# REVISED

# GENERAL INSTRUCTIONS

## AND

# COURSE CURRICULUM

## FOR

# M.Sc. BIOTECHNOLOGY (CBCS)

## Effective from Session 2025-2026

**DEPARTMENT OF BIOTECHNOLOGY**
**HIMACHAL PRADESH UNIVERSITY**
**SUMMER HILL, SHIMLA-171 005**

Annexure-I

**DEPARTMENT OF BIOTECHNOLOGY**
**HIMACHAL PRADESH UNIVERSITY**
SUMMER HILL, SHIMLA-171 005

**M.Sc. BIOTECHNOLOGY PROGRAMME (CBCS)**

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

1. The M.Sc. Biotechnology programme will be of two years duration spread over four semesters
2. There will be sixteen (16) courses in M.Sc. Biotechnology Programme. 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-301TH to MBT-EL-304TH). The distribution of marks in each course for theory, practical and internal assessment will be as per details given in the OUTLINES OF COURSES FOR M.Sc. BIOTECHNOLOGY.
3. There will be 40 marks for internal assessment in each course except course MBT-205 (Remedial course will have 30 marks for Internal Assessment), and Elective Course (MBT-EL-301TH to MBT-EL-304TH). A total of two Internal Assessment tests (Term 1 and Term 2) of 15 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 (30 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% lectures: 2 marks, iv) 81-85% lectures: 3 marks; v) 86-90% lectures: 4 marks; vi) 91% and above lectures: 5 marks. However, for Elective Course, a total of two Internal Assessment tests (Term 1 and Term 2) of 12.5 marks each (25 MCQ, each question will carry 0.5 marks in each test) will be held in a semester, and remaining 5 marks will be for the class attendance as per criterion mentioned above for other courses.
4. The Chairman of the Department will notify the date sheet for Internal Assessment tests (Term 1 and Term 2) 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, seminar and viva voce will be of 250 marks (150 for dissertation and 100 marks for seminar and viva voce).
6. The admission to M.Sc. Biotechnology programme of Himachal Pradesh University at campus will be through a Combined Entrance Examination (GAT-B) conducted by Regional Center for Biotechnology (RCB), Faridabad or as decided by the Department of Biotechnology (DBT), Govt. of India from time to time. However, admission to M.Sc. Biotechnology Programme 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.
   - 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.
7. The tuition fee and other monthly/ annual charges will be as per the University rules.

# OUTLINES OF COURSES FOR M.Sc. BIOTECHOLOGY (CBCS)

| Courses | Title of course | Marks | | | Total Marks | Credits |
|---|---|---|---|---|---|---|
| | | Theory (Th) | Practical (Pr) | Internal Assessment (IA) | | L+T+P |
| ***Semester I*** | | | | | | |
| MBT-101 | Remedial course | 70 | - | 30 | **100** | 3+2+0 = 5 |
| | (1) Introductory Biology (for Non Biology students) | | | | | |
| | (2) Introductory Mathematics (for Biology students) | | | | | |
| MBT-102 | Biochemistry | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-103 | General Microbiology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-104 | Cell and Molecular Biology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-105 | Instrumental methods of Analysis | 70 | 40 | 40 | **150** | 3+1+1=5 |
| **Total Marks in Semester I** | | **350** | **160** | **190** | **700** | **Total = 25** |
| ***Semester II*** | | | | | | |
| MBT-201 | Recombinant DNA Technology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-202 | Immunology and Immunotechnology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-203 | Plant Biotechnology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-204 | Animal Biotechnology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-205 | Biochemical Engineering | 70 | 40 | 40 | **150** | 3+1+1=5 |
| **Total Marks in Semester II** | | **350** | **200** | **200** | **750** | **Total = 25** |
| ***Semester III*** | | | | | | |
| MBT-301 | Environmental Biotechnology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-302 | Fermentation Technology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-303 | Computer and Bioinformatics | 70 | 40 | 40 | **150** | 3+1+1=5 |
| MBT-304 | Enzyme Technology | 70 | 40 | 40 | **150** | 3+1+1=5 |
| Elective Paper (Any One) | | 70 | - | 30 | **100** | **3+2+0 = 5** |
| MBT-EL-301 | Metabolic Engineering | | | | | |
| MBT-EL-302 | Biobusiness Management and Entrepreneurship | | | | | |
| MBT-EL-303 | Food Biotechnology | | | | | |
| MBT-EL-304 | Biotechnology in Disease Diagnosis | | | | | |
| **Total Marks in Semester III** | | **350** | **160** | **190** | **700** | **Total = 25** |
| ***Semester IV*** | | | | | | |
| MBT-401 | Dissertation and Viva-voce | 250 | | | **250** | **35** |
| **Total Marks in Semester IV** | | - | - | **250** | **250** | **Total = 35** |
| **Grand Total (Semester I-IV)** | | **1050** | **520** | **580+250** | **2400** | **25+25+25+35 = 110** |

**[L:- Theory; T:-Tutorial; P:-Practical]**

# PROGRAM OUTCOMES AND COURSE OUTCOMES

**M.Sc. Biotechnology**

| **Program Outcomes (POs):**<br>On completion of this Program Students will be able to: |
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| Learn the concept of Biotechnology and the applied aspects of Biotechnology which provide students with theoretical knowledge and practical abilities required to work in the food industry, research centers, and food-related national and international organizations. Students will be able to apply their professional skills needed for careers in Biotechnology and related scientific and professional fields. The students will learn the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological, pharmaceutical, medical and agricultural applications. They will be able to communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing. The In-house project for six months would inculcate the scientific temperament and also to test their theoretical knowledge which will be used for practical purpose. This will make them more skilled and their confidence will be built to take such projects in near future for R&D and also for entrepreneurship development. Students will also be able to design solutions for problems and design processes and find solutions that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. They will be able to gain domain knowledge and know-how for successful career in academia, industry and research. This will promote lifelong learning to meet the ever evolving professional demands by developing ethical, inter personal and team skills. |

| Course Outcomes (COs)<br>On completion of this course Students will be able to: | |
|---|---|
| **Course Name** | **Course Outcome** |
| **MBT-101 (1) &(2)<br>(Introductory Biology/ Mathematics)** | CO1: Understand and perform statistical analysis based on biological experimental data and will also be able to use and apply various statistical tools.<br>CO2:Will be able to do quantitative analysis of biological systems<br>CO3: Students will be able to know principles and practices of statistical methods of biological research<br>CO4: Will be able to apply basic techniques applicable to modern mathematics |
| **MBT-102 Biochemistry** | CO1: Students learn about biological macromolecules, proteins, carbohydrates, nucleic acids, porphyrins, lipids, their structure, properties and functions and chemistry<br>CO2:Biochemical roles of water and fat soluble vitamins and their coenzymes<br>CO3:Metabolism (both catabolism and anabolism) of these macromolecules with a separate reference of ETC and oxidative phosphorylation<br>CO4:Will be able to apply tools and techniques of biochemistry in industry and therapeutics |
| **MBT-103 General Microbiology** | CO1: Use techniques and instruments involved in the study of microorganisms and their products<br>CO2: Apply the knowledge to understand the microbial physiology and to identify the microorganisms<br>CO3: Gain in depth knowledge about viruses and bacteriophages<br>CO4: Isolate and identify specific microorganisms by use of special enrichment method techniques |
| **MBT-104 Cell and Molecular Biology** | CO1: Demonstrate the knowledge of common and advanced laboratory practices in cell and molecular biology<br>CO2: Exhibit clear and concise communication of scientific data<br>CO3: Engage in review of scientific literature in the areas of biomedical sciences<br>CO4: Critique and professionally present primary literature articles in the general biomedical sciences field |
| **MBT-105 Instrumental methods of Analysis** | CO1: Learn and master the techniques of microbiology, molecular biology, mammalian & plant tissue/ cell culture for commercial exploitation of |

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| | cellular systems by using microscope, biosafety cabinet, sterilization systems, cell syndicator, centrifuges, electrophoresis systems, gel-doc system, lyophilization/ freeze-drier, PCR, RT-PCR, liquid chromatography systems/ ACTA-Prime etc.<br>CO2: Students perform experiments to determine unknown molecular mass of protein(s), purification of human IgG, milk protein casein, serum albumin etc.<br>CO3: Students use techniques of electrophoresis to check electrophoretic purity and determination of molecular mass of protein(s) by this technique<br>CO4: To check for DNA, RNA, purine/ pyrimidine, amino acid(s) content in samples<br>CO5: Students will also perform hands on special instruments such as HPLC and GLC for assay of test compounds. |
| **MBT-201 Recombinant DNA Technology** | CO1: Understand principles of genetic manipulation; isolation of total genomic DNA, meaning of recombinant DNA technology<br>CO2: Students also gain an insight as to how restriction and ligation of DNA molecules; amplifying recombinant DNA, molecular cloning; bacterial transformation is done<br>CO3: Use of selective markers: Shortgun cloning; Cell competency and Screening of genomic and cDNA libraries is done<br>CO4: Electrophoresis and hybridization techniques; Quantitative and real- time PCR techniques |
| **MBT-202 Immunology and Immunotechnology** | CO1: Candidates learn to perform various immunological techniques.<br>CO2: Learn advanced techniques such as ELISA, immunoelectropohoresis, etc.<br>CO3: Students perform differential leukocyte count, precipitation, agglutination and immunodiffusion (Ouchterlony and Mancini Technique) tests<br>CO4: Student learn about various types of immunoelectrophoresis and ELISA.<br>CO5: They will also be able to isolate IgG from human serum by affinity chromatography and check the isolated IgG using immune diffusion and precipitation tests.<br>CO6: Will also be able to perform and apply tools and techniques of agglutination for detection of RA factor in Serum. |
| **MBT-203 Plant Biotechnology** | CO1: The students acquire the knowledge about the culture condition of plants and how further the same |

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| | can be used in agriculture applications.<br>CO2: Determine the factors influencing plant cell differentiation and thereby execute proper techniques for proper plant growth.<br>CO3: In-vitro clonal propagation and large scale production of plants through micro propagation<br>CO4: Will be able to prepare artificial seeds through gel entrapment. |
| **MBT-204 Animal Biotechnology** | CO1: Students acquire knowledge about the basic techniques in animal sciences and study the effect analysis and various types of animal cell culture media and buffers/ reagents.<br>CO2: Will be able to describe the in vitro applications of animal cell culture<br>CO3: Will also be able to construct techniques which are involved in transgenic animal technology and its applications<br>CO4: Will get sensitized about the ethical, social and moral issues related to cloning |
| **MBT-205 Biochemical Engineering** | CO1: Learn the techniques of bio-product & down-stream bio-process development, therapeutic/ drug-like properties, qualitative & quantitative evaluation and molecular structural analysis.<br>CO2: Calculate the kinetic parameters of enzymatic reactions.<br>CO3: Analyze the kinetic parameters for microbial growth.<br>CO4: Analyze bioprocess design and operation. |
| **MBT-301 Environmental Biotechnology** | CO1: Candidates develop comprehensive theoretical knowledge in the core subjects of cell biology & genetics, biochemistry, microbiology, molecular biology and bioinformatics analytical tools.<br>CO2: Determination of COD & BOD CO3: Transformation of waste into valuable products.<br>CO4: Impact of Genetically modified Organisms (GMO)s and their impact on environment. |
| **MBT-302 Fermentation Technology** | CO1: Learn the techniques of bio-product & down-stream bio-process development, therapeutic/ drug-like properties, qualitative & quantitative evaluation and molecular structural analysis.<br>CO2: Will be able to learn about fermentation process and its application in the industry<br>CO3: Biobuisness and legal issues in Fermentation Technology<br>CO4: In depth knowledge about GMP and GLP |

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| | guidelines in fermentation process. |
| **MBT-303 Computer and Bioinformatics** | CO1: Students learn how to use the basic software and mining of biological data from biological databases.<br>CO2: How the data may be analyzed using online/offline tool.<br>CO3: Prediction of structure and its analysis.<br>CO4: Knowledge as to how the techniques of Bioinformatics are used in design of drugs. |
| **MBT-304 Enzyme Technology** | CO1: The students will be able to have in depth knowledge about the application of enzymes in the industry, research and pharmacheutical sciences<br>CO2:The students will able to assay the enzyme and their kinetics and also apply to this in the industry and other technological field<br>CO3: Will be able to purify enzymes and use the same for the benefit of the mankind<br>CO4: How to commercialize the biotechnological products developed with the use of specific enzymes. |
| **MBT-EL-301 Metabolic Engineering** | CO1: Students will be able to get indepth knowledge as to how the Metabolic engineering aims towards purposeful modification of cellular functions (metabolic, gene regulatory, and signalling)<br>CO2: Students will also gain knowledge about how to achieve desirable goals and enhanced production of metabolites including pharmaceuticals, biofuels and biochemicals and other biotechnology products.<br>CO3: This will also let students know how to provide fundamental and advanced knowledge in the development of microbial strain for bio production through metabolic engineering.<br>CO4:Various tools and techniques required for performing the experiments to reach a specific goal. |
| **MBT-EL-302 Biobusiness Management and Entrepreneurship** | CO1:This will help the students to understand the importance of Biobusiness and entrepreneurship in biotechnology<br>CO2: Will help to develop business ideas and startups, learn about IPR and biosafety issues in biotechnology<br>CO3:The students will be sensitized about the power, opportunities and planning of entrepreneurship<br>CO4: Help the students to develop skills in biobussiness management |
| **MBT-EL-303 Food Biotechnology** | CO1: Food technology course will help the students to use their knowledge of biotechnology for translating it in food sector especially for processing of the local fruits and also for establishing entrepreneurial ventures. |

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| | CO2: Apply knowledge gained in food chemistry, microbiology, engineering, and sensory evaluation to the development, processing, etc.<br>CO3: Preservation of safe, nutritious, and high-quality food products.<br>CO4: Knowledge of Regulatory and safety standard Laws |
| **MBT- EL-304T Biotechnology in Disease Diagnosis** | CO1: Help students to understand the prospects of biotechnology in diagnosis of diseases<br>CO2: will gain knowledge of various biotechnological tools used in disease diagnosis<br>CO3: Knowledge of latest techniques in biotechnology<br>CO4:Understand the importance of enzyme based immunoassays in diagnostics |
| **MBT-401 – Dissertation and Viva-Voce** | CO1: The In-house project for six months would inculcate the scientific temperament and also to test their theoretical knowledge which will be used for practical purpose.<br>CO2: This on one hand will make them more skilled and on the other their confidence will be built to take such projects in near future for R&D and also for entrepreneurship development.<br>CO3: The students will also be familiar with the ground realities of the R&D and other such projects.<br>CO4:Exclusive handling of major tools and their practical use in the industry. |

**Department of Biotechnology**
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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 2 | 0 |

## COURSE MBT-101 (1): REMEDIAL COURSE- INTRODUCTORY BIOLOGY

**Maximum marks: 70** **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

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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 2 | 0 |

## COURSE MBT-101 (2): INTRODUCTORY MATHEMATICS

**Maximum marks: 70** **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.

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**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.

**Department of Biotechnology**
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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 1 | 1 |

## COURSE MBT-102: BIOCHEMISTRY

**Maximum marks: 70** **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, protein denaturation and renaturation, types of protein: 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, concept of $V_{max}$ and $K_m$.

**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.

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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 1 | 1 |

## COURSE MBT-103: GENERAL MICROBIOLOGY

**Maximum marks: 70** **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, Classification of microorganisms, Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concepts of Carl Woese, Basis of microbial classification, Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology, prochlorons and cyanelles.

**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, concept of sterilization and antimicrobial agents in microbiology.

**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: Structure and classification, General structure and life cycle of bacteriophage (T4 and lamda-phage), Hepatic virus (HAV, HAB and HAC), Dengue virus (Flavi virus), Chikungunya virus, Ebola virus, Zika virus, Corona virus, Concept of giant viruses, anti-viral therapy.

**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 measure the size of given microorganism by micrometry.
8. To count microbial cells using hemocytometer.
9. To perform antibiotic sensitivity test by the method of Kirby and Bauer.
10. To determine MIC of a given antibiotic for the micro-organisms.
11. To perform turbidimetry/nephalometry to assess the growth of the micro-organisms.
12. To isolate a specific type of micro-organism by use of selective/enrichment method form a given soil sample.

**Department of Biotechnology**
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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 1 | 1 |

## COURSE MBT-104: CELL AND MOLECULAR BIOLOGY

**Maximum marks: 70** **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 (membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport,electrical properties of membranes). 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
2. Lewin Genes XIII
3. Molecular Cell Biology: Lodish
4. Karp's Cell and Molecular Biology: Gerald Karp
5. Molecular Biology of the Gene: James D. Watson

**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.

| Lecture | Tutorial | Practical |
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## COURSE MBT-105: INSTRUMENTAL METHODS OF ANALYSIS

**Maximum marks: 70** **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

| Lecture | Tutorial | Practical |
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## COURSE MBT-201: RECOMBINANT DNA TECHNOLOGY

**Maximum marks: 70** **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: bacteria, yeast, plant and mammalian host systems

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

**UNIT III** **11**

Sequencing and other techniques: DNA, RNA sequencing (Maxam Gilbert, Sanger sequencing, Automated sequencing, Shotgun sequencing, Pyrosequencing, Nanopore sequencing, Next generation sequencing), Protein sequencing (Edman degradation, Peptide mass fingerprinting, Mass spectrometry), DNA finger and foot printing, Gene silencing, antisence RNA technology, CRISPER technology, Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting.

**UNIT IV** **11**

Polymerase chain reaction and its types, Site directed mutagenesis, protein engineering, molecular markers.

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

Applications of r-DNA technology in biofuel, paper, textile and food, agriculture, horticulture, medicine, environment and forensic science.

**Suggested books [Latest edition]**

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

**List of practicals**

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

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**HIMACHAL PRADESH UNIVERSITY**
Summer Hill, Shimla-171 005 (H.P.), India

| Lecture | Tutorial | Practical |
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**COURSE MBT-202: IMMUNOLOGY AND IMMUNOTECHNOLOGY**

**Maximum marks: 70** **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, 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, concept of idiotypes and anti-idiotypes, 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**

Antigen-antibody interactions, 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**

Vaccines: Live, inactivated of killed, subunit, DNA vaccines, recombinant vector vaccines, conjugate or multivalent vaccines, Autoimmunity and autoimmune disorders: Organ specific (Hoshimoto thyroiditis, Pernicious anemia, Good Pasteur syndrome, Diabetes Mellitus type 1, Grave's disease, Mysthenia Gravis and Systemic lupus erythromatosus, Multiple sclerosis, Rheumatoid arthritis), hyper-sensitivity and its types, tumor antigens and tumor immunity.

**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.

**Department of Biotechnology**
**HIMACHAL PRADESH UNIVERSITY**
Summer Hill, Shimla-171 005 (H.P.), India

| Lecture | Tutorial | Practical |
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## COURSE MBT-203: PLANT BIOTECHNOLOGY

**Maximum marks: 70** **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**

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 morphogenesis. Initiation of aseptic culture techniques, single cell and cell suspension culture, callus culture, protoplast culture and somatic hybridization.

**UNIT II** **11**

*In vitro* and *in vivo* pollination and fertilization, embryo culture and embryo rescue, somatic embryogenesis, artificial seeds. Doubled haploid production through distant hybridization, Androgenesis *(anther and pollen culture)* and Gynogenesis *(ovary and ovule culture)*.

**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. Production of useful bio-chemical substances through tissue culture system, Scale-up through bio-reactors.

**UNIT IV** **11**

Bioinsecticides, biopesticides and biofertilizers. Transgenic plant and their production. Regulatory framework for regulation of GM crops in India, Preservation of plant genetic resources: Germplasm collection and conservation. Designing and erection of polytunnels and greenhouses. Acclimatization and hardening of micropropagated plants.

**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

**Department of Biotechnology**
**HIMACHAL PRADESH UNIVERSITY**
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| Lecture | Tutorial | Practical |
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## COURSE MBT-204: ANIMAL BIOTECHNOLOGY

**Maximum marks: 70** **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.

**Department of Biotechnology**
**HIMACHAL PRADESH UNIVERSITY**
Summer Hill, Shimla-171 005 (H.P.), India

| Lecture | Tutorial | Practical |
|---|---|---|
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## COURSE MBT-205: BIOCHEMICAL ENGINEERING

**Maximum marks: 70** **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, Growth yield, Specific growth rate, Product yield, Saturation constant, Yield equations based on $Y_G$, $Y_{O2}$, $Y_{ATP}$, Maintenance energy, 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**

Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed-batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, 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** **9**

Translation of laboratory, pilot and plant scale data, Criteria for translation between two scales of operation, Scale-up practices and bases for scale-up methods, 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**

Fluids Types and properties, 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 ($\mu_{max}$), saturation constant ($K_S$) and growth yield ($Y_{X/S}$) for *S. 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 point and thermal death time for *E. coli*.
6. Disruption of microbial cells for the release of the intracellular protein.
7. Evaluation of alcohol as chemical agent to control microbial growth.

**Department of Biotechnology**
**HIMACHAL PRADESH UNIVERSITY**
Summer Hill, Shimla-171 005 (H.P.), India

| Lecture | Tutorial | Practical |
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## COURSE MBT-301: ENVIRONMENTAL BIOTECHNOLOGY

**Maximum marks: 70** **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: Air borne transmission of viruses, bacteria and fungi, their diseases and preventive measures, assessment of air quality. Aquatic microbiology: Different water ecosystems, water potability, microbial assessment of water quality, major water borne diseases and their control measures. Soil microbiology: types of soil and classification, physical and chemical characteristics, microflora of soil, microbial interactions symbiosis, mutualism, commensalisms, competition, amensalism, synergism, parasitism, predation. Biogeochemical cycles (C, N, P & S).

**UNIT II** **11**

Solid waste management: Solid waste types, characterization, methods of waste collection, segregation and transport. Solid waste treatment (gasification, incineration, sanitary landfill, composting, saccharification). Solid wastes valorisation i.e. foods (SCP, mushroom, yeast); fuel (ethanol, methanol, biogas, biomethane, biohydrogen, biohythane), biofertilizers, compost, vermicompost. Treatment of specific waste i.e. hazardous waste, e-waste. Concept of carbon footprint, life cycle assessment, 10 R's of waste management for circular bioeconomy.

**UNIT III** **11**

Waste water treatment: Types of waste water, waste water quality parameters. 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), inorganic substances and oil spills. Emerging biotechnological and nanotechnological methods in waste water treatment.

**UNIT IV** **11**

Air, water, soil, noise and thermal pollutions. Ozone depletion, acid rain, Greenhouse effect and global warming. Bioremediation and biorestoration of contaminated lands. Bioaccumulation and biosorption of essential metals, Biodegradation of pesticides, chlorinated hydrocarbons and xenobiotic compounds, Biodeterioration of paper, leather, wood and textiles. Bioleaching, biomining, microbes in extraction of metals, desulfurization of coal and petroleum extraction, Molecular approaches in environmental management, GMO and their impact on environment.

**Suggested books [Latest edition]**

1. Microbial ecology: Alexander M
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. Determination of indoor and outdoor microbial contamination
2. Detection of bacteriological quality of water with special reference to feacal Coliform.
3. Estimation of total solids in sewage samples.
4. Determination of DO in waste water samples.
5. Determination of BOD of waste water samples.
6. Determination of COD of waste water samples
7. Estimation of volatile matter and fixed residues in sewage samples.
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.

**Department of Biotechnology**
**HIMACHAL PRADESH UNIVERSITY**
Summer Hill, Shimla-171 005 (H.P.), India

| Lecture | Tutorial | Practical |
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## COURSE MBT-302: FERMENTATION TECHNOLOGY

**Maximum marks: 70** **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, , Monitoring and control of environmental parameters in fermentation process, Approaches for improvement of industrial organisms, chemically defined media for commercial fermentation, renewable feedstock as raw material (whey, molasses, corn steep liquor, lignocellulosic material, etc.) in fermentation process, Solid state fermentation, principle, solid state bioreactor operation, merits and demerits.

**UNIT II** **15**

Bio-Process technology: Primary and secondary metabolites, Vinegar fermentation, Citric acid and lactic acid fermentation, Production of Riboflavin and Vitamin B-12 by fermentation, production of commercially important enzymes (amylase, protease, cellulase, lipase, glucose isomerase), Bio-process technology for the production of recombinant vaccines, therapeutic proteins and antibiotics.

**UNIT III** **08**

Integrated bio-process technology for the production of compressed bakers' yeast, Brewing technology: Malting, mashing, fermentation and pasteurization of beer, defects of beer, Wine production: types of wines, maturation and fining of wine, champagne, Production of distilled alcoholic beverages – Whisky and Brandy, traditional and oriental fermented beverages.

**UNIT IV** **07**

Energy forming bioprocess for the production of liquid fuel (ethanol), gaseous fuel (methane), microbial production of hydrogen. acetone-butanol, biodiesel, algal biofuel, Single cell protein,

Advancements in effluent treatment methods used in fermentation industry, Different method of spent wash treatment (bio-methanation, incineration and bio composting).

**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 *S. cerevisiae*.
5. Production of wine from Apple/ Grape juice by *S. 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.
9. Biotransformation of sucrose by invertase of *S. cerevisiae.*
10. Effect of incubation temperature and medium pH on microbial growth.

**Department of Biotechnology**
**HIMACHAL PRADESH UNIVERSITY**
Summer Hill, Shimla-171 005 (H.P.), India

| Lecture | Tutorial | Practical |
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## COURSE MMB-303: COMPUTER AND BIOINFORMATICS

**Maximum marks: 70** **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.
2. Bioinformatics: A practical guide to the analysis of genes and proteins, Ed. Baxvains.
3. Molecular Evolution: A phylogenetic approach: ROM and Holmas EC.
4. Bioinformatics: Sequences, structure and databanks: Des Higgins and Willie Taylor.
5. Computer today: Suresh K Basandra.
6. Computer fundamentals: PK Sinha.

**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.

**Department of Biotechnology**
**HIMACHAL PRADESH UNIVERSITY**
Summer Hill, Shimla-171 005 (H.P.), India

| Lecture | Tutorial | Practical |
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## COURSE MBT-304: ENZYME TECHNOLOGY

**Maximum marks: 70** **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, enzyme inhibition, determination of Vmax and Km values, Allosteric enzymes.

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, regulatory aspects of enzyme use, enzyme business, major manufacturers of enzymes in India and World

**UNIT II** **10**

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, immobilized enzyme processes - production of high fructose corn syrups, production of antibiotics, production of acrylamide and use of immobilized invertase, lactase, raffinase.

**UNIT III** **11**

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

Immobilized enzyme reactors: Packed bed, fluidized bed reactor, Plug floe reactor, Membrane/hollow fiber reactors,

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, artificial/designer enzymes, un-natural substrates, enzyme engineering, extremophilic enzymes, hybrid enzymes, zymogens, ribozymes, abzymes, synzymes.

**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, invertase 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.

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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 2 | 0 |

**ELECTIVE PAPER**

## COURSE MBT-EL-301: METABOLIC ENGINEERING

**Maximum marks: 70** **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 (9), 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, flux map, 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).
2. Metabolic Engineering: GN Stephanopoulous, AA Aristidon and J Neilson.

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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 2 | 0 |

## COURSE MBT-EL-302: BIOBUSINESS MANAGEMENT AND ENTREPRENEURSHIP

**Maximum marks: 70** **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**

Biobusiness in Biotechnology: Concept of Bio-business management, Project formulation, business plan, technological Assessment, feasibility and commercial viability of a project.
Economics of bioprocesses: Total product cost, capital investment estimation and profitability, manufacturing cost estimation, Risk capital and working capital, cost analysis for R & D decision making, Market analysis.

**Unit II** **12**

Introduction to Intellectual Property: Patents, Trademarks, Trade secrets, Copyright & Related Rights, Industrial Design and Rights, Geographical Indications- importance of IPR , legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO). Licensing and Patenting of bio-product, An introduction to Patent Filing Procedures, Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner, Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

**Unit III** **12**

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms
Biosafety Guidelines: Biosafety guidelines and regulations, GMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis, assessment and management; Guidelines for recombinant DNA research in laboratories and precautions, GLP, GCP, GMP and GDPs guidelines in bioprocesses.

**Unit IV** **10**

Concept of Entrepreneurship, Entrepreneurship opportunities in India, Development of Entrepreneurship and its barriers; Stages in entrepreneurial process; Registration process of an entrepreneurial unit as legal entity, Establishing small scale industry, Industrial sickness- symptoms, control and rehabilitation of sick units, Startup funding sources- government and private, Biobussiness incubation schemes, Case study of successful startups/Entrepreneurs, Agreements and Treaties: GATT, TRIPS Agreements; Ethics in Biotechnology-Social responsibility and entrepreneurial discipline

**Suggested books [Latest edition]**

1. Demain AL and Solomon NA. Manual of Industrial Microbiology and Biotechnology.
2. Kankanala C Genetic Patent Law & Strategy, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K. Biotechnology and Intelectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S. IPR, Biosafety and Bioethics. Pearson
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

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| Lecture | Tutorial | Practical |
|---|---|---|
| 3 | 2 | 0 |

## COURSE MMB-EL-303: FOOD BIOTECHNOLOGY

**Maximum marks: 70** **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.

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**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, traditional and oriental fermented foods, microbial cells as food (single cell proteins, mushrooms), fermented beverages: beer and wine. Amino acid production: glutamic acid and lysine. Probiotics and prebiotics, nutraceuticals, low calorie sweetener, food coloring and naturally occurring flavor modifiers, Production of mushrooms – Production steps, harvesting and preservation and nutritive value

**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.

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**HIMACHAL PRADESH UNIVERSITY**
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| Lecture | Tutorial | Practical |
|---|---|---|
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## COURSE MBT-EL-304: BIOTECHNOLOGY IN DISEASE DIAGNOSIS

**Maximum marks: 70** **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**

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays, Monoclonal antibody therapy, RNA-baed therapeutics (SiRNA, CRISPER, RNAi), Applications of enzyme immunoassays in diagnostics.

**UNIT II** **12**

Applications of PCR, RT-PCR, RFLP, FISH, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology. Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

**UNIT 3** **10**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Immunodiagnostic tests. Immuno florescence, Radio-immunoassay, Immuno-histochemical staining, Blotting, Biosensors, Biological screening, Gene therapy, Lab and instruments management system (LIMS).

**UNIT 4** **11**

GLC, HPLC, FPLC, UPLC, Electron microscopy, flowcytometry and cell sorting, Mass spectroscopy, MALDI-TOF, Electrophoresis.

**Suggested books [Latest edition]**

1. Molecular diagnostics: George P. Patrinos
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA.. Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB. Zinsser Microbiology. 19th edition. AppletonCentuary-Crofts publication.
8. Microscopic Techniques in Biotechnology, Michael Hoppert

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| Total credits |
| --- |
| 35 |

## COURSE MBT-401: DISSERTATION AND VIVA-VOCE

**Maximum marks: 250**

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Each of the candidates will carry out the dissertation work assigned to him/ her. The candidate will submit three bound copies of the dissertation work performed by him/ her duly certified by the guide/supervisor. The dissertation should cover the abstract/ summary, introduction, materials and methods, results and discussion, and references. The candidate will deliver the seminar on his/her dissertation followed by viva-voce. 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

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

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

Website

www.elsevier.com