# GENERAL INSTRUCTIONS

# AND

# COURSE CURRICULUM

# FOR

# M. Sc. BIOTECHNOLOGY

## Effective from July, 2009

DEPARTMENT OF BIOTECHNOLOGY
HIMACHAL PRADESH UNIVERSITY
SUMMER HILL, SHIMLA-171005

Annexure-I

**TMENT OF BIOTECHNOLOGY**
**HAL PRADESH UNIVERSITY**
MER-HILL, SHIMLA-171005

## M.Sc. BIOTECHNOLOGY PROGRAMME

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 seventeen courses for M.Sc. Biotechnology programme. In the first semester, there will be five courses and in rest of the three semesters, there will be four courses per semester. Each course will consist of a theory and a practical paper except course I (remedial /course), course No. XV (Biobusiness Management) and course No. XVI (Special paper) will have only theory paper. Course No. XVII will consist of project report only.
3. 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
4. There will be 30 marks as an internal assessment in each course except course I (Remedial), Course XV (Biobusiness Management) and Course XVI (Special paper). A total of two internal assessment tests of 10 marks each will be held in a semester. For internal assessment, the concerned teacher will examine the students in his/her subject by giving multiple choice questions (MCQ) of ½ marks each 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) Without condonation of lectures upto 75% 1 mark; 76-80% lectures 2 marks, 81-85% lectures 3 marks; 86-90% lectures, 4 marks; 91% and above lectures 5 marks. However, for the course I (Remedial), Course XV (Biobusiness Management) and Course XVI (Special paper), the internal assessment will be of 20 marks. A total of two internal assessment tests of 7½ marks each (multiple choice questions (MCQ) of ½ marks each) will be held in a semester and remaining 5 marks will be for the class attendance.
5. The Chairman of the department will notify the date sheet for internal assessment tests 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 absence to the Chairman of the Department. Such cases will be discussed in the Departmental Council/Staff Council and if it finds the reason given by the student valid, it will recommend to the Chairman to allow the student to sit in such test separately.
6. In Minor Project, the students will write a review article on a topic of recent advances in biotechnology. Their respective project supervisors will decide the topic of the article. The students will have to submit the article by the date notified by the Chairman of the Department and the Departmental Council will evaluate these (30 marks). The students will have to deliver a seminar on his/her review article (20 marks). However, the candidates who can manage in-house training during the winter vacation (6 weeks) at other Institutions/Industries at their own will be encouraged by the Department of Biotechnology to undergo such training(s).
7. The project work will be in the specialized area of the Biotechnology. The project work will start from the third semester. The students will submit the project report by the due date as fixed by the Examination Branch. The Departmental Council

will evaluate these. There will be a viva-voce examination on the project report and training report by the Departmental Council. If the Chairman of the Department feels, he may invite an External Expert for evaluation of the Project Reports. The evaluation of the Project Report and Seminar will be of 60 and 40 marks, respectively.

8. Each student will have to deliver a seminar on the topic of his/her project work. The entire faculty of the Department will do the evaluation of the seminar.

9. The admission to M.Sc. Biotechnology programme of Himachal Pradesh University at campus will be through a Combined Entrance Examination conducted by Jawaharlal Nehru University (JNU), New Delhi 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 H. P. University will be through an entrance test conducted by H. P. University or as decided by H. P. 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 H. P. University norms.

10. The tuition fee and other monthly/annual charges will be as per University rules.

## URSES FOR M. Sc. BIOTECHNOLOGY

| Course No. | Title of course | Marks | | | Total Marks |
|---|---|---|---|---|---|
| | | Theory | Practical | Internal assessment | |
| ***Semester I*** | | | | | |
| I | Remedial course | 80 | - | 20 | 100 |
| | (1) Introductory Biology (for Non Biology students) | | | | |
| | (2) Introductory Mathematics (for Biology students) | | | | |
| II | Biochemistry | 70 | 50 | 30 | 150 |
| III | Microbiology | 70 | 50 | 30 | 150 |
| IV | Genetics and Molecular Biology | 70 | 50 | 30 | 150 |
| V | Instrumental methods of Analysis | 70 | 50 | 30 | 150 |
| **Total Marks in Semester I** | | 360 | 200 | 140 | 700 |
| ***Semester II*** | | | | | |
| VI | Recombinant DNA Technology | 70 | 50 | 30 | 150 |
| VII | Immunology and Immunotechnology | 70 | 50 | 30 | 150 |
| VIII | Plant Biotechnology | 70 | 50 | 30 | 150 |
| IX | Animal Biotechnology | 70 | 50 | 30 | 150 |
| **Total Marks in Semester II** | | 280 | 200 | 120 | 600 |
| ***Semester III*** | | | | | |
| X | Biochemical Engineering | 70 | 50 | 30 | 150 |
| XI | Fermentation Technology | 70 | 50 | 30 | 150 |
| XII | Enzyme Technology | 70 | 50 | 30 | 150 |
| XIII | Computer and Bioinformatics | 70 | 50 | 30 | 150 |
| | Minor Project | - | - | 50* | 50 |
| **Total Marks in Semester III** | | 280 | 200 | 170 | 650 |
| ***Semester IV*** | | | | | |
| XIV | Environmental Biotechnology | 70 | 50 | 30 | 150 |
| XV | Biobusiness Management | 80 | - | 20 | 100 |
| XVI | Special Paper (Any One) | 80 | - | 20 | 100 |
| | (1) Biocatalysis and Biotransformation<br>(2) Food Biotechnology<br>(3) Metabolic Engineering<br>(4) NanoBiotechnology | | | | |
| XVII | Research Project Report | - | - | 60* | 60 |
| | Seminar and Viva-Voce | - | - | 40* | 40 |
| **Total Marks in Semester IV** | | 230 | 50 | 170 | 450 |
| **Grand Total (Semester I-IV)** | | 1150 | 650 | 600 | 2400 |

* The Departmental Council will evaluate the Minor Project/Research Project Report and will conduct viva-voce examination of the students.

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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

### COURSE I (1): REMEDIAL COURSE- INTRODUCTORY BIOLOGY (for Non Biology students)

**Maximum Marks - 80** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**A. Elementary Biology**

1. Brief introduction about major microbial plant and animal groups. **4**

2. Level of organization in the living world. **2**

3. Cell structure and function of cell organelles, cell division: mitosis and meiosis. **9**

4. Physical and chemical basis of heredity, Mendel's laws. **3**

5. Gamete formation in plants and animals pollination, fertilization, and developments in plants, reproduction in animals. **3**

6. Photosynthesis, respiration, chemistry of biomolecules. **2**

7. Brief accounts of populations, communities, ecology, ecosystems and food chains. **2**

**B. Introduction to Biotechnology:**

1. Definition, History, Scope and Multidisciplinary nature of Biotechnology. **4**

2. Some important breakthrough in Biotechnology in **7**
   (i) Agriculture (ii) Food (iii) Medicine (iv) Environment

3. Applications of Biotechnology **2**

4. Current trends in Biotechnology-Major R&D institution & Biotechnology based industries . **4**

5. Scientific writing and presentation. **3**

**List of Books:**

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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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

### COURSE I (2): REMEDIAL COURSE- INTRODUCTORY MATHEMATICS (for Biology students)

**Maximum Marks - 80** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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1. Determinants: properties of determinants, Grammer rule. Matrices: types of matrices, addition, multiplication, inverse, solution of linear equation by matrix method. Integration: indefinite and definite integrats of functions of only one variable by method of substitution and integration by parts-simple cases. **8**

2. 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 **8**

3. Linear correlations: product moment coefficient of correlations, Spearmanôs rank difference correlation methods; Regression analysis: simple regression, regression lines, regression equations, regression equations in case of correlation tables. **7**

4. Probability distribution: addition and multiplication theorems, Bayes theorem, Bionomial, Poisson, and normal distribution. **6**

5. Parametric tests: F and T tests, $X^2$ test, $X^2$ test as a test of independence and goodness of test, experimental design. **6**

6. 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, difference between means. **5**

7. Analysis of variance: assumptions, techniques of analysis of variance, analysis of variance in one-way techniques. **5**

**List of Books:**

6. Systematic Modern Mathematics Part I and II: **L. R. Danda, G. K. Saini and Suranjan Saha**
7. Statistical methods**: S. P Gupta**

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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

## COURSE II : BIOCHEMISTRY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Amino Acids and Proteins :** **8**

Amino acids as building blocks of proteins, their structure, classification and chemical properties. Structure of peptide bond, organizational levels of protein structure. General reactions of amino acids, catabolism of amino acids. Assimilation of $NH_3$ (including urea cycle).

**2. Carbohydrates :** **8**

Classification, structure and properties of carbohydrates Glycolysis, TCA cycle, Pentose phosphate pathway, Gluconeogenesis, ETC and oxidative phosphorylation .

**3. Nucleic Acids and Porphyrins :** **10**

Structure and properties of nucleic acid bases, nucleosides and nucleotides, biologically important nucleotides, Physical and chemical properties of RNA/DNA. Hydrolysis of nucleic acids. Biosynthesis & degradation of purine and pyrimidine nucleotides. Biosynthesis of deoxyribonucleotides.

Structure, properties and classification of porphyrins. Porphyrin biosynthesis & degradation.

**4. Lipids:** **10**

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

**5. Enzymes:** **2**

Chemical Nature, Classification, Units of enzyme activity

**6. Vitamins and Coenzymes:** **7**

Chemistry and biochemical roles of water and fat-soluble vitamins and their coenzymes.

1. Principles of Biochemistry **: A. L. Lehninger, D.L. 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 Practical**

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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## COURSE III : MICROBIOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1.** Introduction to history of microbiology, methods of classification and major groups of microorganisms on the basis of rRNA cataloging. Concept of sterilization in microbiology. **6**

**2.** Ultrastructure of a bacterial cell, cyanobacteria and fungal cell. Brief introduction to viroids and virusoids (sub viral particles) **4**

**3.** 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. **6**

**4.** Concept of microbial growth, effect of environmental factors on growth such as salt concentration, pH, temperature etc., growth monitoring and characteristics. **6**

**5.** Microbial genetics and recombination: mutations, mutant screening, enrichment and selection, conjugation, transduction and transformation. **6**

**6.** Microbial metabolism: Emden Meyorhoff Parnas Pathways, 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. **6**

**7.** Virology: Overview of virus classification of animal, Titration of viruses, General structure and life cycle of bacteriophage, Hepatic virus (HAV, HAB, HAC), Dengue virus (Flavi virus), Bird flu virus (Avian influenza virus) **6**

**8.** Applications of following microorganisms in Biotechnology: *Aspergillus*, *Escherichia coli*, *Bacillus spp*., *Saccharomyces cerevesiae*, *Zymomonas*, *Streptomyces, spp*., *Pseudomonas*, *Spirulina*, *Frankia*, *Rhizobium* and *Agrobacterium*. **5**

**List of Book**

1. The Microbial World- **Stainer RY, Ingraham JL, Wheelis ML and Painter PR**
2. Introduction to Microbiology ï **Pelczar and Reid**
3. General Microbiology ï **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.

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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

## COURSE IV : GENETICS AND MOLECULAR BIOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Classical Concept of genetics** **6**

Law of inheritance, Genetic linkages, Sex linked inheritance, maternal inheritance, Alleles, Multiple alleles, Crossing over.

**2. Genetic Material** **12**

Structure and chemical composition of chromatin, DNA melting, Repetative DNA, COT-curve, C-value paradox, Mutation and mutagenesis, site directed mutagenesis, Mutation at the level of DNA, Mechanism of counter mutations, Uses of mutations.

**3. DNA Replication** **5**

Initiation of DNA replication, Unwinding of DNA, Elongation of strands, Discontinuous replication.

**4. Transcription and Genetic Code** **5**

Basics of transcription, Role of RNA, Transcription in prokaryotes and eukaryotes, Reverse transcription, Transcriptional signals, Genetic code.

**5. Translation** **6**

Polypeptide synthesis, Fidelity of translation, Inhibitors of translation, Post transcriptional and post translational modifications.

**6. Gene Induction and Repression** **7**

Promoter, terminator, Catabolite repression, lac operon, tryptophan operon, arabinose operon, Attenuation, Positive and negative control.

**7.** DNA damage and repair, DNA-protein and DNA-drug interactions, DNA Microarray technique. **4**

**List of Books**

1. Molecular Biology and Biotechnology-**C. A. Smith and E. J. Wood**
2. Molecular Biology- **G. M. Malacinski and D. Freifelder**
3. Genetics-**Strickberger**

1. To study different human phenotypic traits
2. To study multiple alleles in human (Blood Groups)
3. To study multiple alleles in plants (*Trifolium*)
4. To study cytoplasmic and nuclear inheritance on the basis of phenotypic characters
5. Isolation of DNA from *E. coli.*
6. Extraction of DNA from plant and animal cells
7. UV-absorbance of nucleic acids (hyper and hypo chromic effect) and quantification of nucleic acids and proteins.
8. Induction of β-galactosidase strain of *E. coli*.
9. Effect of protein synthesis inhibitors on the activity of β-galactosidase.
10. Melting temperature determination of DNA

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**SYLLABUS FOR M.SC. BIOTECHNOLOGY**

## COURSE V : INSTRUMENTAL METHODS OF ANALYSIS

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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1. 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. **6**

2. Electrophoresis: Paper and gel electrophoresis, Ferguson plots, Immuno-electrophoresis, isoelectric focussing, two-dimensional electrophoresis, capillary electrophoresis, western blotting and pulse field gel electrophoresis. **4**

3. Chromatography: Paper, TLC, Gas chromatography, gel filtration, ion-exchange chromatography, reverse phase chromatography, hydrophobic interaction and affinity chromatography, HPLC. **8**

4. Spectrophotometry, UV & Visible spectroscopy, spectrofluorimetry, Atomic absorption and atomic emission spectroscopy. **6**

**5.** Mass Spectrometry, NMR, Infrared and Raman Spectroscopy and their application. **4**

6. ORD and Circular dichorism. **2**

7. Electron Microscopy: Transmission and Scanning Electron Microscopy, Concept of Tunneling Electron Microscopy and Atomic Force Microscopy **6**

8. Radioisotope Techniques: Radio-tracers, interaction of radiation with matter, GM counter, Proportional and Scintillation counters, methods of quench correction auto-radiography, radioimmunoassay and enzyme linked immunosorbent assay. **6**

**9.** Florescent activated cell sorter (FACS) and Coulter counter. **2**

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 perform Native PAGE for a given protein mixture.
5. To perform SDS-PAGE for separation of proteins in a given sample.
6. To perform gel exclusion chromatography for the separation of serum proteins.
7. To perform DEAE anion exchange chromatography for the separation of human IgG.
8. To perform Protein A affinity chromatography for the separation of human IgG.
9. To separate phospholipids mixture by TLC.
10. Use of GLC for analysis of various alcohols.
11. To perform micro titer ELISA using human serum
12. To perform DOT-ELISA using human serum

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**SYLLABUS FOR M.SC. BIOTECHNOLOGY**

## COURSE VI : RECOMBINANT DNA TECHNOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Introduction** **2**

History and scope of Recombinant DNA Technology.

**2. Enzymology of Recombinant DNA** **6**

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.

**3. Isolation and Purification of nucleic acid** **4**

Basic techniques and considerations criteria of purity, isolation and purification of phage DNA plasmid, chromosomal DNA, RNA and mRNA.

**4. Cloning and expression vector** **6**

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

**5. Cloning and expression hosts** **2**

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

**6. DNA Cloning Strategies** **5**

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.

**7. Nucleic acid Blotting and Hybridization** **4**

Southern and northern blotting and hybridization techniques, radio active and non-radio active labeling of probe, western blotting.

**8. Expression of cloned genes** **4**

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

**9. Sequencing and other techniques** **4**

DNA, RNA and protein sequencing, RFLP, DNA finger and foot printing.

**nd site directed mutagenesis: 3**

olymerase chain reaction, site-directed mutagenesis and

**11. Impact of rDNA on human genetics 3**

Mapping & cloning of human disease genes, DNA based diagnosis, gene targetting, human genome project history and scope.

**12. Applications of r-DNA technology 2**

Application of genetic engineering in industry, agriculture and forensic science

**List of Book**

1. Recombinant DNA principles and Methodologies ï **James J. Greene**
2. Molecular Biotechnology ï **Glick and Pasternak**
3. Principles of Gene Manipulation ï **R. W. Old and S. B. Primrose**
4. Genetic Engineering Fundamentals ï **Kammermeyer and Clark**

**List of Practical**

1. Preparation and purification of pUC plasmid by alkaline lysis method.
2. Preparatin and purification of genomic DNA
3. Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
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 Temperature cycler.
8. RFLP, Preparation of sequencing gels
9. Assay of activity of restriction endonuclease and topoisomerase I.

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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

### COURSE VII : IMMUNOLOGY AND IMMUNOTECHNOLOGY

**Total Marks 70** **Teaching Hours 45**

**Note:** Examiner will set 9 (nine) questions covering all topics/sections of the syllabus. Out of the nine questions, there will be an objective type question covering the entire syllabus which will be compulsory. The students will attempt five questions including an objective type compulsory question. All questions will carry equal marks.

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**1.Basic Immunology** **12**

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

**2. Advanced immunology** **14**

Cellular and molecualr aspects:- nature of antigens, anjtibody structure, function and diversity, T-cell receptors, complement system , major histo-compatibility complex (MHC), MHC restriction, antigen presentation, lymphokines, regulation of immune response, immunological tolerance

**3. Immunological Techniques** **6**

Immuno diffusion, immunoelectrophoresis, ELISA

**4. Advanced Concepts and Topics** **8**

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

**5. Hybridoma Technology** **5**

Fusion of myeloma cells with lymphocytes, concept of trioma, hybrid-hybridoma and thymoma , production of monoclonal antibodies and their application

**List of Books**

1. Immunology - **Janis Kuby**
2. Essentials of Immunology (6th Edition)- **Ivan Roitt**
3. Cellular aaand Molecular Immunology - **Abul K. Abbas , Andrew H. Lichtman and Jordan S**
4. Immunology: An Introduction - **Ian R. Tizard**
5. A Handbook of Practical Immunology - **G.P. Talwar**

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.

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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

### COURSE VIII : PLANT BIOTECHNOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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| | | |
|---|---|---|
| **1.** | Introductory history, scope and application of plant biotechnology | **1** |
| **2.** | Plant Cell and tissue culture media,plant growth regulators in tissue culture-their use and preparation | **3** |
| **3.** | Cellular totipotency, Cytodifferentiation and morphogenesis | **3** |
| **4.** | Initiation of aseptic culture techniques, single cell and cell suspension culture, callus culture, protoplast culture and somatic hybridization | **7** |
| **5.** | *In vitro* and *in vivo* pollination and fertilization, embryo culture and embryo rescue, somatic embryogenesis, artificial seeds | **6** |
| **6.** | Doubled haploid production through distant hybridization, Androgenesis *(anther and pollen culture)* and Gynogenesis *(ovary and ovule culture)* | **6** |
| **7.** | *In vitro* clonal propagation and large scale production of plants through micropropagation - Prospects and problems, meristem tip culture, shhot tip culture and shoot tip grafting. | **6** |
| **8.** | Production of useful bio-chemical substances through tissue culture system, Scale-up through Bio-reactors | **3** |
| **9.** | Bioinsecticides, biopesticides and biofertilizers. | **3** |
| **10.** | Transgenic plant and their production | **3** |
| **11.** | Preservation of plant genetic resources: Germplasm collection and conservation | **2** |
| **12.** | Designing and erection of polutunnels, greenhouses. Acclimatization and hardening of micropropagated plants. | **2** |

plications 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 Engg. in Plants - **Mantell, Mathews & Mavkee**
5. Plant Cell Biology - A Practical Approach - **N. Harris & K J 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

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**SYLLABUS FOR M.SC. BIOTECHNOLOGY**

## CPURSE IX : ANIMAL BIOTECHNOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1.** 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. **5**

**2.** 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. **5**

**3.** Preservation and maintenance of animal cell lines, cryo-preservation and transport of animal germplasm (i.e. semen, ova and embryos). **5**

**4.** Concept of stem cells, tissue engineering and its application **5**

**5.** Production of monoclonal antibodies by hybridoma technique, scale up (*in vivo* and *in vitro*), brief concept of trioma and thymoma. **5**

**6.** Gene cloning techniques for mammalian cells, cloning in mammalian cells. **5**

**7.** Transgenic animals, *in vitro* fertilization and embryo transfer. Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy. **5**

**8.** Chemical carcinogenesis, transfection, oncogenes and antioncogenes **5**

**9.** Cell synchronization methods and their applications, Concept of idiotype/antoidiotype and their application **5**

### List of Books

**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 - **Butler M**
**5.** The Animal Cell Culture and Technology - **Butler M**
**6.** Culture of Animal Cells - **Freshney RT**

ure media and concept of sterilization in animal cell culture.

2. Subculturing and maintenance of continuous cell lines such as myeloma, Hep-2 and HeLa cells.
3. To generate a primary cell line from mouse skin (fibroblasts) or intraperitoneal cells.
4. To obtain spleenocytes and intraperitoneal 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.

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## COURSE X : BIOCHEMICAL ENGINEERING

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Microbial Growth Kinetics** **10**

Thermodynamic principles, Stationary cell 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.

**2. Product Kinetics** **2**

Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non-growth associated product synthesis

**3. Bioreactors** **6**

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

**4. Scale-up Studies** **4**

Translation of laboratory, pilot and plant scale data, Criteria for translation between two scale of operation, Scale-up practices, Bases for scale-up methods, Comparison of various scale-up methods, Nongeometric scale-up

**5. Bioreactor Control** **4**

Manual and automatic control system, on-line and off-line analytical instruments, methods of measurement of process variables, Data analysis and process control.

**6. Kinetics and Engineering of Sterilization** **5**

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.

**7. Mass Transfer in Microbial System** **8**

Fluids and its properties, Non-Newtonian fluids, introduction to tranport phenomena, Gasï liquid mass transfer, Intra-particle diffusion, Oxygen transfer and utilization in gassed microbial system, mass transfer resistances, Oxygen transfer rate and

mination of oxygen transfer coefficient, oxygen transfer enecks in bioprocesses, heat transfer in biological efficient correlations.

**8. Down Stream Processing** **6**

Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells, Super-critical fluid extraction, integrated product separation and purification.

## List of Books

1. Biochemical Engineering: **Aiba and Hemphery**
2. Biochemical Engineering Fundamentals: **J. E. Bailey and D. F.Ollis**
3. Principles of Microbes and Cell Cultivation: **S. John Pirt**
4. Bioprocess Engineering Principles: **Pauline M. Doran**
5. Principles of fermentation technology: **P.F. Stanbury and A. Whitekar**

## List of Practical

1. Microbial Growth kinetics-Determination of specific growth rate ($\mu_{max}$), saturation constant ($K_S$) and growth yield ($Y_{X/S}$) for *Saccharomyces cerevisiae* in batch culture.
2. Concentration of protein by ultrafiltration.
3. Determination of $K_La$ by sulphite oxidation method.
4. Determination of $K_La$ in a bioreactor by dynamic 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*

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## COURSE XI : FERMENTATION TECHNOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Fermentation** **10**

Definition and scope of fermentation, Isolation and preservation of industrial cultures, selection and design, Biochemical basis and overview of products based on enzyme catalysis and cell metabolism, Basic design and operation of fermenter, Economics of fermentation processes. Approaches for the genetic improvement of industrial organisms, chemically defined media for commercial fermentation

**2. Solid State fermentation** **8**

Advantages and disadvantages of solid state fermentation, Effect of environmental parameters on kinetics and growth of product formation and cellular physiology, Process variables and process control, Principles of solid state bioreactor design and operation and product leaching.

**3. Bio-Process Technology** **10**

Primary and secondary metabolites, Integrated process analysis of a few bio-process technology products like baker's yeast, ethanol, acetone, butanol, organic acids and enzymes.

**4. Health Care** **5**

Bio-process technology for the production of recombinant vaccines, therapeutic proteins, antibiotics and diagnostics.

**5. Energy** **6**

Energy forming bio-processes for the production of liquid fuel (ethanol), and gaseous fuel (methane), Microbial production of hydrogen.

**6. Advanced Control Strategies** **6**

Monitoring and control of environmental parameters in fermentation process, enzyme and microbial cell based bio-sensors.

**iba and Hemphery**
2. Principles of Microbes and Cell Cultivation: **S. John Pirt**
4. Industrial Microbiology: **L. E. Casida**
4. Industrial Microbiology: **Prescott and Dunn**
5. Principles of fermentation technology: **P.F. Stanbury and A. Whitekar**

**List of Practical**

1. Basic Design of a Laboratory Fermenter
2. Cleaning and sterilization of Fermenter Vessel.
3. Determination Growth Curve in a Batch Culture.
4. Determination of Viability of Cells in a Yeast Culture by Methylene Blue Staining, Plate Count and Haemocytometer Methods
5. Production of Ethanol by simple/complex carbohydrate sources (media) using *Sachharomyces cerevisiae*.
6. Production of Wine from Apple / Grape Juices by *Sachharomyces cerevisiae*.
7. Production of Citric acid by solid-state-fermentation using *Aspergillus niger.*

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## COURSE XII : ENZYME TECHNOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Introduction to enzyme and enzyme technology** **3**

History and scope of enzymes and enzyme technology, nomenclature of enzymes, enzyme activity units, enzyme business, major manufacturers of enzymes in India and World.

**2. Enzyme Kinetics** **5**

Activation Energy & Transition State concept. Mechanism of enzyme catalysis, simple kinetics of enzyme action, effect of pH, ionic strength, temperature and pressure on enzyme activity, reversible reaction, enzyme inhibition, determination of Vmax and Km values.

**3. Sources and preparation of enzymes** **6**

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.

**4. Large scale use of enzymes in solution:** **8**

Use of enzymes in detergents, food industry, fruit juice, wine, brewing and distilling industries, textile industries, pharmaceutical and chemical industries, application of enzymes in medicine

**5. Preparation and kinetics of immobilised enzymes:** **6**

Methods of immobilization of enzymes, Physical adsorption, covalent binding, entrapment and micro encapsulation, kinetics of immobilised enzymes, effect of solute partition and diffusion on the kinetics of immobilised enzymes

**6. Immobilised enzymes and their use:** **8**

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

4

analysis, biosensors- calorimetric, potentiometric, electric biosensors and immunosensors.

**8. Advanced topics in enzyme technology:** **5**

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.

**List of Books**

1. Enzyme Technology - **M.F. Chaplin and D.C. Bucks**
2. Industrial Enzymology ï **Godfrey and West**
2. Enzyme ï **Copeland**
4. Enzymes in Industry ï **W. Gerhartz**

**List of Practical**

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 and inhibitors.
5. Immobilization of enzymes/whole 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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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

### COURSE XIII : COMPUTER AND BIOINFORMATICS

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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1. Word processing using MS-Word, formatting the document, tables, mail merge and spell check **5**

2. Spreadsheets basics with MS Excel, labels, numerical and formula entries, basic mathematical and statistical functions, graphical representation of data **4**

3. Introduction to data structures and database concepts **3**

4. Basics of Microsoft Access: Databox wizard, creating fields, properties and tables, datanet records, sorting, queries, forms and records. **8**

5. Introduction to internet use and search engines: www, HTML, URLs, browsers: Netscape (opera) Explorer, Search engines: Google, PubMED, Sequence information sources (Structure and use on web): EMBL, GENBANK, Entrez, Unigene. Protein information sources (Structure and use on web): PDB, Swissprot, TrEMBL **8**

6. Sequence and phylogeny analysis: Detection of open reading frames (ORFs), gene identification and prediction, method of gene family identification, outline of sequence assembly, mutation matrices, pairwise alignments, introduction to BLAST (using it on web and interpreting results), multiple sequence alignment, phylogenetic analysis. **10**

7. Molecular modeling: introduction, dynamic simulation, conformational search, molecular modeling packages (Chem3D, Hyperchem), protein modeling, structure prediction and molecular docking. **7**

and Applications Genimics Proteomics and Drug Mendiratta, P. Rastogi, Prentice Hall of India Private Ltd
2) Bioinformatics: The Machine Learning Approach Pierre Baldi and Soren Brunak, MIT Press
3) Bioinformatics: A practical guide to the analysis of genes and proteins, Ed. By Baxvains
4) Bioinformatics online (Methods in Enzymology V. 266 computer method for macromolecular sequence) , Ed. By Doolittle, academic Press
5) Molecular Evolution: a phylogenetic approach, ROM and Holmas EC, Blackwell science
6) Bioinformatics: Sequences, structure and databanks, Des Higgins and Willie Taylor, Oxford University Press

**List of Practical**

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

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# SYLLABUS FOR M.Sc. BIOTECHNOLOGY

## COURSE XIV : ENVIRONMENTAL BIOTECHNOLOGY

**Maximum Marks - 70** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Environmental Biotechnology** **2**

Introduction, Basic concepts, Current status of biotechnology in environment protection.

**2. Environmental Pollution** **6**

Air, Water, Soil, Noise and Thermal pollution: Their source, Effect and biotechnology based control measures.

**3. Waste Water Treatment** **12**

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, toxic compounds and dissolved inorganic substances, Emerging biotechnological processes in waste water treatment.

**4. Environmental Microbiology** **10**

Microbiology of soil, air and water, Microbial Leaching and biomining, Recovery of metals from solutions, Microbes in petroleum extraction, Microbial desulfurization of coal, microbial transportation of toxic metals, Biodegradation of chlorinated hydrocarbons and xenobiotic compounds, pesticides, oil spills, and toxic dyes industrial effluents.

**5. Environmental Genetics** **5**

Molecular approach to environmental management, Degradative plasmids, Genetic exchange in xenobiotic chemicals.

**6. Global Environmental Problems** **5**

Ozone depletion, UV-B, Green house effect and acid rain, Their impact and biotechnological approaches for management.

**7. Waste Land** **5**

Uses and management, Bioremediation and biorestoration of contaminated lands.

1. Biotechnology and waste water treatment- **C. F. foster**
2. Environmental Biotechnology-**C. F. Foster and D. A. John Wase**
3. Waste water engineering, treatment and disposal-**Metcalf and Eddy**
4. Environmental Microbiology- **W. D. Grant and P. E. Long**

**List of Practical**

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.
7. Determination of COD of waste water samples.
8. Determination of rate of decomposition of organic matter.
9. Design and operation of multistage reactor for degradation of waste water.
10. Isolation and purification of degradative plasmids for aromatic compounds.

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## COURSE XV : BIOBUSINESS MANAGEMENT

**Maximum Marks – 80** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of the nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Introduction to Biobusiness** **10**

Principles of business management and concept of Biobusiness, SWOT analysis of Indian Biobusiness

**2. Project formulation** **4**

Project formulation and selection based on size, technological assessment, technical report, feasibility and commercial viability of project.

**3. Project cost and market potential** **7**

Total product cost, capital investment and profitability, manufacturing cost estimation, capital investment estimation, Risk capital and working capital, manufacturing cost estimation for an intracellular protein, using cost analysis for R & D decision making.

**4. Legal Protection in Biotechnology** **10**

Regulatory and IPR issues in Biotechnology, Intellectual Property Protection (IPP), Trade secret protection, licensing of bio-product, procedure for obtaining US patent, characteristics of the disclosure for a biotechnology invention, marketing a biotechnology invention, trade regulations.

**5. Bio-safety** **5**

General guidelines (GLP, GMP), containment facilities, types of containment, guidelines for recombinant DNA research, release of genetically modified organisms (GMOs)

**6.** ISO Series, GATT **4**

**7. Industrial Sickness** **3**

Symptoms, Control and rehabilitation and sick units.

**8. Ethics in Biotechnology** **2**

Statutory requirements of social responsibility and entrepreneurial discipline.

**List of Books:**

1. Patent Law - **P. Narayan**
2. Economic reforms and Indian markets - **S. L Rao**
3. Manual of Industrial Microbiology and Biotechnology - **A. L. Demain and N.A. Solomon**

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# SYLLABUS FOR M.SC. BIOTECHNOLOGY

## Special Paper

## COURSE XVI (1) : BIOCATALYSIS AND BIOTRANSFORMATION

**Maximum Marks - 80** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Introduction** **2**

General usage of biocatalyst, fermentation and applied biocatalysis.

**2. Biotransformation Reactions** **3**

Types of bioconversion reactions, Procedures for biotransformations, use of cells and enzymes for biotransformation, Genetic manipulations of organisms for biotransformation, Application of bioconversions.

**3.Transformation of Steroids or Sterols** **3**

Reaction types of microbial transformations from steroids, Microbial breakdown of sterol side chain.

**4. Transformation of non steroid compounds** **3**

L-Ascorbic acid, Dihydroxy acetone from glycerol, Prostaglandins, Hydantoinases, Carbamoylases, Catalytic antibodies

**5. Transformation of Antibiotics** **5**

Acylases and peptidases, Reaction of penicillin and cepharosporin substrates, Protection of amino groups

**6. Transformation of Pesticides** **4**

Accumulation of pesticides, Pesticides as carbon source, Conjugate formation

**7. Biotransformation of Nitrile group** **10**

Nitrile 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

**8. Biotransformation by Lipases** **10**

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 ans enatiomerically pure chemical and pharmaceutical intermediates)

sis, Microbial metabolism of tropane alkaloids, Morphine alkaloi biosynthesis, Transformation of morphine alkaloid by *Pseudomonas putida* M10, Microbial transformation of heroin

**List of Books**

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

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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

### Special paper

### COURSE XVI (2) : FOOD BIOTECHNOLOGY

**Maximum Marks - 80** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Food Fermentation Technology** **5**

Origin, scope, and development of fermented products, Primary feed stock, raw materials and conversions, Fermented food and microbial starters, Commercial potential, Food fermentation industries, their magnitude, R & D innovations

**2. Development of Novel Food and food Ingredients** **12**

Single cell protein, Polysaccharides, Low calorie sweeteners, Naturally produced flavor modifiers, Amino acids, Vitamins, Food supplements, Food coloring, Neutraceuticals, Water binding agents

**3. Bioreactors in Food Fermentations** **8**

Cultivation of microorganisms, Instrumentation regulation and process control, Laboratory scale submerged and solid state fermentation, Pilot scale submerged and solid state fermentation

**4. Food Spoilage and Preservation** **12**

General principle of spoilage, Microbial toxins (endotoxins and exotoxins), Contamination and preservation, Factors affecting spoilage, Methods of food preservation (Thermal processing, Cold preservation, Chemical preservatives, food dehydration, Food irradiation, Biological control), Monitoring of food quality

**5. Packaging of Food** **8**

Need for packaging, Reqiurements for packaging, Containers for packaging (Glass, Metal, Plastics, Moulded pulp and Aluminium foil), Dispensing devices

**List of Books**

1. Biotechnology: Food Fermentation Vol I and II, Eds. **V. K. Joshi and A. Pandey**
2. Food Processing: Biotechnological Applications- Eds. **S. S. Marwaha ans J. K. Arora**

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## SYLLABUS FOR M.SC. BIOTECHNOLOGY

### Special Paper

### COURSE XVI (3) : METABOLIC ENGINEERING

**Maximum Marks - 80** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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**1. Introduction to metabolic engineering:** **5**

Concept and importance of metabolic engineering, improvement of microbial strain and fermentation processes by metabolic engineering, tools of metabolic engineering.

**2. Regulation of metabolic pathways:** **5**

Regulation of enzyme activity, regulation of enzyme concentration, regulation of metabolic network.

**3. Metabolic engineering in practice:** **15**

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.

**4. Metabolic flux analysis:** **10**

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

**5. Application of metabolic flux analysis:** **10**

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

**List of books:**

**1.** Metabolic Engineering by **S. Y. Lee and E. P. Popoutsakis** (Eds), Marcel Dekker, New York, USA.

**2.** Metabolic Engineering by **G. N. Stephanopoulous, A. A. Aristidon, J, Neilson**, Academic Press, USA.

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# SYLLABUS FOR M.SC. BIOTECHNOLOGY

## Special Paper

## COURSE XVI (4) : NANOBIOTECHNOLOGY

**Maximum Marks - 80** **Teaching Hours - 45**

**Note** : Examiner will set 09 (nine) questions covering all topics / sections of the syllabus. Out of nine questions, there will be an objective type question covering entire syllabus which will be compulsory. The students will attempt five questions including the compulsory questions. All questions will carry equal marks.

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1. Introduction: Definition, interdisciplinary nature, learning from nature (linear and rotary molecular motors, abalone shells) and scope. **2**

2. Bionanostructures: a) Protein based nanostructures self assembly engineered nanopores, protein micro-arrays, magnetosomes, bacteriorhodopsin and their application. **5**

   b) 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. **5**

   c) Silica nanoparticles for analytical microbial biofilms structure and applications, artificial cells. **3**

   d) Nanostructured fluids and soft material: Applications in drug solubilization and delivery, nutraceuticals enhanced oil recovery, antimicrobial and cosmetic nanoemulsions, food colloids, templating of nanoparticles. **5**

3. DNA-Nanotechnology: Structural DNA assembly, nanopore DNA sequencing, DNA coupled to carbon nanotubes, DNA-modified surfaces, polyelectrolyte behavior in DNA, self assembling toroidal nanoparticles **5**

4. Applications of nanoparticles: Nanoparticles for biological assays, as drug delivery vehicles and as contrast agent. **5**

5. Application of nanotechnology/nanobiology/nanotechnology in biomineralization, medicine and surgery (stem cell biology, artificial organs, tissue engineering, cardiology and cardiac surgery, organ transplantation and cancer). **15**

rkin, C.A., Nanobiotechnology. Concepts. Applications & H-Verlag
2. Bauerlin, E., Biomineralization-From Biology to Biotechnology & Medical Applications. Wiley VCH-Verlag
3. Lyshevski, Sergey Edward, Nano & Microscience, Engineering Technology and Medical Series. CRC Press
4. Cao, G., Nanostructures and Nanomaterials. Imperial College Press
5. Ralph S. Greco, Fritz B. Prinz, R. Lane Smith. Nanoscale Technology in Biological Systems. CRC Press.

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## COURSE XVII : RESEARCH PROJECT REPORT

**Maximum Marks - 60**

Each of the candidates will carry out the project work assigned to him/her. The candidate will submit three bound copies of the research project work performed by him/her duly certified by the guide/supervisor. The project report should cover the 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

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. PhD Thesis, Himachal Pradesh University, Shimla, India.

Website

www.elsevier.com