REVISED

GENERAL INSTRUCTIONS
and
COURSE CURRICULUM

FOR

M.Sc. BIOTECHNOLOGY

(PG Teaching Program in Biotechnology)

(Effective from July, 2020)

DEPARTMENT OF BIOTECHNOLOGY

HIMACHAL PRADESH UNIVERSITY

(NAAC Accredited "A" Grade University)

SUMMERHILL – SHIMLA – 171005 (HP) – India

www.hpuniv.ac.in/biotech

Annexure-I

M.Sc. BIOTECHNOLOGY PROGRAM
DEPARTMENT OF BIOTECHNOLOGY

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

1. The M.Sc. Biotechnology program will be of two years duration spread over four semesters
2. ***There will be sixteen (16) courses in M.Sc. Biotechnology Program***. In the 1st, 2nd and 3rd semesters, there will be five courses each. Each course will consist of a theory and a practical paper except Course MBT-101 (Remedial course) and Elective Course (Course MBT-EL-301 to 303). The distribution of marks in each course for theory, practical and internal assessment will be as per details given in the *OUTLINE OF COURSES FOR M.Sc. BIOTECHNOLOGY*.
3. ***There will be 30 marks for internal assessment in each course except course MBT-205*** (Remedial course will have 20 marks for Internal Assessment), and Elective Course (MBT-EL-301 to 304). A total of two Internal Assessment tests of 10 marks each will be held in a semester. For Internal Assessment examination(s), the concerned teacher will examine the students in his/ her subject by giving multiple choice questions (MCQ) of 0.5 marks each (20 MCQ in each test) covering the syllabus taught in the classes. Remaining 10 marks will include class seminar (5 marks) and class attendance 5 marks. The criteria to be followed shall be : i) Up to 75% lectures including condoning of lectures as per ordinances: zero mark, ii) without condoning of lectures 75%: 1 mark; iii) 76-80 % attendance : 2 marks, iv) 81-85 % : 3 marks; v) 86-90 % : 4 marks; vi) 91 % and above attendance : 5 marks. However, for Remedial and Elective Course, a total of two Internal Assessment tests of 7.5 marks each (15 MCQ, of 0.5 marks each question in each test) will be held in a semester, and remaining 5 marks will be for class attendance as per criterion mentioned above for other courses.
4. ***The Chairman of the Department will notify the date sheet for Internal Assessment test(s) at the beginning of semester/ academic calendar***. In case a student is absent in the Internal Assessment test, the student will explain in writing the reason for his/ her absence to the Chairman of the Department. Such case(s) will be discussed in the Departmental Council and if the Council finds the reason given by the student valid, it will recommend to the Chairman to allow the student to sit in such a test separately.
5. ***The in-house dissertation work will commence in the 4th semester.*** The dissertation work will be guided by faculty duly approved by B.O.S. in Biotechnology. The students will submit the dissertation (two copies) in a hard bound form by the due date fixed by the Examination Branch. The Departmental Council will evaluate the dissertation and will conduct seminar and viva-voce examination of the students. If the Chairman of the department feels, he may invite an External Expert for evaluation of the dissertations. The evaluation of the dissertation and seminar/ viva voce will be of 150 and 100 marks, respectively.
6. ***The admission to M.Sc. Biotechnology program of Himachal Pradesh University at campus will be through a Combined Entrance Examination GAT-B conducted by Regional Centre for Biotechnology (RCB), Faridabad on behalf of DBT-Govt. of India or as decided by the Department of Biotechnology (DBT), Govt. of India from time to time.*** However, admission to M.Sc. Biotechnology Program offered by Institutions affiliated to Himachal Pradesh University will be through an Entrance Test conducted by Himachal Pradesh University or as decided by Himachal Pradesh University from time to time.
7. ***Eligibility for admission will be Bachelor Degree under 10+2+3 pattern of Education*** in Physical Sciences, Biological Sciences, Pharmacy, Agriculture, Veterinary Sciences, Fisheries or a Bachelor Degree in Engineering/Technology or medicine (MBBS) with minimum of 55% marks. However, relaxation to SC/ST in minimum marks at Bachelor's degree will be as per Himachal Pradesh University norms.
8. ***The tuition fee and other monthly/ annual charges will be as per University rules (Tuition Fee waiver for Girl students).***

OUTLINE OF COURSES FOR M.Sc. BIOTECHOLOGY

Course	Course Title	Marks			
		Theory	Practical	Int. Asst.	Total
Semester I					
MBT-101	Remedial course				
	(1) Introductory Biology (for Non Biology students)				
	(2) Introductory Mathematics (for Biology students)	80	-	20	**100**
MBT-102	Biochemistry (Common with M. Sc. Microbiology course: MMB-102)	80	40	30	**150**
MBT-103	Microbiology	80	40	30	**150**
MBT-104	Cell and Molecular Biology (Common with M. Sc. Microbiology course: MMB-104)	80	40	30	**150**
MBT-105	Instrumental methods of Analysis (Common with M. Sc. Microbiology course: MMB-105)	80	40	30	**150**
Total Marks in Semester I		**400**	**160**	**140**	**700**
Semester II					
MBT-201	Recombinant DNA Technology (Common with M. Sc. Microbiology course: MMB-201)	80	40	30	**150**
MBT-202	Immunology and Immunotechnology (Common with M. Sc. Microbiology course: MMB-202)	80	40	30	**150**
MBT-203	Plant Biotechnology	80	40	30	**150**
MBT-204	Animal Biotechnology	80	40	30	**150**
MBT-205	Biochemical Engineering	80	40	30	**150**
Total Marks in Semester II		**400**	**200**	**150**	**750**
Semester III					
MBT-301	Environmental Microbiology and Biotechnology (Common with M. Sc. Microbiology course: MMB-301)	80	40	30	**150**
MBT-302	Fermentation Technology	80	40	30	**150**
MBT-303	Computer and Bioinformatics (Common with M. Sc. Microbiology course: MMB-303)	80	40	30	**150**
MBT-304	Enzyme Technology (Common with M. Sc. Microbiology course: MMB-304)	80	40	30	**150**
Elective Paper (Any One)					
MBT-EL-301	Metabolic Engineering (Common with M. Sc. Microbiology course: MMB-EL-301)	80	-	20	**100**
MBT-EL-302	Biocatalysis and Biotransformation				
MBT-EL-303	Food Technology (Common with M. Sc. Microbiology course: MMB-EL-303)				
MBT-EL-304	Nano-biotechnology				
Total Marks in Semester III		**400**	**160**	**140**	**700**
Semester IV					
MBT-401	Dissertation	-	-	150	**150**
	Seminar and Viva-Voce	-	-	100	**100**
Total Marks in Semester IV		**-**	**-**	**250**	**250**
Grand Total (Semester I-IV)		**1200**	**520**	**680**	**2400**

COURSE No. : MBT-101 (1)	REMEDIAL COURSE-INTRODUCTORY BIOLOGY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **12**

Brief introduction about major microbial plant and animal groups. Level of organization in the living world. Cell structure and function of cell organelles, cell division: mitosis and meiosis. Physical and chemical basis of heredity and Mendel's laws.

UNIT II **11**

Gamete formation in plants and animals pollination, fertilization, and developments in plants, reproduction in animals. Photosynthesis, respiration, chemistry of biomolecules. Brief accounts of populations, communities, ecology, ecosystems and food chains.

UNIT III **11**

Definition, history, scope and multidisciplinary nature of biotechnology. Some important break-through in biotechnology, agriculture, food, medicine and environment.

UNIT IV **11**

Applications of biotechnology, current trends in biotechnology; Major R & D institution & biotechnology based industries. Scientific writing and presentation.

Suggested books [Latest edition]

1. Introduction to Biotechnology: Smith
2. Biology**:** Peter H Raven
3. The Cell - A Molecular Approach: Cooper and Hausman
4. Biotechnology - Fundamentals and Application: Purohit
5. Cell Biology**:** Smith and Gerald

COURSE No. : MBT-101 (2)	INTRODUCTORY MATHEMATICS
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **16**

Determinants: properties of determinants, Grammer rule. Matrices: types of matrices, addition, multiplication, inverse, solution of linear equation by matrix method. Integration: indefinite and definite integrals of functions of only one variable by method of substitution and integration by parts-simple cases.

Principles and practice of statistical methods of biological research, samples and populations; Measures of central tendencies: mean, mode, median and ogives; Measures of dispersion: range, standard deviation and variance

UNIT II **07**

Linear correlations: product moment coefficient of correlations, Spearman's rank difference correlation methods; Regression analysis: simple regression, regression lines, regression equations, regression equations in case of correlation tables.

UNIT III **12**

Probability distribution: addition and multiplication theorems, Bayes theorem, Bionomial, Poisson, and normal distribution.

Parametric tests: F and T tests, X^2 test, X^2 test as a test of independence and goodness of test, experimental design.

UNIT IV **10**

Statistical inference: hypothesis testing, significance level, two-tailed and one-tailed tests of hypothesis, Test of significance: concept and basic terminology of large and small sample, means, and difference between means.

Analysis of variance: assumptions, techniques of analysis of variance, analysis of variance in one-way techniques.

Suggested books [Latest edition]

1. Systematic Modern Mathematics Part I and II: LR Danda, GK Saini and S Saha.
2. Statistical methods**:** SP Gupta.

COURSE No. : MBT-102	BIOCHEMISTRY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **11**

Functional diversity of proteins, amino acids as building blocks of proteins, their structure, classification and chemical properties, determination of amino acid sequence of a protein, simple peptides, structure of peptide bond, organizational levels of protein structure. Properties of proteins: simple, conjugated, fibrous and globular proteins. General reactions of amino acids, catabolic aspects of amino acids. Assimilation of NH_3 (including urea cycle). Enzymes: Their chemical nature, coenzymes, cofactors and prosthetic groups, classification, units of enzyme activity, factors affecting enzyme activity.

UNIT II **12**

Carbohydrates : Their **c**lassification, structure and properties. Glycolysis, TCA cycle, Pentose phosphate pathway, Gluconeogenesis, ETC and oxidative phosphorylation. Chemistry and biochemical roles of water and fat-soluble vitamins and their coenzymes. Deficiency diseases of vitamins.

UNIT III **11**

Structure and properties of nucleic acid bases, nucleosides and nucleotides, biologically important nucleotides, Physical and chemical properties of RNA/DNA including DNA denaturation. Chemical and enzymatic hydrolysis of nucleic acids. Biosynthesis & degradation of purine and pyrimidine nucleotides. Biosynthesis of deoxyribonucleotides. Structure, properties and classification of porphyrins. Porphyrin biosynthesis & degradation.

UNIT IV **11**

Fatty acids as building blocks of most lipids, their structure, nomenclature and properties, classification of lipids, General structure and function of major lipid subclasses: Acylglycerols, phosphoglycerides, sphingolipids, glycosphingolipids, terpenes, steroids, Prostaglandins, catabolism of Fatty acids, β-, α-, ω-oxidation, oxidation of unsaturated fatty acids. Ketone Bodies: their formation and utilization. Biosynthesis of saturated and unsaturated fatty acids, triacylglycerol and cholesterol.

Suggested books [Latest edition]

1. Principles of Biochemistry: AL Lehninger, DL Nelson and M M Cox.
2. Biochemistry: Lubert Stryer.
3. Biochemistry: Zubay.
4. Biochemistry: J Stenesh.
5. Outlines of Biochemistry: Conn and Stumpf
6. Practical Biochemistry: Plummer

List of practicals

1. Qualitative tests for proteins and amino acids.
2. Qualitative tests for carbohydrates.
3. Quantitative estimation of proteins by Lowry's and Bradford method.
4. Quantitative estimation of RNA by Orcinol method.
5. Quantitative estimation of DNA by Diphenylamine method.
6. Quantitative estimation of carbohydrates by Anthrone method.
7. Quantitative estimation of total cholesterol in Serum.
8. Assay of Salivary amylase.
9. To study the U.V. absorption of nucleic acids.
10. To find the saponification number of a fat.

COURSE No. : MBT-103	MICROBIOLOGY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **11**

Introduction to history of microbiology, methods of classification and major groups of microorganisms on the basis of rRNA cataloging. Concept of sterilization in microbiology.

UNIT II **12**

Ultrastructure of a bacterial cell, cyanobacteria and fungal cell. Brief introduction to viroids and virusoids (sub viral particles). Concept of nutrition (micro, macro and trace nutrients), types of nutrition (passive, facilitated, and active transportation) and categories of microorganisms on the basis of mode of nutrition. Concept of microbial growth, effect of environmental factors on growth such as salt concentration, pH, temperature etc., growth monitoring and characteristics.

UNIT III **12**

Microbial metabolism: Emden Meyorhoff Parnas Pathway, Kreb's cycle, Glyoxalate cycle, Entnor-Doudroff Pathway, Hexose Mono Phosphate Shunt and concept of ATP generation in bacteria, Substrate level phosphorylation, oxidative and photo- phosphorylation. Applications of following microorganisms in Biotechnology: *Aspergillus*, *Escherichia coli*, *Bacillus spp*., *Saccharomyces cerevesiae*, *Zymomonas*, *Streptomyces, spp*., *Pseudomonas*, *Spirulina*, *Frankia*, *Rhizobium* and *Agrobacterium*.

UNIT IV **12**

Virology: Overview of virus classification of animal, Titration of viruses, General structure and life cycle of bacteriophage, Hepatic virus (HAV, HAB and HAC), Dengue virus (Flavi virus), Chikungunya virus, Concept of giant viruses..

Suggested books [Latest edition]

1. The Microbial World: Stainer RY, Ingraham JL, Wheelis ML and Painter PR
2. Introduction to Microbiology: Pelczar and Reid
3. General Microbiology: Tortora, Funke and Case

List of practical

1. To study various parts of a microscope.
2. To perform simple staining for a given microorganism.
3. To perform negative staining using India ink.
4. To perform Gram staining for a given micro-organism.
5. To perform Acid-fast staining for *Mycobacterium tuberculosis.*
6. To perform spore staining by the method of Schaeffer and Fulton.
7. To perform MBRT test to check the quality of milk samples.
8. To measure the size of given microorganism by micrometry.
9. To count microbial cells using hemocytometer.
10. To perform antibiotic sensitivity test by the method of Kirby and Bauer.
11. To determine MIC of a given antibiotic for the micro-organisms.
12. To perform turbidimetry/nephalometry to assess the growth of the micro-organisms.
13. To isolate a specific type of micro-organism by use of selective/enrichment method form a given soil sample.

COURSE No. : MBT-104	CELL AND MOLECULAR BIOLOGY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **12**

Membrane structure and function. Structural organization and function of cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, cytoskeleton. Structure and organization of DNA, genes, chromatin and chromosomes, superhelicity in DNA and its topological properties, DNA denaturation and renaturation, repetitive DNA, COT-curve, C-value paradox. Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

UNIT II **11**

DNA replication (enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanisms, genetic recombination (homologous and site-specific), transformation, conjugation and transduction. RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

UNIT III **11**

Basic features of the genetic code. Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins). Control of gene expression at transcription and translation level (regulating the expression of prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Operon concept, lac operon, tryptophan operon.

UNIT IV **11**

Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways. General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins. Cancer genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis.

Suggested books [Latest edition]

1. Molecular Biology of Cell: Bruce Albert et. al. (Tylor and Francis Inc.)
2. Lewin Genes XIII: Jones and Barlett Publisher, Inc.
3. Molecular Cell Biology: Lodish et al. WH Freeman.
4. Karp's Cell and Molecular Biology: Gerald Karp, John Wiley Publications.
5. Molecular Biology of the Gene: James D. Watson, Pearson Education.

List of practicals

1. UV-absorbance of nucleic acids (hyper and hypo chromic effect) and quantification of nucleic acids and proteins.
2. To determine the melting temperature of DNA.
3. To study different stages of mitosis by onion root tip squash method.
4. To study different stages of meiosis using permanent slides.
5. To study multiple alleles in human (Blood Groups).
6. To study multiple alleles in plants (*Trifolium*).
7. To study cytoplasmic and nuclear inheritance on the basis of phenotypic characters.
8. Isolation of DNA from *E. coli.*
9. Extraction of DNA from plant
10. Extraction of DNA from human blood.
11. Induction of β-galactosidase strain of *E. coli.*
12. Effect of protein synthesis inhibitors on the activity of β-galactosidase.

COURSE No. : MBT-105	INSTRUMENTAL METHODS OF ANALYSIS
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **12**

Centrifugation: Concept of centrifugation, sedimentation coefficient, differential, rate zonal and isopycnic centrifugation, Analytical and preparative ultracentrifuges, k and k' factor, derating of rotor, special purpose rotors.

Chromatography: Paper, TLC, Gas chromatography, gel filtration, ion-exchange chromatography, reverse phase chromatography, hydrophobic interaction, affinity chromatography and HPLC.

UNIT II **12**

Electrophoresis: Paper and gel electrophoresis, Ferguson plots, Immuno-electrophoresis, isoelectric focusing, two-dimensional electrophoresis, capillary electrophoresis, western blotting and pulse field gel electrophoresis.

Spectrophotometry: UV & Visible spectroscopy, spectro-fluorimetry, atomic absorption and atomic emission spectroscopy. ORD and Circular dichorism, Florescent activated cell sorter (FACS).

UNIT III **10**

Principle of microscopy, limit of resolution, Electron Microscopy: Transmission and Scanning Electron Microscopy, Concept of Tunneling Electron Microscopy and Atomic Force Microscopy .

UNIT IV **11**

Radioisotope Techniques: Radio-tracers, types of radioisotopes, interaction of radiation with matter, adsorbed body dose, GM counter, Proportional and Scintillation counters, methods of quench correction, auto-radiography and radioimmunoassay.

Suggested books [Latest edition]

1. Principles and techniques of Practical biochemistry: Eds. K Wilson and J Walker
2. Fundamentals of Immunology: Paul Williams
3. Biophysical Chemistry: D Friefielder

List of practicals

1. Density gradient centrifugation for separation of bacterial and human (blood) cells.
2. To perform salting out and dialysis for partial purification of protein(s) in a given mixture.
3. To perform rapid dialysis using Sephadex G-15 gel permeation column.
4. To determine the void volume of gel permeation column.
5. To perform Native PAGE for a given protein mixture.
6. To perform SDS-PAGE for separation of proteins in a given sample.
7. To perform gel exclusion chromatography for the separation of serum proteins.
8. To perform DEAE anion exchange chromatography for the separation of human IgG.
9. To perform Protein-A affinity chromatography for the separation of human IgG.
10. To separate phospholipids/carbohydrates mixture by TLC.
11. Use of GLC for analysis of alcohols such as methanol and ethanol.
12. To perform micro titer ELISA using human serum
13. To perform DOT-ELISA using human serum

COURSE No. : MBT-201	RECOMBINANT DNA TECHNOLOGY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **11**

Introduction: History and scope of Recombinant DNA Technology

Enzymology of Recombinant DNA: enzymes that break, mend and synthesize DNA and RNA backbone bonds, remove phosphates at nucleic acid termini, and proteins which protect, coat, twist and untwist DNA.

Isolation and Purification of nucleic acid: Basic techniques and considerations criteria of purity, isolation and purification of phage DNA plasmid, chromosomal DNA, RNA and mRNA.

UNIT II **12**

Cloning and expression vectors: Characteristics of cloning and expression vectors; plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors; bacterial, yeast, plant and mammalian expression vectors.

Cloning and expression hosts: Characteristics of cloning and expression host, bacterial, yeast, plant and mammalian host systems for cloning and expression of genes.

DNA Cloning Strategies : Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid, transformation and transfection, electroporation, screening of gene library and selection of clone.

UNIT III **11**

Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting.

Expression of cloned genes: Expression of cloned genes in *E. coli*, *Bacillus subtilis*, *Streptomyces*, yeast and mammalian cells, detection and analysis of proteins expression from cloned genes.

Sequencing and other techniques: DNA, RNA and protein sequencing, DNA finger and foot printing, CRISPER technology, antisence RNA.

UNIT IV **11**

Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, site-directed mutagenesis and protein engineering, molecular markers.

Impact of rDNA on human genetics: DNA based diagnosis, gene targeting, human genome project history and scope, ethical issues in relation to rDNA technology.

Applications of r-DNA technology: Application of genetic engineering in industry, agriculture, medicine, environment and forensic science

Suggested books [Latest edition]

1. Recombinant DNA principles and Methodologies: James J Greene
2. Molecular Biotechnology: Glick and Pasternak
3. Principles of Gene Manipulation: RW Old and SB Primrose
4. Genetic Engineering Fundamentals: Kammermeyer and Clark

List of practicals

1. Preparation and purification of pUCplasmid.
2. Preparation and purification of genomic DNA
3. Restriction digestion and ligation of plasmid and genomic DNA and gel electrophoresis.
4. Construction of restriction map
5. Cloning of DNA in plasmid
6. Transformation of *E. coli* cells with recombinant plasmid.
7. Southern blotting and hybridization with non-radioactive probes.
8. Amplification of DNA with PCR Temperature cycler.
9. Assay of activity of restriction endonuclease and topoisomerase I.

COURSE No. : MBT-202	IMMUNOLOGY AND IMMUNOTECHNOLOGY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **11**

Types of immunity: innate, acquired, active and passive, primary and secondary lymphoid organs, antigen-antibody Interactions (physical aspects), elements of immune system: T-cells, B-cells, cell mediated subset of T-cells, helper and suppressor cells, markers, third population of lymphocytes, antigen presenting cells, cell mediated and humoral immunity, antibody dependent cell mediated cytotoxicity, natural killer cells

UNIT II **12**

Cellular and molecular aspects: nature of antigens, basic structure of antibodies, their function and diversity, antibody classes and biological activity, T-cell receptors, complement system, major histo-compatibility complex (MHC), MHC molecules, exogenous and endogenous antigen presentation, lymphokines, regulation of immune response, immunological tolerance

UNIT III **11**

Agglutination, Precipitation, Single and double immuno diffusion, immunoelectrophoresis, ELISA and its various types, Western blotting, Fusion of myeloma cells with lymphocytes, concept of trioma, hybrid-hybridoma and thymoma, applications of monoclonal antibodies

UNIT IV **11**

Synthetic vaccines, autoimmunity, hyper-sensitivity, tumor immunity, concept of idiotypes and anti-idiotypes

Suggested books [Latest edition]

1. Immunology: Janis Kuby
2. Essentials of Immunology: Ivan Roitt
3. Cellular and Molecular Immunology: Abul K Abbas, Andrew H Lichtman and S Jordan.
4. Immunology: An Introduction: Ian R Tizard
5. A Handbook of Practical Immunology: GP Talwar

List of practicals

1. To study the techniques of immunization and generation of antibodies.
2. To perform differential leukocyte count of human blood.
3. Isolation of IgG from human serum by affinity chromatography using protein A column.
4. To perform precipitation tests (a) ring test (b) slide test in solution given an antigen and antibody.
5. To perform precipitation reactions in gel by Ouchterlony Technique given an antigen and antibody (double immunodiffusion) .
6. To perform single radial immunodiffusion (Mancini's Technique) using an antigen and antibody.
7. To perform immunoelectrophoresis given an antigen and antibody.
8. To perform rocket immunoelectrophoresis on given antigen and antibody.
9. To perform ELISA.
10. To perform rapid Agglutination Test for detection of RA factor in serum.

COURSE No. : MBT-203	PLANT BIOTECHNOLOGY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **11**

Introductory history, scope and application of plant biotechnology. Plant cell and tissue culture media, plant growth regulators in tissue culture-their use and preparation. Cellular totipotency, cyto-differentiation and organoganesis; somatic embryogenesis; transfer and establishment of whole plants in soil (acclimatization & hardening); Designing and erection of polytunnels and greenhouses.

UNIT II **11**

Initiation of aseptic culture techniques; *In- vitro* and *in vivo* pollination and fertilization; single cell and cell suspension culture, callus culture, embryo culture and embryo rescue; protoplast culture and somatic hybridization, selection of hybrid cells; symmetric and asymmetric hybrids, cybrids.

UNIT III **11**

In vitro clonal propagation and large-scale production of plants through micropropagation. Prospects and problems, meristem tip culture, shoot tip culture and shoot tip grafting. Doubled haploid production through distant hybridization, Production of haploid plants through androgenesis *(anther and pollen culture)* and gynogenesis *(ovary and ovule culture)* and their utilization.

UNIT IV **12**

Production of useful bio-chemical substances through tissue culture system, Scale-up through bio-reactors. Bioinsecticides, biopesticides and biofertilizers. Gene transfer in nuclear genome and chloroplasts; Agrobacterium-mediated gene transfer, direct gene transfer. Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance, longer shelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice), edible vaccines. Preservation of plant genetic resources: Germplasm collection and conservation.

Suggested books [Latest edition]

1. Plant Tissue Culture - Applications and Limitations: SS Bhojwani.
2. Genome Organization and Expression in Plants: CJ Lever.
3. Plant Cell Culture - A Practical Approach: RA Dixon & Gonzales.
4. Principles of Plant Biotechnology - An Introduction to Genetic Enggnieering in Plants: Mantell, Mathews & Mavkee.
5. Plant Cell Biology - A Practical Approach: N Harris & KJ Oparke.

List of practicals

1. Essentials of plant tissue culture laboratory
2. Good Laboratory Practices and safety guidelines
3. Basic design and lay-out of plant tissue culture laboratory
4. Preparation of basal tissue culture and preparation of stocks
5. Anther/ Pollen Culture
6. Ovary/ Ovule Culture
7. Callus Culture
8. Protoplast isolation and culture
9. Isolation of Plant Genome
10. Preparation of artificial seeds through gel entrapment

COURSE No. : MBT-204	ANIMAL BIOTECHNOLOGY
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **12**

Introduction, brief history and terminology, source of some important mammalian cell lines. Balanced salt solutions and simple growth media, serum and its quality, medium sterilization.

Basic techniques of scale up of animal cell culture: roller bottles modification of roller bottles, multiunit system and concept of bioreactors including hollow fiber system & their application.

UNIT II **12**

Preservation and maintenance of animal cell lines, cryo-preservation and transport of animal germplasm (i.e. semen, ova and embryos). Production of monoclonal antibodies by hybridoma technique, scale up (*in vivo* and *in vitro*), brief concept of trioma and thymoma.

UNIT III **10**

Concept of stem cells, Embryonic and adult stem cells, tissue engineering and its application. Gene cloning techniques for mammalian cells, cloning in mammalian cells. Transgenic animals, *in vitro* fertilization and embryo transfer. Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy.

UNIT VI **11**

Chemical carcinogenesis, transfection, oncogenes and antioncogenes. Cell synchronization methods and their applications, Concept of idiotype/ anti-idiotype and their applications.

Suggested books[Latest edition]

1. Animal Cell Biotechnology: RE Spier and JB Griffiths
2. Living Resources for Biotechnology - Animal cells: A Doyle, R Hay and BE Kirsop
3. Animal Biotechnology: Murray Moo-Young
4. Animal Cell Biotechnology-Principles and Practices: M Butler.
5. The Animal Cell Culture and Technology: M Butler.
6. Culture of Animal Cells: RT Freshney.

List of practicals

1. Preparation of tissue culture media and concept of sterilization in animal cell culture.
2. Sub-culturing and maintenance of continuous cell lines (any one such as myeloma, Hep-2/ HeLa/ Vero cells).
3. To generate a primary cell line from mouse skin (fibroblasts) or intra-peritoneal cells.
4. To obtain spleenocytes and intra-peritoneal macrophages.
5. To determine doubling time of a given cell line.
6. Use of Leighton tubes for culture of cells.
7. Cytotoxic assay of a given antibiotic for a cell line.
8. Effect of nutrient (serum) on growth of given cell line.

COURSE No. : MBT-205	BIOCHEMICAL ENGINEERING
Maximum Marks: 80	Teaching hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **12**

Microbial Growth and Product Formation Kinetics: Microbial growth, Growth yield, Specific growth rate, Product yield, Saturation constant, Biomass energetics, Yield equations based on Y_G, Y_{O2}, Y_{ATP}, Maintenance energy, Kinetics of balanced growth, Transient growth kinetics, Structured models and applications, Growth kinetics of batch, fed-batch, plug flow and continuous culture, Comparison of batch and continuous culture system, High cell density cultures. Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non-growth associated product synthesis

UNIT II **10**

Bioreactors and Bioreactor Control: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed-batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics**,** Manual and automatic control system, on-line and off-line analytical instruments, methods of measurement of process variables, Data analysis and process control.

UNIT III **09**

Kinetics of Sterilization and Scale-up Studies: Translation of laboratory, pilot and plant scale data, Criteria for translation between two scales of operation, Scale-up practices, Bases for scale-up methods, Comparison of various scale-up methods, Nongeometric scale-up. Kinetics of media sterilization, design of batch sterilization process, D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration, single fibre efficiency.

UNIT IV **14**

Mass Transfer in Microbial System and Down Stream Processing

Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas–liquid mass transfer, Intra-particle diffusion, Oxygen transfer and utilization in gassed microbial system, mass transfer resistances, Oxygen transfer rate and factors affecting it, determination of oxygen transfer coefficient, oxygen transfer efficiency, Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.

Suggested books [Latest edition]

1. Biochemical Engineering: Aiba and Hemphery.
2. Biochemical Engineering Fundamentals: JE Bailey and DF Ollis.
3. Principles of Microbes and Cell Cultivation: S John Pirt.
4. Bioprocess Engineering Principles: Pauline M Doran.
5. Principles of fermentation technology: PF Stanbury and A Whitekar.

List of practicals

1. Design and operation of a laboratory fermenter.
2. Microbial Growth kinetics-Determination of specific growth rate (μ_{max}), saturation constant (K_S) and growth yield ($Y_{X/S}$) for *Saccharomyces cerevisiae* in batch culture.
3. Concentration of protein by ultra-filtration.
4. Determination of K_La by sulphite oxidation method.
5. Determination of thermal death rate constant and decimal reduction time for *E. coli*.
6. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein.
7. Bio-transformation of sucrose into high fructose syrup by immobilized cell of *Saccharomyces cerevisiae.*

COURSE No. : MBT-301	ENVIRONMENTAL MICROBIOLOGY & BIOTECHNOLOGY
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **12**

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).

UNIT II **11**

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 III **11**

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 IV **11**

Air, Water, Soil, Noise and Thermal pollution. Ozone depletion, Green house effect and acid rain. Bioremediation and biorestoration 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.

Suggested books [Latest edition]

1. Microbial ecology: Alexander M; John Wiley and Sons, Inc., New York.
2. Pollution - Ecology and biotreatment: Longman Scientific Technical.
3. Advances in microbial ecology: S Ec Eldowney, DJ Hardman, S Waite S and KC Marshall.

List of practicals

1. Estimation of total solids in sewage samples.
2. Estimation of volatile matter and fixed residues in sewage samples.
3. Rapid detection of bacteriological quality of water with special reference to feacal Coliform.
4. Determination of dissolved oxygen in waste water samples.
5. Determination of BOD of waste water samples.
6. Determination of COD of waste water samples.
7. Determination of rate of decomposition of organic matter.
8. Determination of moisture content of soil sample.
9. Determination of microbial biodiversity in soil.
10. Determination of hardness of given water sample.
11. Transformation of waste in to valuable products.

COURSE No. : MBT-302	FERMENTATION TECHNOLOGY
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **15**

Fermentation: Definition and scope of fermentation, Isolation, screening, selection and preservation of industrial cultures, Basic design and operation of fermenter, Common technological problems in fermentation processes and their solutions, Approaches for improvement of industrial organisms, chemically defined media for commercial fermentation, Solid state fermentation, principle, solid state bioreactor operation, merits and demerits.

UNIT II **15**

Bio-Process technology: Primary and secondary metabolites, integrated bio-process technology for products like baker's yeast, organic acids, enzymes and biofuels. Bio-process technology for the production of recombinant vaccines, therapeutic proteins and antibiotics, Monitoring and control of environmental parameters in fermentation process, bio-sensors.

UNIT III **08**

Economics of fermentation processes: Total product cost, capital investment and profitability, manufacturing cost estimation, capital investment estimation, Risk capital and working capital, cost analysis for R & D decision making.

UNIT IV **07**

Biobusiness and Legal issues in Biotechnology: Concept of Bio-business management, Project formulation, business plan, technological Assessment, feasibility and commercial viability of a project.
Regulatory and IPR issues, Intellectual Property Rights (IPR), Licensing and Patenting of bio-product, GLP and GMP guidelines in fermentation processes.

Suggested books [Latest edition]

1. Modern Industrial Microbiology and Biotechnology: Nduka Okafor
2. Principles of Microbes and Cell Cultivation: S John Pirt
4. Industrial Microbiology: LE Casida
4. Industrial Microbiology: Prescott and Dunn
5. Principles of fermentation technology: PF Stanbury and A Whitekar

List of practicals

1. Isolation, screening, selection and preservation of industrially important microorganisms.
2. Preparation of microbial growth curve in a batch culture.
3. Determination of viability of cells in a yeast culture by Trypan blue staining, Standard Plate Count and Neubaeur chamber methods.
4. Production of ethanol by using simple/ complex carbohydrate source(s) (media) using *Saccharomyces cerevisiae*.
5. Production of wine from Apple/ Grape juice by *Saccharomyces cerevisiae*.
6. Microbiological examination of fermented foods.
7. Determination of quality of milk sample by methylene blue reduction test.
8. Role of yeast in bread making.

COURSE No. : MBT-303	COMPUTER AND BIOINFORMATICS
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **14**

Computer basics. Concept of Operating systems: Windows and UNIX. Hardware, software, Introduction to programming languages (machine level, assembly level and high level language), Computer Network concepts. Word processing using MS-Word, formatting the document, tables, mail merge and spell check. Spreadsheets basics with MS Excel, numerical and formula entries, basic mathematical and statistical functions, graphical representation of data.

UNIT II **11**

Introduction to internet use and search engines: www, HTML, URLs, browsers: Netscape (opera), Explorer, Search engines: Google. Introduction to data structures and database concepts.

Basics of Microsoft Access: Databox wizard, creating fields, properties and tables, datanet records, sorting, queries, forms and records.

UNIT III **10**

PubMed, Sequence information sources (Structure and use on web): EMBL, GENBANK, Entrez, and Unigene. Protein information sources (Structure and use on web): PDB, SwissProt and TrEMBL; Sequence and phylogeny analysis: Detection of open reading frames (ORF's), gene identification and prediction, method of gene family identification and outline of sequence assembly.

UNIT IV **10**

Mutation matrices, pairwise alignments, introduction to BLAST (using it on web and interpreting results), multiple sequence alignment, phylogenetic analysis. Molecular modeling: introduction, dynamic simulation, conformational search, molecular modeling packages (Chem3D, Hyperchem), protein modeling, structure prediction and molecular docking.

Suggested books [Latest edition]

1. Bioinformatics: Methods and Applications Genomics Proteomics and Drug Discovery: SC Rastogi, N Mendiratta, P. Rastogi, Prentice Hall of India Private Ltd
2. Bioinformatics: A practical guide to the analysis of genes and proteins, Ed. Baxvains.
3. Molecular Evolution: A phylogenetic approach: ROM and Holmas EC, Blackwell science
4. Bioinformatics: Sequences, structure and databanks: Des Higgins and Willie Taylor, Oxford University Press
5. Computer today: Suresh K Basandra, Galgotia Publications Pvt Ltd.
6. Computer fundamentals: PK Sinha, BPB Publications.

List of practicals

1. Word processing commands using MS-Word.
2. Mail Merge facility of MS-Word.
3. Graphical presentation using MS-Excel.
4. Creation of Data tables in MS Access and simple queries with SQL.
5. Online Bibliographic and patent search.
6. Offline Bibliographic search using Derwent Biotechnology Abstracts.
7. Sequence information resource
8. Understanding and using on web: Embl, GEnbank, Entrez, Unigene
9. Protein information resource
10. Understanding and using on web: PDB, Swissprot, TrEMBL using BLAST and interpretation of results, multiple sequence alignment using Clustal-W.

COURSE No. : MBT-205	ENZYME TECHNOLOGY
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **11**

Introduction to enzyme and enzyme technology: History and scope of enzymes and enzyme technology, nomenclature of enzymes, enzyme activity units.

Enzyme Kinetics: Activation Energy & Transition State concept. Mechanism of enzyme catalysis, simple kinetics of enzyme action, factors affecting enzyme activity, reversible reaction, enzyme inhibition, determination of Vmax and Km values.

Sources and preparation of enzymes: Sources of enzymes, screening strategies for novel enzymes, media for enzyme production, methods of purification and concentration of intracellular and extracellular enzymes, factors affecting enzyme stability, preparation of enzymes for sale, customer service, safety and regulatory aspects of enzyme use, enzyme business, major manufacturers of enzymes in India and World

UNIT II **10**

Large Scale use of enzymes in solution: Use of enzymes in detergents, food industry, fruit juice, wine, brewing and distilling industries, textile industries, waste treatment, diagnostics, pharmaceutical and chemical industries, application of enzymes in medicine

Preparation and kinetics of immobilized enzymes: Methods of immobilization of enzymes, Physical adsorption, covalent binding, entrapment and micro encapsulation, kinetics of immobilized enzymes, effect of solute partition and diffusion on the kinetics of immobilized enzymes, use of immobilized enzymes.

UNIT III **11**

Immobilized enzymes and their use, Enzyme reactors, stirred tank reactors, plug flow reactors, continuous flow stirred tank fluidized bed reactor, Membrane/hollow fiber reactors, selection of reactors, productivity and performance of various types of reactors, immobilized enzyme processes - production of high fructose corn syrups, production of antibiotics, production of acrylamide and use of immobilized invertase, lactase, raffinase.

Biosensors: Use of enzymes in analysis, biosensors- calorimetric, potentiometric, amperometric, optical, piezoelectric biosensors and immuno-sensors.

UNIT IV **11**

Advanced topics in enzyme technology: Enzyme reactions in biphasic liquid systems; proteases, glycosidases and lipases in synthetic reactions, interesterification of lipids, artificial enzymes, un-natural substrates, enzyme engineering, extremophilic enzymes, hybrid enzymes, high throughput screening and assay techniques.

Suggested books [Latest edition]

1. Enzyme Technology: MF Chaplin and DC Bucks
2. Industrial Enzymology: Godfrey and West
3. Enzyme: Copeland
4. Enzymes in Industry: W Gerhartz

List of practicals

1. Assay of some common enzymes (amylase, protease, pectinase, lipase etc.)
2. Microbial production of an enzyme.
3. Purification of enzyme, determination of V_{max} and Km values.
4. Effect of temperature, pH, ionic strength, inhibitors and metal ions.
5. Immobilization of enzymes/ cells by adsorption, covalent linkage, entrapment methods.
6. Enzyme reactions in biphasic aqueous - organic solvent.
7. Application of enzymes in detergents, chemical production, juice clarification and bioprocessing.

ELECTIVE PAPER

COURSE No. : MBT-EL-301	METABOLIC ENGINEERING
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **10**

Introduction to metabolic engineering and regulation of metabolic pathways: Concept and importance of metabolic engineering, improvement of microbial strain and fermentation processes by metabolic engineering, tools of metabolic engineering. Regulation of enzyme activity, regulation of enzyme concentration, regulation of metabolic network.

UNIT II **15**

Metabolic engineering in practice: Enhancement of productivity, extension of substrate range, extension of product spectrum and novel products, improvement of cellular properties, intervention in health and diseases, xenobiotics degradation.

UNIT III 10

Metabolic flux analysis: Theory, detection of elementary flux modes in biochemical network, metabolic flux distribution in *Corynebacterium glutamicum* during growth and lysine overproduction.

UNIT VI 10

Application of metabolic flux analysis: Calculation of theoretical yield, amino acid production by glutamic acid bacteria, metabolic flux in mammalian cell culture, metabolic engineering of lactic acid bacteria, riboflavin production by *Bacillus subtilis*, metabolic engineering of *Saccharomyces cerevisiae*.

SUGGESTED BOOKS [Latest edition]

1. Metabolic Engineering: SY Lee and EP Popoutsakis (Eds), Marcel Dekker, New York, USA.
2. Metabolic Engineering: GN Stephanopoulous, AA Aristidon and J Neilson, Academic Press, USA.

COURSE No. : MBT-EL-302	BIOCATALYSIS AND BIOTRANSFORMATION
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I 11

General usage of biocatalyst, fermentation and applied biocatalysis. Types of bioconversion reactions, Procedures for bio-transformations, use of cells and enzymes for biotransformation, Genetic manipulations of organisms for biotransformation, Application of bioconversions. Reaction types of microbial transformations from steroids, Microbial breakdown of sterol side chain. Transformation of non steroid compounds: L-Ascorbic acid, Dihydroxy acetone from glycerol, Prostaglandins, Hydantoinases, Carbamoylases, Catalytic antibodies

UNIT II 12

Transformation of Antibiotics: Acylases and peptidases, Reaction of penicillin and cepharosporin substrates, Protection of amino groups. Transformation of Pesticides**:** Accumulation of pesticides, Pesticides as carbon source, Conjugate formation. Alkaloid Biotransfromation: Tropane alkaloid biosynthesis, Microbial metabolism of tropane alkaloids, Morphine alkaloid biosynthesis, Transformation of morphine alkaloid by *Pseudomonas putida* M10, Microbial transformation of heroin

UNIT III 11

Biotransformation of nitrile group: **N**itrile hydratases and nitrilases, Biotechnology of nitrile transformations, regio and stereo selective biotransformation of nitriles, commercial processes, search for novel nitrile biotransforming activities, Redesign of existing enzyme by protein engineering, metabolic engineering by multistep biotransfornation, Cyanide biotranformation

UNIT IV 11

Biotransformation by Lipases**:** Commercial lipases, Properties and application of lipases, Lipid or surfactant coated lipases, inter-esterification of fats and oils, Enantioselective esterification by lipase, Commercial application (Food ingredients and enatiomerically pure chemical and pharmaceutical intermediates).

SUGGESTED BOOKS [Latest edition]

1. Biotechnology - Vol 8a: Eds. HJ Rehm and G Reed
2. A text book of Industrial Microbiology: W Crueger and A Crueger
3. Microbial Biotechnology: AN Glazer and H Nikaido

COURSE No. : MBT-EL-303	FOOD TECHNOLOGY
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

Unit I **10**

Introduction and history of food microbiology, General characteristics, classification and importance of microorganisms important in food microbiology, Principles of food preservation. Asepsis–Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying, canning, food irradiation). Factors influencing microbial growth in food – Extrinsic and intrinsic factors; Chemical preservatives.

Unit II **12**

Contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products, Fish and sea foods, poultry food, spoilage of canned foods. Detection of spoilage and characterization. Food-borne infections and intoxications: Bacterial and nonbacterial toxins with examples of infective and toxic types – *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia,* Nematodes, protozoa, algae, fungi and viruses.

Unit III **13**

Food fermentations: Industrial production method for microbial starters, bread, cheese, vinegar, fermented vegetables, fermented dairy products; fermented foods, microbial cells as food (single cell proteins, mushrooms), fermented beverages: beer and wine. Amino acid production: glutamic acid and lysine. Production of probiotics and prebiotics, nutraceuticals, low calorie sweetener, food coloring and naturally occurring flavor modifiers.

Unit IV **10**

Food quality standards, Monitoring and control, Food Adulteration, R&D innovations in food microbiology, Genetically modified foods, Need and requirements of food packaging; Containers for packaging, Dispensing devices, Food Regulations/Safety & Quality Standards & Food Laws

Suggested books [Latest edition]

1. Food microbiology- Royal society of chemistry: MR Adams and MO Moss.
2. Principles of fermentation technology: PF Stanbury, A Whitekar and SJ Hall, Pergamon Press.
3. Basic Food Microbiology: GJ Banwart, CBS Publishers.

COURSE No. : MBT-EL-304	NANOBIOTECHNOLOGY
Maximum Marks: 80	Teaching Hours: 45

Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks

UNIT I **12**

Introduction: Definition, interdisciplinary nature, learning from nature (linear and rotary molecular motors, abalone shells) and scope.

Bio-nanostructures: Protein based nanostructures self-assembly engineered nanopores, protein micro-arrays, magnetosomes, bacteriorhodopsin and their application.

DNA based nanostructures: DNA-protein nanostructure, DNA-templated electronics, DNA Gold nanoparticle conjugates-chip based DNA detection, DNA Nanostructures for mechanics and computing, nanoparticles as non-viral transfection agent.

UNIT II **11**

Silica nanoparticles for analytical microbial biofilms structure and applications, artificial cells.

Nanostructured fluids and soft material: Applications in drug solubilization and delivery, nutraceuticals enhanced oil recovery, antimicrobial and cosmetic nanoemulsions, food colloids, templating of nanoparticles.

UNIT III **11**

DNA-Nanotechnology: Structural DNA assembly, nanopore DNA sequencing, DNA coupled to carbon nanotubes, DNA-modified surfaces, polyelectrolyte behavior in DNA, self-assembling toroidal nanoparticles

Applications of nanoparticles: Nanoparticles for biological assays, as drug delivery vehicles and as contrast agent.

UNIT IV **12**

Application of nanotechnology/ nanobiology/ nanotechnology in bio-mineralization, medicine and surgery (stem cell biology, artificial organs, tissue engineering, cardiology and cardiac surgery, organ transplantation and cancer).

Suggested books [Latest edition]

1. Nanobiotechnology. Concepts. Applications & Perspectives: CM Niemeyer and CA Mirkin, Wiley VCH-Verlag.
2. From Biology to Biotechnology & Medical Applications: E Bauerlin, Biomineralization - Wiley VCH-Verlag.
3. Nano & Microscience, Engineering Technology and Medical Series: Lyshevski, Sergey Edward, CRC Press.
4. Nanostructures and Nanomaterials: G Cao, Imperial College Press.
5. Nanoscale Technology in Biological Systems: RS Greco, FB Prinz and RL Smith. CRC Press.

COURSE No. : MBT-401	DISSERTATION
Maximum Marks: 250 (150 + 100)	Full Semester (6 months)

Note: Every candidate will carry out the project work assigned to him/ her. The candidate will submit three bound copies of the Report of Research Project work performed by him/ her duly certified by the guide/supervisor. The project report should cover the abstract/ summary, introduction, materials and methods, results and discussion, and references. The references will be arranged alphabetically under the format given below:

Referred Journal

Bhalla TC, Sharma NN and Sharma M (2006) Expression of alkaline protease in *Rhodococcus* sp. J Appl Biotechnol 32:225-230

Books

Demartino, GN (1996) Purification of proteolytic enzyme. In: Proteolytic enzyme: a practical approach. Berjnon RJ and Bond JS eds, IRL Press NewYork

Theses

Verma ML (2006) Production, purification and characterization of thermotolerant *P. aeruginosa* lipase. PhD Thesis, Himachal Pradesh University, Shimla, India.

Website

www.elsevier.com