technique II	15Hrs
A. Centrifugation: basic principles, mathematics and theory (RCF, sedimentation coefficient etc) B. Types of centrifuge: microcentrifuge, high speed & ultracentrifuges. C. Preparative centrifugation: differential and density gradient centrifugation, applications (isolation of cell components). D. Analytical centrifugation: determination of molecular weight by sedimentation velocity	
Unit III : Biophysical Techniques-III	15Hrs
A.Spectrophotometry: nature of light, Lambert and Beer's law. **B.**Principle working and application of spectrophotometry- UV-visible, infrared, fluorescence **C.** NMR (Nuclear Magnetic Resonance) **D.**Basic introduction to Raman and Mass spectrophotometry	
Unit IV : Radioactivity	15Hrs
A. Radioactive and stable isotopes, pattern and rate of radioactive decay, units of radioactivity. B. Measurement of radioactivity: basic principle, instrumentation and technique of i. Geiger-Muller counter, ii Solid scintillation counter iii. Liquid scintillation counter C. Brief idea of Cerenkov radiation, autoradiography. D. Measurement of stable isotopes: falling drop method and Mass spectrometry. E. Applications of isotopes in biochemistry- principles of tracer techniques, its advantages and limitations, distribution studies, metabolic studies, clinical application.	

Reference Books:

1. Methods of General and Molecular Bacteriology, 1993.Edited by Philip. Gerhardt, ASM Publications.
2. Biophysical Chemistry VOL:I,II,III; The conformation of biological macromolecules. By;Cantor and Schimmel. Hans-Peterschmauder, Michael schweizer, Lilian M.Schweizer.
3. Biophysical Chemistry By: Upadhaya Upadhyaya Nath.
4. Principles and Techniques of Practical Biochemistry by K.Wilson and J.Walker,Cambridge University Press
5. Morrison–Physical Biochemistry (Oxford).
6. Hames, B.D. and Rickwood, D. Gel Electrophoresis A practical Approach, Oxford University Press,NewYork.
7. Cotterill,R.M J. Biophysics An Introduction, John Wilely and Sans England.
8. Nolting ,B. Methods in Modern Biophysics IIEd. Springer, Germany.
9. Narayana.P. Essentials of Biophysics NewAge International Pub. New Delhi.
10. Keeler,J. Understanding NMR spectroscopy. John Wiely and Sons England.
11. Holler,F.J.,D.A.SkoogandS.R.Crouch, Principles of Instrumental Analysis IVED.Thomson,Brooks/ColePub. US

Semester	**I**
Paper Code	**01MSCBT04**
Paper Title	**Molecular Biology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: By the end of this course, the students will be able to:

CO1: Understand the Meselson and Stahl Experiment
CO2: Explain the mechanism of DNA replication
CO3: Describe the details of transcription initiation, elongation and termination
CO4: Understand the process of protein synthesis
CO5: Understand the concept of gene

Unit 1: Replication, Mutations and Repair	15Hrs
A. Messelson and Stahl Experiment- semi-conservation replication. B. DNA Replication: in prokaryotic (detail). comparison between prokaryotic and eukaryotic DNA replication C. Mechanisms of DNA replication, enzymes and accessory proteins involved in DNA replication. D. Gene mutations: types of mutations. mutagens- chemical and physical mutagens E. DNA repair: direct repair, Ada protein, NER, BER, MMR, SOS repair, transcription- repair coupling, repair of double-strand breaks.	
Unit2 : Transcription Post transcriptional Modifications of RNA	15Hrs
A. Prokaryotic transcription: RNA polymerase holoenzyme and apoenzyme, different sigma factors. B. Details of transcription initiation, elongation , termination. C. Transcription regulation (lac operon, ara operon, trp operon, negative autogenous control). D. Eukaryotic transcription: three types of RNA polymerases. Promoter of RNA polymerase II. E. Packaging of chromosomes and its relation to transcription regulation. F. Modifications of RNA: 5' cap formation, polyadenylation, splicing of nuclear pre-mRNA, mRNA stability.	
Unit 3 :Protein Biosynthesis	15Hrs
A. Genetic code: characteristics, deciphering the code. B. Protein biosynthesis**:** prokaryotic and eukaryotic translation, the translational machinery, mechanism of prokaryotic and eukaryotic translation initiation, elongation and termination. C. Post translation modification of protein.	

D. Couple transcription and translation	
Unit 4 Genes: Molecular structure of prokaryote and eukaryote genes	15Hrs
A. Concept of gene- introns, exons, cistron, recon, split Genes, spacers, C-value paradox, idea of coy curve. B.Bacterial genetic system: recombination (transformation, conjugation, transduction and transposition) plasmids, salient features of the *E.coli* genetic map. C. Extrachromosomal inheritance: maternal effects, D. Types of genes- regulatory gene, structural gene	

Reference Books:

1. Cell Biology Genetics Mole Biology Evolution And Ecology,P.S.Verma,2005,S.Chand
2. Biotechnology (E.H.), B.D. Singh,2008, Kalyani Publication
3. Cell And Molecular Biology Gerald Karp,2007.John Willey And Son Pvt. Ltd.
4. Cell Biology,C.B.Powar,2005,Himalaya Publishing House.
5. Cell,B. Lewin, 2007, Jones And Bartlett Publisher, London.
6. Cytology,Verma And Argawal, 2005,S.Chand, New Delhi

Semester	**I**
Paper Code	**01MSCBT05**
Paper Title	**Advanced Environmental Biotechnology**
Number of teaching hours per week	**4**
Total number of teachings hrs per semester	**60**
Number of credits	**3**

Course learning outcomes: By the completion of this course, the students -

Outcome 1. Have developed a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow including the microbiomes of the human gut and animal gut.
Outcome 2. Are able to identify the important role microorganisms play in maintaining healthy environment by degradation of solid/liquid wastes
Outcome 3. Have understood the significance of BOD/COD and various tests involving use of enumerating fecal *E.coli* for assessing quality of water.
Outcome 4. Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation

Unit 1 : Bioremediation of Xenobiotics	15Hrs
Applications of microbes in biodegradation and bioremediation: Microbial degradation of cellulose, lignin, pesticides, xenobiotics and other recalcitrant chemicals, petroleum and hydrocarbons and its ecological significance. Bioprospecting and bioleaching, Bioaccumulation of heavy metals ions from industrial effluents.	
Unit2 : Biological Control	15Hrs
Biomagnification and degradative plasmids, biotransformation. Biodeterioration and its control. Biological control and biopesticides. definition, significance, types , sources, manufacture, use and mode of action. Entemo pathogenic fungi, viral insecticides. significance of Bacillus thuringiensis in biocontrol.	
Unit 3 : Role of Microbes in Waste treatment	15Hrs
Microbes and pollution : waste water; Types, Sources, Microbiology. Methods of waste water treatment. Eutrophication: Definition, causes and effects. Algal blooms, Red tides. Solid waste: Source, types and characterization. Methods of treatment: Physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Use of genetically engineered organisms for control of pollution.	
Unit 4 : Biosensor And Biofuels	15Hrs
Microbes as biological weapons, Role of microbes in production of Biofuels. Biogas production and factors affecting methane formation. Biosensors: Principle, working, Types of biosensors Applications of biosensors in environmental monitoring. Application of microbes as biosensors.	

Reference Books:

1. Mooray Moo-Young. (Eds). Comprehensive Biotechnology (Vol. I, II, III) Pergamon Press, England.
2. Metcalf and Eddy. Waste water engineering treatment and uses. McGraw Hill.
3. Jogdand, S.N. Environmental Biotechnology. Himalaya Publication House.
4. De, A.K. Environmental Chemistry. Wiley Eastern Ltd.
5. Abbasi and Abbasi. Renewable Energy Sources and their environmental impact. Prentice Hall of India, Pvt. Ltd.
6. Chatterji, A.K. Introduction to Environmental Biotechnology. Prentice Hall of India.
7. Thakur, I. S. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.
8. Mohapatra, P. K. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.

Semester	**I**
Paper Code	**01MSCBT06**
Paper Title	**Environmental Microbiology And Waste Management**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course learning outcomes: By the completion of this course, the students -

Outcome 1. Have developed a fairly good knowledge and understanding of different types of environments and habitats

Outcome 2. Are able to identify the important role microorganisms play in maintaining healthy environment by degradation of solid/liquid wastes

Outcome 3. Have understood the significance and use of for assessing quality of water.
Outcome 4. Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation

Unit 1 : Enviromental Microbiology	15Hrs
Aerobiology: Brief account of air borne transmission of microbes – viruses – bacteria and fungi, their diseases and preventive measures. Assessment of air quality. **Aquatic microbiology:** Water ecosystems – fresh water and marine habitats. Potability of water – microbial assessment of water quality, brief account of major water borne diseases and their control measures. **Soil** Microbiology: Classification of soils – physical and chemical characteristics, microflora of soil, a brief account of microbial interactions symbiosis – mutualism – commensalisms – competition – amensalism – synergism – parasitism – predation; Biogeochemical cycles (C, N, P & S).	
Unit2 : Solid Waste Treatment	15Hrs
Solid Waste treatment: Wastes–types, characterization, solid waste treatment, saccharification, gasification, composting, utilization of solid wastes, foods (SCP, mushroom, yeast); fuel (ethanol, methane) and , Biofertilizers, compost, vermicompost.	
Unit 3 : Effluent Treatment Technique	15Hrs
What is waste water? Waste water quality parameters, Objectives of waste water treatment, Aerobic treatment of waste water (Trickling Filters, Rotating Biological Contactors, Fluidized bed reactors, Activated Sludge, Oxidation Ponds), Anaerobic treatment of waste water (Anaerobic Contact Digesters, Packed Bed Reactors, Anaerobic Baffled Digesters, Up-flow Anaerobic Sludge Blanket Reactors), Advanced waste water treatment for removal of suspended solids, nutrients (N &P), oil and grease and dissolved inorganic substances, Emerging biotechnological and nanotechnological processes in waste water treatment.	
Unit 4 : Enviroment Pollution And Enviroment Clean Up	15Hrs
Air, Water, Soil, Noise and Thermal pollution. Ozone depletion, Greenhouse effect and acid rain. Bioremediation and bio restoration of contaminated lands. Bioaccumulation and biosorption of metals and biodegradation of pesticides; biodeterioration of paper leather, wood and textiles. Microbial Leaching and biomining, Microbes in petroleum extraction, Microbial desulfurization of coal, Biodegradation of chlorinated hydrocarbons and xenobiotic compounds. Molecular approach to environmental management, degradative plasmids, genetic exchange in xenobiotic chemicals, GMO and their impact on environment.	

Reference Books:

1. Mooray Moo Young. (Eds). Comprehensive Biotechnology (Vol.I,II,III) Pergamon Press, England.
2. Metcalf and Eddy. Waste water engineering treatment and uses. McGraw Hill.
3. Jogdand, S. N. Environmental Biotechnology. Himalaya Publication House.
4. De, A.K. Environmental Chemistry. Wiley Eastern Ltd.
5. Abbasi and Abbasi. Renewable Energy Sources and their environmental impact. Prentice Hall of India, Pvt. Ltd.
6. Chatterji ,A. K. Introduction to Environmental Biotechnology. Prentice Hall of India.
7. Thakur, I. S. Text Book of Environmental Biotechnology. I. K. International Publisher, New

Delhi.
8. Mohapatra, P. K. Text Book of Environmental Biotechnology .I.K. International Publisher, New Delhi. Biotechnology: B.D. Singh, Kalyani Publication.
9. Biotechnology: U. Satyanarayan, Books & Allied Pvt.Ltd.
10. Biotechnology: V. Kumarsen, Saras Publication.
11. Environmental Biotechnology: S.V.S. Rana, Second edition.
12. Biotechnology- Rehm and Reid.
13. Waste water microbiology by G. Bitton
14. Biodegradation and bioremediation by M. Alexander
15. Waste water treatment for pollution control, 2nd edition. Arceivala Environmental Biotechnology by H. Jordening

Semester	**I**
Paper Code	**01MSCBT07**
Paper Title	**Microbial Technology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: By the end of this course, the students will be able to:

CO1. Lay foundation to basics in microbial technology

CO2. Acquire knowledge of fermentation technology

CO3. Provide understanding of various products of industrial importance.

CO4. Facilitates understanding the importance of microbial technology in industry

Unit 1 : Fundamentals of Microbial Technology	15Hrs
General concepts of microbial technology, principles of exploitation of micro-organisms and their products, Industrial microorganisms– Bacteria, Algae and Fungi , Screening of microorganisms for industrial products , Isolation and preservation of microorganisms for industrial products; isolation, selection and improvement of microbial cultures , Strain development– strategies of strain improvement, mutation, selection and recombination, Use of recombinant DNA technology and protoplast fusion techniques for strain improvement	
Unit2: Processes for Microbial Fermentation	15Hrs
Brief history of fermentation; Fermentation–general concepts; Fermentation design– Overview of aerobic and anaerobic fermentation process; Submerged and solid state fermentation , Factors affecting submerged and solid state fermentation (SSF); Substrates used in SSF and their advantages; Applications of fermentation, Importance of media in fermentation; media types: components and formulations, Substrates with sources for Carbon and Nitrogen, inoculum development, Storage of cultures for repeated fermentations, production of microbial biomass, Factors affecting fermentation process	
Unit 3 : Microbial products and Food additives	15Hrs
Organic acids– Citric acid, Amino acids– Glutamic acid, Lysin Enzymes– Proteases, Amylases, Lipases, Enzyme Biosensors, Food fermentations and food produced by microbes; Dairy products– Cheese, Yoghurt; Other products-bread, cheese, vinegar, fermented dairy products, Oriental fermented foods, microbial cells as food-single cell proteins; production of alcohol and fermented beverages, beer and wine	
Unit 4 : Applications of Microbial technology	15Hrs
Health care: Production of antibiotics–penicillin, Production of therapeutic drugs, recombinant vaccines–BCG, Hepatitis-B, Monoclonal antibodies, Insulin, Vitamins–B12, D & C, Riboflavin, Cyanocobalamin, Biofuel and Biodiesel production, methane, alcohol, hydrogen Biomining–Extraction of Cu, Au and U from ore, Bioplastics (biopolymers), Bioremediation	

Reference Books

1. Text Book of Biotechnology– By H.K. Das (Wiley Publications)
2. Biotechnology– By H.J. Rehm and G. Reed.VIH Publications, Germany
3. Biogas Technology- By B.T. Nijaguna
4. Biotechnology- By K. Trehan 5.Industrial Microbiology- By L.E. Casida
5. Food Microbiology- By M.R. Adams and M.O. Moss 7.Introduction to Biotechnology- By P.K. Gupta
6. Essentials of Biotechnology for Students- By Satya N. Das
7. Bioethics– Readings and Cases- By B.A. Brody and H. T. Engelhardt. Jr. (Pearson Education)
8. Bioprocess Engineering-By Shuler (Pearson Education)
9. Essentials of Biotechnology-By Irfan Ali Khan and Atiya Khanum (UkaazPublications)
10. Gene, Genomics and Genetic Engineering- By Irfan Ali Khan and Atiya Khanum(Ukaaz Publications)

Semester	**I**
Paper Code	**01MSCBT08**
Paper Title	**Virology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course learning outcomes: Students have-
Outcome 1. Understood what are viruses and the chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophages)
Outcome 2. Understanding about the biology of bacteriophages.

Outcome 3. Gained knowledge of a variety of plant viruses and animal viruses.
Outcome 4. The ability to describe role of viruses in the causation of the cancer'

Unit 1: Morphology, Classification And Cultivation of Viruses	15Hrs
Cataloging the virus through virus classification schemes of ICTV / ICNV. Morphology and ultra-structure of viruses. Virus related agents, viroids and prions. Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA. Assay of viruses – Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point)	
Unit 2 :Viral Multiplication	15Hrs
Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions, multiplication of bacteriophages.	
Unit 3 :Pathogenesis of Viruses	15Hrs
Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.	
Unit 4: Control of Viruses and Emerging Viruses	15Hrs
Control of viral infections through vaccines, interferons and chemotherapeutic agents. Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.Emerging viruses	

Reference Books:

1. Medical Virology 10Th Edition by Morag C and Tim bury M C 1994. Churchil Livingstone, London.
2. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. 1994.Blackwell Scientific Publications. Oxford.
3. Virology 3rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. 1994. Prentice Hall,Englewood Cliff, New Jersey.
4. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons1995.
5. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press,Washington, D.C.
6. Applied Virology. 1984. Edited by Edonard Kurstak. Academic Press Inc.
7. Introduction to Modern Virology by Dimmock.
8. Prion diseases by Gaschup, M.H.
9. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A.
10. Principles of Virology. 2000 by Edward Arnold.

Semester	**I**
Paper Code	**01MSCBT09**
Paper Title	**Research Methodology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: By the end of this course, the students will be able to:
CO1. Explain the steps and motivation in research
CO2. Explain the techniques of sampling
CO3. Understand the scientific writing skills, presentation skills etc

Unit 1: Introduction to Research Methodology	15Hrs
A. Introduction of research	

B. Objective of research C. Motivation in research D. Steps in research process E. Research design: concepts and type of research design F. Design of research of the basis of application – pure and applied	
Unit 2 : Direction to Research Methodology	15Hrs
A. Design of research on the basis of methodology – exploratoryand descriptive B. Descriptive research – qualitative and quantitative. C. Quantitative – field studies (field experiments and laboratoryexperiments) D. Sampling and data collection: techniques of sampling (random,stratified, systematic, multistage) E. Primary and secondary sources of data	
Unit 3 : Research Formulation	15Hrs
A. Presentation skills – formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; B. Scientific poster preparation & presentation; C. Participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; D. Internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.	
Unit 4 : Scientific Writing	15Hrs
A. Technical writing skills - types of reports; layout of a formal report; B. scientific writing skills - importance of communicating science; problems while writing a scientific document; C. Plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; D. Publishing scientific papers-peer review process and problems, recent developments such as open access and non blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.	

Reference Books:

1. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press.
2. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

PRACTICAL-I
Based on Theory C I & CII Credit : 2

1. Isolation of mitochondria.
2. Isolation of Bacteria, fungi, Actinomycetes and Yeast.
3. Assay of viruses
4. Cell motility and flagella staining.
5. Cell types of plants- maceration of various tissue explants and identification of xylem,

trachied, stomata, root hair, etc.

6. Isolation of neutrophils and demonstration of phagocytosis.
7. Determination of osmotic fragility of RBC membrane.
8. Isolation of chlorophyll and xanthophylls from spinach leaves.
9. Study of meiosis and mitosis.
10. Histological study of tissues by Microtomy.
11. Cleanliness, media preparation, sterilization, culturing methods, dilution techniques.
12. Staining techniques in microbiology; simple staining, gram staining, spore staining, capsule staining, flagella staining.
13. Isolation of pure culture by different techniques.
14. Replica plating technique.

PRACTICAL-I
Based on Theory CIII & EI Credit :2

1. Separation of proteins by ion exchange chromatography

2. Separation of lipids by thin layer chromatography
3. Polyacrylamide gel electrophoresis: SDS-PAGE of proteins.
4. Estimation of proteins by Lowry's and Bradford method.
5. Qualitative analysis of Carbohydrate, protein, lipid and nucleic acids.
6. Estimation of protein by E280/E260 method
7. Introduction to measurements: balance and pipefitting, preparation of solutions of given molarity and normality.
8. Measurement of pH: buffering capacity, to determine pKa value and hence the dissociation constant of a given acid using pH meter.
9. Colorimetry: To determine the dissociation constant of a given indicator calorimetrically and to prepare buffer solutions in the pH range 2.2 to8.0
10. Colorimetry: Assay of DNA by diphenyl amine method.
11. Colorimetry: Assay of RNA by orcinol method.
12. Potentiometry: To determine redox potential of Fe++ and Fe+++.
13. Conductometry: to determine cell constant of 0.1M KCl.
14. Conductometry: Titration of strong acid *vs* strong base, to find out equivalent conductance of salt formed.
15. Viscometry: To determine radius of glycerol molecule.
16. Viscometry: To determine molecular weight of protein and DNA.
17. Viscometry: To determine changes in the conformation of bovine serum albumin by viscosity measurements, effect of pH on conformation of BSA.

GONDWANA UNIVERSITY
GADCHIROLI

SYLLABI AND COURSE OF STUDY IN BIOTECHNOLOGY

BIOTECHNOLOGY COURSE

PG SEMESTER II
UNDER NEP-2020

From session 2023 Onwards

Teaching and Examination Scheme
M.Sc. Semester II
Master of Science
(Biotechnology)

<table>
<tr><th colspan="7">SEM – II</th></tr>
<tr><th>Major (Mandatory)</th><th>Credit</th><th>Elective</th><th>Credit</th><th>On Job Training /Field Project (OJT/FP)</th><th>Credit</th><th>Total Credit</th></tr>
<tr><td rowspan="4">1. Enzymology – Paper - I Theory = 03 Credit
Theory = 100 (80 + 20)

2. Immunology & Immunological Techniques – Paper - II
Theory = 03 Credit
Theory = 100 (80 + 20)

3. Molecular Biology & Bioinformatics– Paper - III Theory = 03 Credit
Theory = 100 (80 + 20)</td><td rowspan="4">(3x3) 9</td><td>1. Industrial Biotechnology,
Paper - IV Theory = 03 Credit
Theory = 100 (80 + 20)</td><td rowspan="4">3</td><td rowspan="4">1 OJT

Practical

Seminar</td><td rowspan="4">3

4

1</td><td rowspan="4">20</td></tr>
<tr><td>2. Advanced Plant & Agricultural Biotechnology , Paper - IV
Theory = 03 Credit
Theory = 100 (80 + 20)</td></tr>
<tr><td>3.Medical Biotechnology,
Paper - IV
Theory = 03 Credit
Theory = 100 (80 + 20)</td></tr>
<tr><td>4. Food & Dairy Biotechnology, Paper - IV
Theory = 03 Credit
Theory = 100 (80 + 20)

5. Pharmaceutical Biotechnology Paper - IV
Theory = 03 Credit
Theory = 100 (80 + 20)
Note: Student will select any one elective paper</td></tr>
</table>

NEP 2020

SEMESTER PATTERN

M.Sc. Biotechnology (PG) Program

Faculty of Science and Technology

(Affiliated Colleges)

(W.e.f. Academic Year 2023-24)

Scheme of teaching and examination under semester pattern for M.Sc. Program in Biotechnology
M.Sc. Semester II Biotechnology

	Core Course	**Elective**	**Minor**
SEM II	**Major1- 02MSCBT01** (3 Credits) (4Hours/Week)	**Elective Course – 02MSCBT04** Student shall select any one course. (3Credits) (4Hours/Week)	**02MSCBT09** OJT/FP (3 Credits) (4Hours/Week)
	Major2 – 02MSCBT02 (3Credits) (4Hours/Week)		
	Major 3 – 02MSCBT03 (3Credits) (4 Hours/Week)		Practical 4 credit
	Practical(Lab 3&4) Based on Major Course (3-8 Hour/Week) 4 credit		Seminar 1 Credit

Total 20 Credit

MARKING SCHEME Semester II														
Code	Theory / Practical	Teaching Scheme					Credit	Examination Scheme						
								Duration in hrs.	Max. Marks		Total	Minimum Marks		
		Theory		Practical		Total			External	Internal		Theory	Practical	
		UA	CA	UA	CA									
Major - 02MSCBT01	Theory	80	20	**LAB-1 75**	25	300	3	3	80	20	100	40	40	
Major - 02MSCBT02	Theory	80	20				3	3	80	20	100	40	40	
Major - 02MSCBT03	Theory	80	20	**LAB-2 75**	25	300	3	3	80	20	100	40	40	
Elective – 02MSCBT04	Theory	80	20				3	3	80	20	100	40	40	
OJT - 02MSCBT09	-	80	20	-	-	100	3	3	80	20	100	40	40	
SEMINAR	-	-	50			50	1	-	-	50	50	-	-	
Practical (Lab 3 & 4)		-	-				4							
TOTAL		**400**	**150**	**150**	**50**	**750**	**20**							

MAJOR COURSE

Semester	**I**

Paper Code	**02MSCBT01**
Paper Title	**Enzymology**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**3**

Course Outcomes: By the end of this course, the students will be able to:
CO1: Understand enzyme structure and differences between enzymes and normal catalytic substances
CO2: Define factors that effect enzyme activity
CO3: Explain cofactor and coenzymes chemical structure
CO4: Describe the process of purification and isolation of enzymes

Unit I: General Enzymology, Specificity and its Kinetics	15Hrs
A. Enzyme classification and nomenclature. B. Concept of holo enzymes, coenzymes, apoenzyme, Substrate, Inhibitor, Activator, Modulators etc. C. Commercial application of enzymes (food, industry, Research, Pharmaceutical field) Enzyme immobilization. D. Substrate Specificity-Lock and Key model, Induced fit model. E. Enzyme kinetics: Michaelis-Menten equation (derivation, significance and transformation). F. Lineweaver-Burk equation. G. Effect of pH, Temperature, Substrate Concentration, enzyme Concentration,	
Unit II: Enzyme Inhibition	15Hrs
A.Enzyme inhibition and types of inhibitors. B.Reversible and Irreversible Inhibitors, competitive, noncompetitive, un competitive inhibitors. C.Enzyme Inhibition Kinetics. D. Concept of multienzyme complexes: fatty acid synthase and dehydrogenase complexes.	
Unit III: Mechanism of enzyme action	15Hrs
A. Models enzyme action, catalysis by proximity effect, acid-base catalysis, covalent catalysis, metal ion catalysis, nucleophilic and electrophilic catalysis, electrostatic interaction, B. Unit of Enzyme activity, Enzyme assay. C. Purification and Isolation of enzymes D. Membrane bound enzymes and Isoenzymes	
Unit IV: Enzyme Regulation	15Hrs
A. Concept of enzyme regulation: Allosteric (example ATCase), Proteolytic Activation (example zymogen structure) B. Types of Allosteric regulation: homotropic allosteric modulator, heterotropic allosteric modulator C. Ping Pong mechanism. D. Chemical modification and calmodulin mediated regulation. Isoenzymes. Lysozymes	

Reference Books:

1. Palmer, T. & Bonner, P., Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (2nd Ed.). Howood Publishing Chishester, England. 2008. 72 2.
2. Okotore, R.O. (2015) Essentials of Enzymology Xlibris, USA. 2015.
3. Bisswanger, H., Enzyme Kinetics: Principles and Methods (3rd Ed.). Willey-VCH. 2017.
4. Rocha-Martin, J., Immobilization of Enzymes and Cells: Methods and Protocols, Springer US. 2020
5. Phillips, J., Fundamentals of Enzymology Ed-Tech Press, United Kingdom. 2019.
6. Marangoni A.G. (2003) Enzyme Kinetics-A Modern Approach.
7. Price N.C and Stevens L. (2014) Fundamental of Enzymology. Oxford University Press, New York.
8. Dixon M and Webb E.C. (1979) Enzyme 3rd edition. Academic Press, New York
9. Uhlig H. (1998) Industrial Enzyme and their Application, Jone Wiley, New York

Semester	**II**
Paper Code	**02MSCBT02**
Paper Title	**Immunology and Immunological Techniques**

Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

LEARNING OBJECTIVES: By the end of this course, the students will be able to:
CO1. Understand and describe human body resistance mechanism against disease.
CO2. Outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate
CO3. Understand and explain the basis of allergy and allergic diseases
CO4. Explain the primary and secondary lymphoid organ
CO5. Understand the structure and classes of immunoglobulins

Unit I: History, Cells and Organs of immune system.	15Hrs
A. Concept of Innate immunity, Acquired immunity B. Cells involved in immune response- lymphocytes, granulocytes and agranulocytes. C. Primary lymphoid organs (Bone marrow, Thymus,) D. Secondary lymphoid organs (MALT, GALT, Lymph Nodes, Spleen,) E. Antigen, Antigenicity F. Immunoglobulins: structure of Immunoglobulins and classes of Immunoglobulins	
Unit II: Adaptive and Cell mediated immune response	15Hrs
A. Humoral immune system- Main pathway of complement system, primary response, secondary response, B-cell, BCR, Activation of B Cells B. MHC-I, MHC-II molecules, antigen presentation. C.T-cell development, T Cell Receptor (TCR)- α β T cells, γ δ T cells, Structure of TCR, T-cell activation, Apoptosis in T cells. D. Humoral Immunity, NK cell mediated immunity, mechanism of cell mediated immunity. E. Cell-cell cooperation, role of cytokines-Cytokine receptors,	
Unit III: Immunological Techniques	15Hrs
Immunological techniques: Ag-Ab reactions, Lattice theory, Zone phenomenon, techniques based on precipitation, agglutination, immune diffusion, RIA, ELISA, hybridoma Technology, CFT (complement fixation test)	
Unit IV: Hypersensitivity and Vaccination	15Hrs
A. General feature of Hypersensitivity, types of Hypersensitivity. B. Autoimmune Diseases: Addison's Disease, Grave's Disease. C. Vaccination: Discovery, Principle and Significance of vaccination. D. Concept of autoimmunity and immunological tolerance.	

Books For Reference

1. Kuby R.A. Goldsby *et al*., 2002. Osborne Immunology (Ed: 6) Freeman & Co., New York.

2. Delves *et al*., 2016. Roitt's Essential Immunology (Ed: 13). Blackwell Scientific Publisher, England.

3. Tizard, Ian R. Immunology and introduction, 2010. (Ed: 4), Saunders college publishing, New Delhi.

4. Coico R, Sunshine G. 2009. Immunology: A short course, (Ed: 6), Wiley-Blackwell publishers, Canada

5. Donald M. Weir and John Steward. 1993. Immunology (Ed: 7). ELBS, London.

6. Murphy *et al*., 2008. Janeway's Immunology: the immune system in health and disease. (Ed: 7), Garland Science Publisher, New York.

7.Hudson, L. and Hay, F.C. Practical Immunology. Blackwell publishers 1989.

Semester	**II**
Paper Code	**02MSCBT03**
Paper Title	**Molecular Biology and Bioinformatics**
Number of teaching hours per week	**4**

Total number of teaching hours per semester	**60**
Number of credits	**3**

COURSE OUTCOMES: By the end of this course, the students will be able to:
CO1. Understand the process of homologous recombination
CO2. Explain the basic concepts of RNAi
CO3. Describe the various DNA viruses and cancer
CO4. Understand the concept of computer and understand the computer analysis of genetic sequences

Unit I: Recombination, Chromosome Transfer and Genome Mapping	15Hrs
A. Homologous recombination: Holiday junction. B. FLP/FRT and Cre/Lox recombination, RecA. C. Molecular mapping of genome: Genetic and physical maps, choice of mapping population, D. Southern and fluorescence in situ hybridization for genome analysis, E. Molecular markers- RFLP map, RAPD, and AFLP analysis, linked analysis, application of molecular markers in forensic, disease prognosis, genetic counseling, pedigree etc. STS, microsatellite.	
Unit II: Antisense, Ribozymes and Epigenetics	15Hrs
A. Antisense and ribozyme technology: Molecular mechanism of antisense molecule, biochemistry of ribozyme, hammerhead ribozymes, applications of antisense and ribozyme technologies. B. Epigenetics**:** chromatin marking systems, Direct chemical modification of DNA, Basic concepts of RNAi.	
Unit III : Cancer Biology	15Hrs
A. Characteristics of Cancer cell, Methods to study cancer. B. Angiogenesis, positive and negative factors affecting angiogenesis. Metastasis, biochemical parameters acquired by metastatic cells. C. DNA Viruses and cancer: Polyoma virus, SV40, adeno virus D. Genetics of Cancer: Oncogenes (ras, erb-B, abl), suppressor genes (p53, Rb). E. Cancer stem cells.	
Unit IV: Bioinformatics	15Hrs
A. Computer concept: computer organization, hardware, software, operating system (windows, Unix, brief list of computer languages). B. Concept of networking**:** internet, internet concepts, web browsing, public domain resources in biology. C. Concept of data base management**:** brief idea of data types, data structures, searching, sorting, designing a database, genomic, proteomic, and metabolic pathways databases. D. Computer analysis of genetic sequences**:** general concepts of sequence analysis, identification of functional sequences, homology, brief idea of BLAST, ENTREZ, and PuBMed. E.Bioinformatics tools in drug design.	

Books for Reference

1. Watson J. D., *et al*., 2006. Molecular Biology of the gene (Ed. 5) Pearson Education Inc. London.
2. Jeoffrey M. Cooper and Rober E. Hausman. 2000. The Cell: A Molecular Approach (Ed:4) ASM Press, Washington D.C.
3. Stickberger MW *et al*., Genetics, 2008, (Ed. 3), Macmillan and Company.
4. David Freifelder. 2008. Molecular Biology. (Ed: 2). Narosa Publications. NewDelhi.
5. Bruce Alberts *et al*., 2015. Molecular Biology of Cell (Ed: 6). Garland Science, Taylor and Francis Group
6. Gerald Karp. 2008. Cell and Molecular Biology. (Ed: 5). John Wiley and Sons, New York.
7. Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd. Arthur M Lesk. 2009.
8. Introduction to Bioinformatics(Ed:3). Oxford university press, New York.
9. Attwood, T.K. and Parrysmith, D.J. 2001. Introduction to Bioinformatics. Pearson Education (Singapore) Pvt. Ltd., New Delhi.
10. Andreas D. Baxevanis and B. F. Francis Ouellette. 2005. Bioinformatics - A Practical guide to the analysis of Genes and Proteins (Ed:3). John Wiley & Sons, Inc., Publications, US.
11. David W Mount. 2004. Bioinformatics: sequence and Genome analysis(Ed:2). Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
12. Rastogi, S.C., Menderatta, M. and Rastogi, P. 2004. Bioinformatics - concepts, skills and applications. CBS Publishers & Distributors, New Delhi.

ELECTIVE PAPERS

Semester	**II**
Paper Code	**ELECTIVE -1 (02MSCBT04)**
Paper Title	**Industrial Biotechnology**
Number of teaching hours per week	**4**
Total number of teachings hrs per semester	**60**
Number of credits	**3**

Course Outcomes: By the end of this course, the students will be able to:
CO1. Understand the concept of industrial Fermentation and types of fermentation
CO2. Explain the instrumentation of various fermenters
CO3. Describe the downstream processes
CO4. Understand the industrial production of amylase, penicillin, ethanol etc.

Unit 1: Bioreactor Technology-I	15Hrs
A. Definition of fermentation B. Concept of Industrial Fermentation, Types of fermentation (Industrial Types) C. General layout of fermentation unit D. Design of fermenter- Geometry of fermenter E. Types of fermenters- Batch and continuous, airlift, fluidized bed, loop reactors, rotator disc reactors, fed batch reactors	
Unit 2: Bioreactor Technology-II	15Hrs
A. Aeration and Agitation, Heat and mass transfer, KLa value, B. Rheology, Power number, Reynold number and other factors, types of microorganisms, medium composition, anti-foaming agents, Product accumulation C. Up-stream processes: medium composition, Raw materials and sterilization D. Inoculum build up, Scale up Substrate utilization, oxygen sag, yield coefficient	
Unit 3 : Down stream processing	15Hrs
A. Filtration, ultrafiltration, Bio separation, membrane filtration, centrifugation, sedimentation, flocculation B. Solvent extraction, counter current extraction C. Chromatographic techniques- ion exchange, affinity, gel filtration, adsorption D. Crystallization, reverse osmosis, drying E. Quality control Testing-Antibiotics F. Packaging and storage	
Unit 4: Industrial Production and Immobilization	15Hrs
A. Industrial Production of amylase, penicillin ethanol, pigment-beta-carotene, vitaminB12 and Gibberellin B. Biosensor C. Immobilized systems- adsorption, covalent bonding, entrapment, encapsulation, cross linking, diffusion characteristics, effective factors, Instability factors, deactivation rates D. Immobilization of enzyme, lyophilization and crystallization of products	

Reference Books (Industrial Biotechnology)

1. Stanbury P.F. *et al*., 1999. Principles of Fermentation Technology, Butterworth-Heinemann, UK.

2. El-Mansi E.M.T *et al*., 2007. Fermentation Microbiology & Biotechnology. CRC / Taylor & Francis.

3. Bailey J and D.F. Ollis. 2017. Biochemical Engineering Fundamentals (Ed: 2) Indian Edition: McGraw-Hill, NY

4. Cinar A *et al*., 2003. Batch Fermentation - Modeling, Monitoring and Control. Marcel Dekker. USA.

Semester	**II**
Paper Code	**ELECTIVE-2 (02MSCBT05)**
Paper Title	**Advanced Plant And Agriculture Biotechnology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes:

CO1: Understand basic techniques of plant transformation and plant tissue culture

CO2: Know various methods of producing genetically modified crops and their societal implications

Unit 1 : Plant Tissue culture	15Hrs
Plant Biotechnology: Introduction to tissue culture, scope, application, Organogenesis, Protoplast isolation and fusion Haploid plant: homozygous line, production, advantage, limitation, Large scale culture: suspension culture, problem	
Unit 2 : Micropropagation	15Hrs
Somaclonal Variation and its process, Embryo rescue: recovery of interspecific hybrid, Micropropagation and its technique, application, Gene transfer method and its technique and application, Somatic hybridization and cybrid production and their applications in crop improvement. Productions of virus free plants using meristem culture.	
Unit 3 :Transgenic Plant	15Hrs
Cryopreservation: Introduction, process, application, Germplasm conservation technique and application Transgenic plant: transgene action, herbicide resistance Vector: Introduction, production of transgenic plant	
Unit 4 : Plant Transformation Technology	15Hrs
Agrobacterium mediated gene transfer Biotransformation introduction, process Golden rice and its uses Plant derived vaccine and application Transgenic plants, genetically modified (GM) plants (Bt cotton, Bt Brinjal)	

Reference Books/ Text Books:

1. Biotechnology: B.D. Singh expending horizons, kalyani publisher
2. Plant Biotechnology: BD Singh, kalyani publisher
3. Biotechnology: U. Satyanarayan, elsvere publication
4. R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992.
5. S S Bhojwani and M K Razdan, Plant Tissue Culture, Elsevier Publ.
6. Plant Tissue Culture by MK Razdan & SS Bhojwani (1996) Elsevier
7. Plant Physiology by L Taiz & E Zeiger 4th Edition (2006) Sinauer Associates Inc, Publishers
8. Experiment in Microbiology, Plant pathology and Tissue culture by K.R. Aneja, Wishwa Prakashan
9. Genetic Transformation of Plants, Edited by Jackson, J.F.; Linskens, H.F. Springer 2003
10. Plant Biotechnology and Transgenic Plants, Edited by Kirsi Marja Oksman-Caldentey, Wolfgang Barz Marcel Dekker 2002 .
11. Slater A., Scott N W, Fowler M R (2010), Plant Biotechnology-the genetic manipulation of plants, Oxford Publishing House
12. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
13. Bhojwari SS (2003) Agrobiotechnology & Plant Tissue Culture.
14. Rajdan MK (2003), Plant Tissue Culture (2nd ed.) IBH Publishing House, New Delhi

Semester	**II**
Paper Code	**ELECTIVE-3 (02MSCBT06)**
Paper Title	**Medical Biotechnology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: This Course will enable students to:

CO1:Get an overview of the immune system with particular reference to diagnostics, therapy and transplantation.

CO2:Understand the genetics behind genetic diseases and syndromes and techniques associated with diagnosis and gene therapy

CO3:Learn about cancer biology with particular reference to carcinogenic agents, basis of cancer, treatment strategies and approaches, stem cells and applications

Unit 1: Immunology	15Hrs
Overview: concept of self and nonself, antigens, antibodies; immune response, evolution of immune response, immunological tolerance, hypersensitivity, humoral and cell mediated immunity, active and passive immunization, antigen processing and MHC. Immunobiology: blood groups and transplantation antigens, HLA. Immune deficiencies and disorders – AIDS, Allergy	
Unit 2 : Diagnostic Tools	15Hrs
Antigen-antibody reaction, agglutination, immune electrophoresis, immunofluorescence, enzyme-linked immunosorbent assay, (ELISA), radioimmunoassay (RIA). Immunization and vaccines – new types of vaccines, edible vaccines. Organ transplantation.	
Unit 3: Genetics	15Hrs
Structure, organization and types of eukaryotic chromosomes, Heterochromatin, euchromatin, telomeres, types of chromosomes. Cell division. Molecular and cellular biology of fertilization *in-vitro* fertilization, assisted reproductive techniques, cloning. Karyotyping - heritable diseases and syndromes. Prenatal diagnosis (amniocentesis and chorionic villus sampling), Diagnosis of genetic diseases, Gene therapy, PCR.	
Unit 4 : Cancer Biology	15Hrs
Cancer biology: Cell cycle and its regulation. Apoptosis. Carcinogenic agents and molecular biology of cancer, Abnormal cell growth: mechanism of transformation of cells. Genetic basis of Cancer, Physical and chemical carcinogenic agents; Viral and cellular oncogenes, tumor suppressor genes, Telomerases and their role in cancer. Recent advances in therapeutic approaches to disease treatment: Stem cells - types and applications. Cancer therapy – immunotoxins and gene therapy.	

Reference Books

1. The Cell. A Molecular Approach. Cooper, G.M. Sunderland: Sinauer Associates, Inc., 2000
2. Basic Genetics. Hartl D.L. & Jones E.W. Jones & Bartlett Pub., 1998
3. Kuby Immunology. Kindt T.J. et at., W.H. Freeman & Co. 2007
4. Lodish *et al.,* 2007. Molecular cell Biology: (Ed: 6), W.H Freeman Publishers.
5. R. G. McKinnell, R. E. Parchment, A. O. Perantoni, G. Barry Pierce, I. Damjanov. 2006. The Biological Basis of Cancer: (Ed: 4), Cambridge University Press, 2006.
6.R. A. Weinberg. 2013. The Biology of Cancer (Ed: 2),W. W. Norton & Company.
7. Watson J.D. *et al*., 2007. Molecular Biology of the Gene (Ed.6), Pearson Education Inc., London.
8. Stephen Hulley (2011), Outlines & Highlights for Designing Clinical Research: An Epidemiologic Approach, Academic Internet Publishers.
9.Dan Wood, Daron Smith (2012), Research in Clinical Practice, Springer Publications.
10. Robert J. Levine (2010), Ethics and Regulation of Clinical Research: Second Edition, Yale University Press.

Semester	**II**
Paper Code	**ELECTIVE 4 (02MSCBT07)**
Paper Title	**Food And Dairy Biotechnology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: This Course will enable students to:
CO1: The students would be able to explain and apply various bio-technological techniques for the improvement of food products.
CO2: The knowledge of food bio-technology would strengthen the students to render their scientific skills in their genetic engineering and protein engineering for the production of food products, bio-preservatives and other useful bio components.
CO3: The students would be able to get career opportunities in the bio-tech foods industries.

Unit 1 : Introduction to food and dairy product	15Hrs
Starter cultures and their biochemical activities; production of alcoholic beverages; production of Single cell protein and Baker's yeast; Mushroom cultivation, Food and dairy products: Cheese, bread and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages	
Unit 2 : Probiotics	15Hrs
Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs, enzyme biotransformations, Role of Plant tissue culture for improvement of food additives; color and flavor, Genetic modifications of microorganisms; detection and rapid diagnosis. Genetically modified foods and crop.	
Unit 3 : Food borne Diseases & Food Preservation	15Hrs
Food borne infections and intoxications; with examples of infective and toxic types-Clostridium, Salmonella, Staphylococcus Mycotoxins in food with reference to *Aspergillus* species. Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation. Fermented foods and beverages. Use of biosensors in food industry.	
Unit 4 : Food Qualty Control	15Hrs
Quality assurance: Microbiological quality standards of food Intellectual property rights and animal welfare, Government regulatory practices and policies. FDA, EPA, HACCP, ISI Risk analysis; consumer and industry perceptions.	

Reference Books

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7^{th} edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9^{th} edition. Pearson Education

Semester	**II**
Paper Code	**ELECTIVE 5 (02MSCBT08)**
Paper Title	**PHARMACEUTICAL BOTECHNOLOGY**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: This Course will enable students to:

CO1: Make themselves more employable in pharma industries.

CO2: Know different aspects of drug development.

CO3: Gain preliminary knowledge of clinical trials.

CO4: Understand the mechanism of action of different drugs.

Unit 1 Introduction	15Hrs
Chemotherapy Antimicrobial Drug. Mechanism of action of antimicrobial agents. Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism). Types of Antibiotics: Classification of antibiotics with example. General characteristics of a Secondary Metabolites: Types and Medicinal Applications	
Unit 2 : Mechanism	15Hrs
Chemotherapeutics Agents Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones. Antiviral drug: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin. Mechanism of action of Anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII.	
Unit 3 : Discovery and Development	15Hrs
Discovery and Development History, drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Stability of Drug, Pharmacokinetics, Pharmacodynamics. Drug delivery systems, Liposomes	
Unit 4 : Clinical Trails	15Hrs
Clinical Trials Phases of Clinical trials of drugs, Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenecity and mutagenecity. Biosimilar Technology, Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.	

Books for References:

1. Pharmaceutical Microbiology - Hugo W. B. and Russell A. D. - Wiley India
2. Pharmacology and Pharmaco biotechnology- Ashutosh Kar-New Age
3. Pharmaceutical- Essentials of Pharmaceuticals- FSK Barar- S.Chand
4. Molecular Biotechnology – B.Glick and J Pasernak -ASM Press.
5. Drug Designing- Doble- McGraw Hill
6. Pharmaceutical Biotechnology- S.P. Vyas, Dixit- CBS
7. Medicinal Chemistry- B.Razdan-CBS
8. Pharmacology and Pharmacotherapeutics- Satoskar, Bhandarkar- Popular
9. Pharmaceutical Biotechnology- Purohit, Saluja- Student Edition
10. Biotechnology: Secondary Metabolites- Ramawat K.G; Merillon J.M - Oxford
11. Chemistry of Natural Products- Ed. R.H. Thomson-Springer
12. Biopharmaceuticals, Jogdand S.N - Himalaya Publishing

PRACTICALS

PRACTICAL - I

Based on Theory CI & CII Credit : 2

1. Western Blotting
2. Determination of activity of invertase from immobilized cells of *Saccharomyces cescerevisiae*
3. Assay of activity of LDH.
4. Purification of immunoglobulins, qualitative assessment.
5. Demonstration of immunochemical reactions (blood group, pregnancy,)
6. Demonstration of ELISA
7. Demonstration of VDRL
8. Widal Test
9. Blood film preparation and identification of cells.
10. Ouchterlony immunodiffusion,
11. Determination of albumin by radial immunodiffusion.
12. Assay of activity of beta-galactosidase
13. Assay of activity of acid phosphatase,
14. Determination of activity in presence of activators.
15. Determination of activity in presence of inhibitors.
16. Enzyme purification by crystallization -urease.
17. Subcellular fractionation and assay of marker enzymes.

PRACTICAL - II

Based on Theory C3 & E1 Credit: 2

1. Production of microbial products (Alcohol/Antibiotic) in bioreactors/fermenter and determine yield potential.

2. Separation of poly A RNA on oligo dT column.
3. Southern blotting.
4. Determination of rheological constant.
5. Determination of oxygen transfer rate, volumetric transfer coefficient.
6. Isolation of genomic DNA.
7. Isolation of plasmid DNA.
8. Isolation of RNA.
9. Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.
10. Restriction fragment length polymorphism.
11. Ames test.
12. Computer aided visualization of amino acid sequence of protein and its 3D structure.
13. Retrieving metabolic pathway using internet.
14. Homology searching using BLAST.
15. Computer aided survey of scientific literature.
16. Immobilization of cell/enzyme.

GONDWANA UNIVERSITY
GADCHIROLI

SYLLABI AND COURSE OF STUDY IN BIOTECHNOLOGY

BIOTECHNOLOGY COURSE

PG SEMESTER II
UNDER NEP-2020

From session 2023 Onwards

Teaching and Examination Scheme
M.Sc. Semester II
Master of Science
(Biotechnology)

<table>
<tr><th colspan="7">SEM – II</th></tr>
<tr><th>Major (Mandatory)</th><th>Credit</th><th>Elective</th><th>Credit</th><th>On Job Training /Field Project (OJT/FP)</th><th>Credit</th><th>Total Credit</th></tr>
<tr><td>1. Enzymology – Paper - I Theory = 03 Credit Theory = 100 (80 + 20)</td><td rowspan="4">(3x3) 9</td><td>1. Industrial Biotechnology, Paper - IV Theory = 03 Credit Theory = 100 (80 + 20)</td><td rowspan="4">3</td><td rowspan="4">1 OJT

Practical

Seminar</td><td rowspan="4">3

4

1</td><td rowspan="4">20</td></tr>
<tr><td>2. Immunology & Immunological Techniques – Paper - II Theory = 03 Credit Theory = 100 (80 + 20)</td><td>2. Advanced Plant & Agricultural Biotechnology , Paper - IV Theory = 03 Credit Theory = 100 (80 + 20)</td></tr>
<tr><td>3.Medical Biotechnology, Paper - IV Theory = 03 Credit Theory = 100 (80 + 20)</td></tr>
<tr><td>3. Molecular Biology & Bioinformatics– Paper - III Theory = 03 Credit Theory = 100 (80 + 20)</td><td>4. Food & Dairy Biotechnology, Paper - IV Theory = 03 Credit Theory = 100 (80 + 20)

5. Pharmaceutical Biotechnology Paper - IV Theory = 03 Credit Theory = 100 (80 + 20)
Note: Student will select any one elective paper</td></tr>
</table>

NEP 2020
SEMESTER PATTERN
M.Sc. Biotechnology (PG) Program
Faculty of Science and Technology
(Affiliated Colleges)

(W.e.f. Academic Year 2023-24)

Scheme of teaching and examination under semester pattern for M.Sc. Program in Biotechnology
M.Sc. Semester II Biotechnology

	Core Course	**Elective**	**Minor**
SEM II	**Major1- 02MSCBT01** (3 Credits) (4Hours/Week)	**Elective Course – 02MSCBT04** Student shall select any one course. (3Credits) (4Hours/Week)	**02MSCBT09** OJT/FP (3 Credits) (4Hours/Week)
	Major2 – 02MSCBT02 (3Credits) (4Hours/Week)		
	Major 3 – 02MSCBT03 (3Credits) (4 Hours/Week)		Practical 4 credit
	Practical(Lab 3&4) Based on Major Course (3-8 Hour/Week) 4 credit		Seminar 1 Credit

Total 20 Credit

MARKING SCHEME
Semester II

Code	Theory / Practical	Teaching Scheme					Credit	Examination Scheme						
		Theory		Practical		Total		Duration in hrs.	Max. Marks		Total	Minimum Marks		
									External	Internal		Theory	Practical	
		UA	CA	UA	CA									
Major - 02MSCBT01	Theory	80	20	**LAB-1 75**	25	300	3	3	80	20	100	40	40	
Major - 02MSCBT02	Theory	80	20				3	3	80	20	100	40	40	
Major - 02MSCBT03	Theory	80	20	**LAB-2 75**	25	300	3	3	80	20	100	40	40	
Elective – 02MSCBT04	Theory	80	20				3	3	80	20	100	40	40	
OJT - 02MSCBT09	-	80	20	-	-	100	3	3	80	20	100	40	40	
SEMINAR	-	-	50			50	1	-	-	50	50	-	-	
Practical (Lab 3 & 4)		-	-				4							
TOTAL		**400**	**150**	**150**	**50**	**750**	**20**							

MAJOR COURSE

Semester	**I**
Paper Code	**02MSCBT01**
Paper Title	**Enzymology**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**3**

Course Outcomes: By the end of this course, the students will be able to:
CO1: Understand enzyme structure and differences between enzymes and normal catalytic substances
CO2: Define factors that effect enzyme activity
CO3: Explain cofactor and coenzymes chemical structure
CO4: Describe the process of purification and isolation of enzymes

Unit I: General Enzymology, Specificity and its Kinetics	15Hrs
A. Enzyme classification and nomenclature. B. Concept of holo enzymes, coenzymes, apoenzyme, Substrate, Inhibitor, Activator, Modulators etc. C. Commercial application of enzymes (food, industry, Research, Pharmaceutical field) Enzyme immobilization. D. Substrate Specificity-Lock and Key model, Induced fit model. E. Enzyme kinetics: Michaelis-Menten equation (derivation, significance and transformation). F. Lineweaver-Burk equation. G. Effect of pH, Temperature, Substrate Concentration, enzyme Concentration,	
Unit II: Enzyme Inhibition	15Hrs
A.Enzyme inhibition and types of inhibitors. B.Reversible and Irreversible Inhibitors, competitive, noncompetitive, un competitive inhibitors. C.Enzyme Inhibition Kinetics. D. Concept of multienzyme complexes: fatty acid synthase and dehydrogenase complexes.	
Unit III: Mechanism of enzyme action	15Hrs
A. Models enzyme action, catalysis by proximity effect, acid-base catalysis, covalent catalysis, metal ion catalysis, nucleophilic and electrophilic catalysis, electrostatic interaction, B. Unit of Enzyme activity, Enzyme assay. C. Purification and Isolation of enzymes D. Membrane bound enzymes and Isoenzymes	
Unit IV: Enzyme Regulation	15Hrs
A. Concept of enzyme regulation: Allosteric (example ATCase), Proteolytic Activation (example zymogen structure) B. Types of Allosteric regulation: homotropic allosteric modulator, heterotropic allosteric modulator C. Ping Pong mechanism. D. Chemical modification and calmodulin mediated regulation. Isoenzymes. Lysozymes	

Reference Books:

1. Palmer, T. & Bonner, P., Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (2nd Ed.). Howood Publishing Chishester, England. 2008. 72 2.
2. Okotore, R.O. (2015) Essentials of Enzymology Xlibris, USA. 2015.
3. Bisswanger, H., Enzyme Kinetics: Principles and Methods (3rd Ed.). Willey-VCH. 2017.
4. Rocha-Martin, J., Immobilization of Enzymes and Cells: Methods and Protocols, Springer US. 2020
5. Phillips, J., Fundamentals of Enzymology Ed-Tech Press, United Kingdom. 2019.
6. Marangoni A.G. (2003) Enzyme Kinetics-A Modern Approach.
7. Price N.C and Stevens L. (2014) Fundamental of Enzymology. Oxford University Press, New York.
8. Dixon M and Webb E.C. (1979) Enzyme 3rd edition. Academic Press, New York
9. Uhlig H. (1998) Industrial Enzyme and their Application, Jone Wiley, New York

Semester	**II**
Paper Code	**02MSCBT02**
Paper Title	**Immunology and Immunological Techniques**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

LEARNING OBJECTIVES: By the end of this course, the students will be able to:
CO1. Understand and describe human body resistance mechanism against disease.
CO2. Outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate
CO3. Understand and explain the basis of allergy and allergic diseases
CO4. Explain the primary and secondary lymphoid organ
CO5. Understand the structure and classes of immunoglobulins

Unit I: History, Cells and Organs of immune system.	15Hrs
A. Concept of Innate immunity, Acquired immunity B. Cells involved in immune response- lymphocytes, granulocytes and agranulocytes. C. Primary lymphoid organs (Bone marrow, Thymus,) D. Secondary lymphoid organs (MALT, GALT, Lymph Nodes, Spleen,) E. Antigen, Antigenicity F. Immunoglobulins: structure of Immunoglobulins and classes of Immunoglobulins	
Unit II: Adaptive and Cell mediated immune response	15Hrs
A. Humoral immune system- Main pathway of complement system, primary response, secondary response, B-cell, BCR, Activation of B Cells B. MHC-I, MHC-II molecules, antigen presentation. C.T-cell development, T Cell Receptor (TCR)- α β T cells, γ δ T cells, Structure of TCR, T-cell activation, Apoptosis in T cells. D. Humoral Immunity, NK cell mediated immunity, mechanism of cell mediated immunity. E. Cell-cell cooperation, role of cytokines-Cytokine receptors,	
Unit III: Immunological Techniques	15Hrs
Immunological techniques: Ag-Ab reactions, Lattice theory, Zone phenomenon, techniques based on precipitation, agglutination, immune diffusion, RIA, ELISA, hybridoma Technology, CFT (complement fixation test)	
Unit IV: Hypersensitivity and Vaccination	15Hrs
A. General feature of Hypersensitivity, types of Hypersensitivity. B. Autoimmune Diseases: Addison's Disease, Grave's Disease. C. Vaccination: Discovery, Principle and Significance of vaccination. D. Concept of autoimmunity and immunological tolerance.	

Books For Reference

1. Kuby R.A. Goldsby *et al*., 2002. Osborne Immunology (Ed: 6) Freeman & Co., New York.

2. Delves *et al*., 2016. Roitt's Essential Immunology (Ed: 13). Blackwell Scientific Publisher, England.

3. Tizard, Ian R. Immunology and introduction, 2010. (Ed: 4), Saunders college publishing, New Delhi.

4. Coico R, Sunshine G. 2009. Immunology: A short course, (Ed: 6), Wiley-Blackwell publishers, Canada

5. Donald M. Weir and John Steward. 1993. Immunology (Ed: 7). ELBS, London.

6. Murphy *et al*., 2008. Janeway's Immunology: the immune system in health and disease. (Ed: 7), Garland Science Publisher, New York.

7.Hudson, L. and Hay, F.C. Practical Immunology. Blackwell publishers 1989.

Semester	**II**
Paper Code	**02MSCBT03**
Paper Title	**Molecular Biology and Bioinformatics**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**3**

COURSE OUTCOMES: By the end of this course, the students will be able to:
CO1. Understand the process of homologous recombination
CO2. Explain the basic concepts of RNAi
CO3. Describe the various DNA viruses and cancer
CO4. Understand the concept of computer and understand the computer analysis of genetic sequences

Unit I: Recombination, Chromosome Transfer and Genome Mapping	15Hrs
A. Homologous recombination: Holiday junction. B. FLP/FRT and Cre/Lox recombination, RecA. C. Molecular mapping of genome: Genetic and physical maps, choice of mapping population, D. Southern and fluorescence in situ hybridization for genome analysis, E. Molecular markers- RFLP map, RAPD, and AFLP analysis, linked analysis, application of molecular markers in forensic, disease prognosis, genetic counseling, pedigree etc. STS, microsatellite.	
Unit II: Antisense, Ribozymes and Epigenetics	15Hrs
A. Antisense and ribozyme technology: Molecular mechanism of antisense molecule, biochemistry of ribozyme, hammerhead ribozymes, applications of antisense and ribozyme technologies. B. Epigenetics**:** chromatin marking systems, Direct chemical modification of DNA, Basic concepts of RNAi.	
Unit III : Cancer Biology	15Hrs
A. Characteristics of Cancer cell, Methods to study cancer. B. Angiogenesis, positive and negative factors affecting angiogenesis. Metastasis, biochemical parameters acquired by metastatic cells. C. DNA Viruses and cancer: Polyoma virus, SV40, adeno virus D. Genetics of Cancer: Oncogenes (ras, erb-B, abl), suppressor genes (p53, Rb). E. Cancer stem cells.	
Unit IV: Bioinformatics	15Hrs
A. Computer concept: computer organization, hardware, software, operating system (windows, Unix, brief list of computer languages). B. Concept of networking**:** internet, internet concepts, web browsing, public domain resources in biology. C. Concept of data base management**:** brief idea of data types, data structures, searching, sorting, designing a database, genomic, proteomic, and metabolic pathways databases. D. Computer analysis of genetic sequences**:** general concepts of sequence analysis, identification of functional sequences, homology, brief idea of BLAST, ENTREZ, and PuBMed. E.Bioinformatics tools in drug design.	

Books for Reference

1. Watson J. D., *et al*., 2006. Molecular Biology of the gene (Ed. 5) Pearson Education Inc. London.
2. Jeoffrey M. Cooper and Rober E. Hausman. 2000. The Cell: A Molecular Approach (Ed:4) ASM Press, Washington D.C.
3. Stickberger MW *et al*., Genetics, 2008, (Ed. 3), Macmillan and Company.
4. David Freifelder. 2008. Molecular Biology. (Ed: 2). Narosa Publications. NewDelhi.
5. Bruce Alberts *et al*., 2015. Molecular Biology of Cell (Ed: 6). Garland Science, Taylor and Francis Group
6. Gerald Karp. 2008. Cell and Molecular Biology. (Ed: 5). John Wiley and Sons, New York.
7. Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd. Arthur M Lesk. 2009.
8. Introduction to Bioinformatics(Ed:3). Oxford university press, New York.
9. Attwood, T.K. and Parrysmith, D.J. 2001. Introduction to Bioinformatics. Pearson Education (Singapore) Pvt. Ltd., New Delhi.
10. Andreas D. Baxevanis and B. F. Francis Ouellette. 2005. Bioinformatics - A Practical guide to the analysis of Genes and Proteins (Ed:3). John Wiley & Sons, Inc., Publications, US.
11. David W Mount. 2004. Bioinformatics: sequence and Genome analysis(Ed:2). Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
12. Rastogi, S.C., Menderatta, M. and Rastogi, P. 2004. Bioinformatics - concepts, skills and applications. CBS Publishers & Distributors, New Delhi.

ELECTIVE PAPERS

Semester	**II**
Paper Code	**ELECTIVE -1 (02MSCBT04)**
Paper Title	**Industrial Biotechnology**
Number of teaching hours per week	**4**
Total number of teachings hrs per semester	**60**
Number of credits	**3**

Course Outcomes: By the end of this course, the students will be able to:
CO1. Understand the concept of industrial Fermentation and types of fermentation
CO2. Explain the instrumentation of various fermenters
CO3. Describe the downstream processes
CO4. Understand the industrial production of amylase, penicillin, ethanol etc.

Unit 1: Bioreactor Technology-I	15Hrs
A. Definition of fermentation B. Concept of Industrial Fermentation, Types of fermentation (Industrial Types) C. General layout of fermentation unit D. Design of fermenter- Geometry of fermenter E. Types of fermenters- Batch and continuous, airlift, fluidized bed, loop reactors, rotator disc reactors, fed batch reactors	
Unit 2: Bioreactor Technology-II	15Hrs
A. Aeration and Agitation, Heat and mass transfer, KLa value, B. Rheology, Power number, Reynold number and other factors, types of microorganisms, medium composition, anti-foaming agents, Product accumulation C. Up-stream processes: medium composition, Raw materials and sterilization D. Inoculum build up, Scale up Substrate utilization, oxygen sag, yield coefficient	
Unit 3 : Down stream processing	15Hrs
A. Filtration, ultrafiltration, Bio separation, membrane filtration, centrifugation, sedimentation, flocculation B. Solvent extraction, counter current extraction C. Chromatographic techniques- ion exchange, affinity, gel filtration, adsorption D. Crystallization, reverse osmosis, drying E. Quality control Testing-Antibiotics F. Packaging and storage	
Unit 4: Industrial Production and Immobilization	15Hrs
A. Industrial Production of amylase, penicillin ethanol, pigment-beta-carotene, vitaminB12 and Gibberellin B. Biosensor C. Immobilized systems- adsorption, covalent bonding, entrapment, encapsulation, cross linking, diffusion characteristics, effective factors, Instability factors, deactivation rates D. Immobilization of enzyme, lyophilization and crystallization of products	

Reference Books (Industrial Biotechnology)

1. Stanbury P.F. *et al*., 1999. Principles of Fermentation Technology, Butterworth-Heinemann, UK.

2. El-Mansi E.M.T *et al*., 2007. Fermentation Microbiology & Biotechnology. CRC / Taylor & Francis.

3. Bailey J and D.F. Ollis. 2017. Biochemical Engineering Fundamentals (Ed: 2) Indian Edition: McGraw-Hill, NY

4. Cinar A *et al*., 2003. Batch Fermentation - Modeling, Monitoring and Control. Marcel Dekker. USA.

Semester	**II**
Paper Code	**ELECTIVE-2 (02MSCBT05)**
Paper Title	**Advanced Plant And Agriculture Biotechnology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes:

CO1: Understand basic techniques of plant transformation and plant tissue culture

CO2: Know various methods of producing genetically modified crops and their societal implications

Unit 1 : Plant Tissue culture	15Hrs
Plant Biotechnology: Introduction to tissue culture, scope, application, Organogenesis, Protoplast isolation and fusion Haploid plant: homozygous line, production, advantage, limitation, Large scale culture: suspension culture, problem	
Unit 2 : Micropropagation	15Hrs
Somaclonal Variation and its process, Embryo rescue: recovery of interspecific hybrid, Micropropagation and its technique, application, Gene transfer method and its technique and application, Somatic hybridization and cybrid production and their applications in crop improvement. Productions of virus free plants using meristem culture.	
Unit 3 :Transgenic Plant	15Hrs
Cryopreservation: Introduction, process, application, Germplasm conservation technique and application Transgenic plant: transgene action, herbicide resistance Vector: Introduction, production of transgenic plant	
Unit 4 : Plant Transformation Technology	15Hrs
Agrobacterium mediated gene transfer Biotransformation introduction, process Golden rice and its uses Plant derived vaccine and application Transgenic plants, genetically modified (GM) plants (Bt cotton, Bt Brinjal)	

Reference Books/ Text Books:

1. Biotechnology: B.D. Singh expending horizons, kalyani publisher
2. Plant Biotechnology: BD Singh, kalyani publisher
3. Biotechnology: U. Satyanarayan, elsvere publication
4. R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992.
5. S S Bhojwani and M K Razdan, Plant Tissue Culture, Elsevier Publ.
6. Plant Tissue Culture by MK Razdan & SS Bhojwani (1996) Elsevier
7. Plant Physiology by L Taiz & E Zeiger 4th Edition (2006) Sinauer Associates Inc, Publishers
8. Experiment in Microbiology, Plant pathology and Tissue culture by K.R. Aneja, Wishwa Prakashan
9. Genetic Transformation of Plants, Edited by Jackson, J.F.; Linskens, H.F. Springer 2003
10. Plant Biotechnology and Transgenic Plants, Edited by Kirsi Marja Oksman-Caldentey, Wolfgang Barz Marcel Dekker 2002 .
11. Slater A., Scott N W, Fowler M R (2010), Plant Biotechnology-the genetic manipulation of plants, Oxford Publishing House
12. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
13. Bhojwari SS (2003) Agrobiotechnology & Plant Tissue Culture.
14. Rajdan MK (2003), Plant Tissue Culture (2nd ed.) IBH Publishing House, New Delhi

Semester	**II**
Paper Code	**ELECTIVE-3 (02MSCBT06)**
Paper Title	**Medical Biotechnology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: This Course will enable students to:

CO1:Get an overview of the immune system with particular reference to diagnostics, therapy and transplantation.

CO2:Understand the genetics behind genetic diseases and syndromes and techniques associated with diagnosis and gene therapy

CO3:Learn about cancer biology with particular reference to carcinogenic agents, basis of cancer, treatment strategies and approaches, stem cells and applications

Unit 1: Immunology	15Hrs
Overview: concept of self and nonself, antigens, antibodies; immune response, evolution of immune response, immunological tolerance, hypersensitivity, humoral and cell mediated immunity, active and passive immunization, antigen processing and MHC. Immunobiology: blood groups and transplantation antigens, HLA. Immune deficiencies and disorders – AIDS, Allergy	
Unit 2 : Diagnostic Tools	15Hrs
Antigen-antibody reaction, agglutination, immune electrophoresis, immunofluorescence, enzyme-linked immunosorbent assay, (ELISA), radioimmunoassay (RIA). Immunization and vaccines – new types of vaccines, edible vaccines. Organ transplantation.	
Unit 3: Genetics	15Hrs
Structure, organization and types of eukaryotic chromosomes, Heterochromatin, euchromatin, telomeres, types of chromosomes. Cell division. Molecular and cellular biology of fertilization *in-vitro* fertilization, assisted reproductive techniques, cloning. Karyotyping - heritable diseases and syndromes. Prenatal diagnosis (amniocentesis and chorionic villus sampling), Diagnosis of genetic diseases, Gene therapy, PCR.	
Unit 4 : Cancer Biology	15Hrs
Cancer biology: Cell cycle and its regulation. Apoptosis. Carcinogenic agents and molecular biology of cancer, Abnormal cell growth: mechanism of transformation of cells. Genetic basis of Cancer, Physical and chemical carcinogenic agents; Viral and cellular oncogenes, tumor suppressor genes, Telomerases and their role in cancer. Recent advances in therapeutic approaches to disease treatment: Stem cells - types and applications. Cancer therapy – immunotoxins and gene therapy.	

Reference Books

1. The Cell. A Molecular Approach. Cooper, G.M. Sunderland: Sinauer Associates, Inc., 2000
2. Basic Genetics. Hartl D.L. & Jones E.W. Jones & Bartlett Pub., 1998
3. Kuby Immunology. Kindt T.J. et at., W.H. Freeman & Co. 2007
4. Lodish *et al.,* 2007. Molecular cell Biology: (Ed: 6), W.H Freeman Publishers.
5. R. G. McKinnell, R. E. Parchment, A. O. Perantoni, G. Barry Pierce, I. Damjanov. 2006. The Biological Basis of Cancer: (Ed: 4), Cambridge University Press, 2006.
6.R. A. Weinberg. 2013. The Biology of Cancer (Ed: 2),W. W. Norton & Company.
7. Watson J.D. *et al*., 2007. Molecular Biology of the Gene (Ed.6), Pearson Education Inc., London.
8. Stephen Hulley (2011), Outlines & Highlights for Designing Clinical Research: An Epidemiologic Approach, Academic Internet Publishers.
9.Dan Wood, Daron Smith (2012), Research in Clinical Practice, Springer Publications.
10. Robert J. Levine (2010), Ethics and Regulation of Clinical Research: Second Edition, Yale University Press.

Semester	**II**
Paper Code	**ELECTIVE 4 (02MSCBT07)**
Paper Title	**Food And Dairy Biotechnology**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: This Course will enable students to:
CO1: The students would be able to explain and apply various bio-technological techniques for the improvement of food products.
CO2: The knowledge of food bio-technology would strengthen the students to render their scientific skills in their genetic engineering and protein engineering for the production of food products, bio-preservatives and other useful bio components.
CO3: The students would be able to get career opportunities in the bio-tech foods industries.

Unit 1 : Introduction to food and dairy product	15Hrs
Starter cultures and their biochemical activities; production of alcoholic beverages; production of Single cell protein and Baker's yeast; Mushroom cultivation, Food and dairy products: Cheese, bread and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages	
Unit 2 : Probiotics	15Hrs
Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs, enzyme biotransformations, Role of Plant tissue culture for improvement of food additives; color and flavor, Genetic modifications of microorganisms; detection and rapid diagnosis. Genetically modified foods and crop.	
Unit 3 : Food borne Diseases & Food Preservation	15Hrs
Food borne infections and intoxications; with examples of infective and toxic types-Clostridium, Salmonella, Staphylococcus Mycotoxins in food with reference to *Aspergillus* species. Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation. Fermented foods and beverages. Use of biosensors in food industry.	
Unit 4 : Food Qualty Control	15Hrs
Quality assurance: Microbiological quality standards of food Intellectual property rights and animal welfare, Government regulatory practices and policies. FDA, EPA, HACCP, ISI Risk analysis; consumer and industry perceptions.	

Reference Books

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7^{th} edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9^{th} edition. Pearson Education

Semester	**II**
Paper Code	**ELECTIVE 5 (02MSCBT08)**
Paper Title	**PHARMACEUTICAL BOTECHNOLOGY**
Number of teaching hours per week	**4**
Total number of teaching hrs per semester	**60**
Number of credits	**3**

Course Outcomes: This Course will enable students to:

CO1: Make themselves more employable in pharma industries.

CO2: Know different aspects of drug development.

CO3: Gain preliminary knowledge of clinical trials.

CO4: Understand the mechanism of action of different drugs.

Unit 1 Introduction	15Hrs
Chemotherapy Antimicrobial Drug. Mechanism of action of antimicrobial agents. Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism). Types of Antibiotics: Classification of antibiotics with example. General characteristics of a Secondary Metabolites: Types and Medicinal Applications	
Unit 2 : Mechanism	15Hrs
Chemotherapeutics Agents Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones. Antiviral drug: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin. Mechanism of action of Anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII.	
Unit 3 : Discovery and Development	15Hrs
Discovery and Development History, drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Stability of Drug, Pharmacokinetics, Pharmacodynamics. Drug delivery systems, Liposomes	
Unit 4 : Clinical Trails	15Hrs
Clinical Trials Phases of Clinical trials of drugs, Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenecity and mutagenecity. Biosimilar Technology, Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.	

Books for References:

1. Pharmaceutical Microbiology - Hugo W. B. and Russell A. D. - Wiley India
2. Pharmacology and Pharmaco biotechnology- Ashutosh Kar-New Age
3. Pharmaceutical- Essentials of Pharmaceuticals- FSK Barar- S.Chand
4. Molecular Biotechnology – B.Glick and J Pasernak -ASM Press.
5. Drug Designing- Doble- McGraw Hill
6. Pharmaceutical Biotechnology- S.P. Vyas, Dixit- CBS
7. Medicinal Chemistry- B.Razdan-CBS
8. Pharmacology and Pharmacotherapeutics- Satoskar, Bhandarkar- Popular
9. Pharmaceutical Biotechnology- Purohit, Saluja- Student Edition
10. Biotechnology: Secondary Metabolites- Ramawat K.G; Merillon J.M - Oxford
11. Chemistry of Natural Products- Ed. R.H. Thomson-Springer
12. Biopharmaceuticals, Jogdand S.N - Himalaya Publishing

PRACTICALS

PRACTICAL - I

Based on Theory CI & CII Credit : 2

1. Western Blotting
2. Determination of activity of invertase from immobilized cells of *Saccharomyces cescerevisiae*
3. Assay of activity of LDH.
4. Purification of immunoglobulins, qualitative assessment.
5. Demonstration of immunochemical reactions (blood group, pregnancy,)
6. Demonstration of ELISA
7. Demonstration of VDRL
8. Widal Test
9. Blood film preparation and identification of cells.
10. Ouchterlony immunodiffusion,
11. Determination of albumin by radial immunodiffusion.
12. Assay of activity of beta-galactosidase
13. Assay of activity of acid phosphatase,
14. Determination of activity in presence of activators.
15. Determination of activity in presence of inhibitors.
16. Enzyme purification by crystallization -urease.
17. Subcellular fractionation and assay of marker enzymes.

PRACTICAL - II

Based on Theory C3 & E1 Credit: 2

1. Production of microbial products (Alcohol/Antibiotic) in bioreactors/fermenter and determine yield potential.
2. Separation of poly A RNA on oligo dT column.
3. Southern blotting.
4. Determination of rheological constant.
5. Determination of oxygen transfer rate, volumetric transfer coefficient.
6. Isolation of genomic DNA.
7. Isolation of plasmid DNA.
8. Isolation of RNA.
9. Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.
10. Restriction fragment length polymorphism.
11. Ames test.
12. Computer aided visualization of amino acid sequence of protein and its 3D structure.
13. Retrieving metabolic pathway using internet.
14. Homology searching using BLAST.
15. Computer aided survey of scientific literature.
16. Immobilization of cell/enzyme.