REVISED

GENERAL INSTRUCTIONS
and
COURSE CURRICULUM

FOR

(PG Teaching Program in Biotechnology)

M.Sc. MICROBIOLOGY

(Effective from July, 2020)

DEPARTMENT OF BIOTECHNOLOGY

HIMACHAL PRADESH UNIVERSITY

(NAAC Accredited "A" Grade University)

SUMMERHILL – SHIMLA – 171005 (HP) – India

www.hpuniv.ac.in/biotech

Annexure-I

M.Sc. MICROBIOLOGY PROGRAMME

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

1. The M.Sc. Biotechnology program will be of two years duration spread over four semesters.
2. ***There will be sixteen (16) courses in M.Sc. Microbiology Programme***. In the 1st, 2nd and 3rd semesters, there will be five courses each. However, in fourth semester there will be only research work. Course-401 will consist of Dissertation, Seminar and viva-voce.
3. The distribution of marks in each course for theory, practical and internal assessment will be as per details given in the *OUTLINE OF COURSES FOR M.Sc.MICROBIOLOGY*.
4. The split for internal assessment except Course 101 and Elective course MMB-EL-301-303 will be: i) Two internal assessment tests of 10 marks each (20 Multiple choice question, each question shall carry 0.5 mark in each test) in each course. 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 condonation of lectures as per ordinances: zero mark, ii) without condemnation of lectures up to 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 the Course-MMB 101 (2) (Mathematics and Statistics) and Elective courses (MMB-EL-301-303), the internal assessment will be of 20 marks. A total of two Internal Assessment tests of 7.5 marks each (15 MCQ, each question will carry 0.5 marks in each Internal Assessment test) will be held in a semester AND remaining 5 marks will be for the class attendance as per criterion mentioned above.
5. For internal assessment, the concerned teacher will examine the students in his/ her subject by giving multiple choice questions (MCQ of 0.5 mark each) covering the syllabus/ topics taught in the classes. The Chairman of the Department/ Coordinator of the programme will notify the date sheet for Internal Assessment test(s) at the beginning of semester/ academic calendar. In case a student is absent in the internal assessment test, the student will explain in writing the reason for absence to the Chairman of the Department/ Coordinator of the programme. Such case(s), if any 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/ Coordinator of the programme to allow the student to sit in such test separately.
6. The candidate who regularly attends teaching/ practical classes and maintains 75% attendance in each of the courses/ practicals shall be permitted to sit in the semester examinations.
7. Any candidate who intends to participate in intra-university or inter-university cultural/ sports/ extracurricular function(s) shall get her/ his name recommended by the Chairperson/ Coordinator Microbiology Programme for being considered for any such participation(s) and benefit(s) if any, thereof.
8. The project work will be in the specialized area of the Microbiology. The research/ dissertation work (Course MMB-401) will start from the 3rd semester. The students will submit the dissertation by the due date as 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 Coordinator of the programme feels, he may invite an External Expert for evaluation of the dissertations. The evaluation of the dissertation and seminar/ viva voce will be of 150 and 100 marks, respectively.
9. The admission to M.Sc. Microbiology programme of Himachal Pradesh University at campus as well as admission to M.Sc. Microbiology programme offered by institutions affiliated to Himachal Pradesh University will be through a Combined Entrance Examination conducted by Himachal Pradesh University Shimla or as decided by Himachal Pradesh University from time to time.
10. Eligibility for admission will be Bachelor Degree under 10+2+3 pattern of Education in Sciences with any of the subjects *i.e.* Microbiology, Biochemistry, Biotechnology, Genetics and Molecular Biology, Botany or Zoology or MBBS/ B.V.Sc from any Institute/ University recognized by the Himachal Pradesh University, Shimla/ University Grant Commission, New Delhi with at least 50% marks OR a Degree of a University recognized as equivalent by the Vice-Chancellor for the purpose.
11. The tuition fee and other monthly/ annual charges will be as per University rules.

OUTLINE OF COURSES FOR M.Sc. MICROBIOLOGY

Course No.	Title of Course	Marks			
		Theory	Practical	Internal assessment	Total
Semester I					
MMB-101	Mathematics and Statistics [Common with M. Sc. Biotechnology course: MMB-101(2)]	80	-	20	100
MMB-102	Biochemistry [Common with M. Sc. Biotechnology course: MMB-102]	80	40	30	150
MMB-103	Bacteriology	80	40	30	150
MMB-104	Cell and Molecular Biology [Common with M. Sc. Biotechnology course: MMB-104]	80	40	30	150
MMB-105	Instrumental Methods of Analysis [Common with M. Sc. Biotechnology course: MMB-105]	80	40	30	150
Total Marks in Semester I		**400**	**160**	**140**	**700**
Semester II					
MMB-201	Recombinant DNA Technology [Common with M. Sc. Biotechnology course: MMB-201]	80	40	30	150
MMB-202	Immunology and Immunotechnology [Common with M. Sc. Biotechnology course: MMB-202])	80	40	30	150
MMB-203	Mycology and Phycology	80	40	30	150
MMB-204	Medical Microbiology	80	40	30	150
MMB-205	Virology	80	40	30	150
Total Marks in Semester II		**400**	**200**	**150**	**750**
Semester III					
MMB-301	Environmental Microbiology and Biotechnology [Common with M. Sc. Biotechnology course: MMB-301]	80	40	30	150
MMB-302	Industrial Microbiology	80	40	30	150
MMB-303	Computers & Bioinformatics [Common with M. Sc. Biotechnology course: MMB-303]	80	40	30	150
MMB-304	Enzyme Technology (Common with M. Sc. Biotechnology course: MMB-304)	80	40	30	150
Elective (any one)		80	-	20	100
MMB-EL-301	Metabolic Engineering [Common with M. Sc. Biotechnology course: MMB-EL-301]				
MMB-EL-302	Microbial Genomics & Proteomics				
MMB-EL-303	Food Technology (Common with M. Sc. Biotechnology course: MMB-EL-303)				
Total Marks in Semester III		**400**	**160**	**140**	**700**
Semester IV					
MMB-401	Dissertation	-	-	150	150
	Seminar and Viva-Voce	-	-	100	100
Total Marks in Semester IV		**-**	**-**	**250**	**250**
Grand Total (Semester I-IV)		**1200**	**520**	**680**	**2400**

***** The Departmental Council will evaluate the dissertation and will conduct seminar and viva-voce examination of the students.

COURSE No. : MMB-101	MATHEMATICS AND STATISTICS
Maximum marks: 80	Teaching hours: 45

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

UNIT I **16**

Determinants: properties of determinants, Grammar 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: L. R. Danda, G. K. Saini and Suranjan Saha.
2. Statistical methods: S. P Gupta.

COURSE No. : MMB-102	BIOCHEMISTRY
Maximum marks: 80	Teaching hours: 45

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

UNIT I **11**

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

UNIT II **12**

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

UNIT III **11**

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

UNIT IV **11**

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

Suggested books [Latest edition]

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

List of practicals

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

COURSE No. : MMB-103	BACTERIOLOGY
Maximum marks: 80	Teaching hours: 45

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

Unit I **11**

Morphology and ultra structure of bacteria – morphological types – cell walls of archaebacteria – gram negative – gram positive eubacteria, L-forms – cell wall synthesis, antigenic properties – capsule – types, composition and function, Structure and function(s) of flagella – cilia – pilli – gas vesicles – chromosomes, carboxysomes – magnetosomes and phycobolisomes – nucleoid – cell division – spores, Reserve food materials – polyhydroxybutyrate – polyphosphate granules – oil droplets – cyanophycin granules and sulphur inclusions.

Unit II **10**

Brief account of photosynthetic and accessory pigments – chlorophyll – bacteriochlorophyll – rhodopsin – carotenoids – phycobilliproteins; Carbohydrates – anabolism – autotrophy – oxygenic – anoxygenic photosynthesis – autotrophic generation of ATP; fixation of CO_2 – Calvin cycle – C3 – C4 pathway. Chemolithotrophy – sulphur – iron – hydrogen – nitrogen oxidations, methanogenesis – luminescence.

Unit III **12**

Cultivation of bacteria - cell division – aerobic – anaerobic – shaker – still – nutritional types – culture media used – growth curve – generation time – asynchronous – synchronous culture – measurement of growth, control of bacteria – physical and chemical agents – preservation methods, Endospore – structure – properties – germination, sporulation and morphogenesis, Dormancy.

Unit IV **12**

Classification of microorganisms – introduction – Haeckel's three kingdom concept – Whittaker's five kingdom concept – three domain concept of Carl Woese, Basis of microbial classification, Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology, cyanobacteria, prochlorons and cyanelles.

Suggested books [Latest edition]

1. Bergey's Manual of Systematic Bacteriology: P.H.A Sneath, N.S Mair, M. Elizabeth.
2. Stryer L. Biochemistry: W.H. Freeman Company, New York
3. General Microbiolgy, Macmillan Educational Ltd.
4. Fundamental Principles of Bacteriology: Stainer R Y, Ingharam JL, Wheelis ML, Painter PR
5. Biology of Microorganisms. Prentice Hall Int. Inc.: A.J. Salle, Brock T.D, Madigan M.T,
6. Microbiology, Mc Graw Hill: Pelczar M.J, Chan E.C.S, Kreig N.R.

List of practicals

1. Microscopy, Microscope and its operations, components, Microscope adjustments, Light sources, microscopic measurements, calibration: Types of microscope available, theory. Observation of various types of microbes under phase contrast, dark field and fluorescence.
2. Preparation of glassware, washing, sterilization techniques, wet heat, dry heat, filter types, laminar flow chamber types, CDC, safety levels.
3. Preparation of culture media, nutritional needs of microbes, dehydrated, selective, differential, autotrophic, heterotrophic. Culture techniques, adjustment of pH, buffers, pure culture techniques, preparation of slants, Sub-culturing.
4. Isolation and identification of bacteria and fungi.
5. Microbial growth measurements, cell count, turbidity measurements, percentage transmission, Optical density, serial dilution, standard plate count.
6. Morphological, nutritional and cultural characteristics of bacteria and identification of microbes: types of dyes, preparation, staining techniques, Gram, capsule, negative, flagella, spore and nuclear.

COURSE No. : MMB-104	CELL AND MOLECULAR BIOLOGY
Maximum marks: 80	Teaching hours: 45

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

UNIT I **12**

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

UNIT II **11**

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

UNIT III **11**

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

UNIT IV **11**

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

Suggested books [Latest edition]

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

List of practicals

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

COURSE No. : MMB-105	INSTRUMENTAL METHODS OF ANALYSIS
Maximum marks: 80	Teaching hours: 45

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

UNIT I **12**

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

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

UNIT II **12**

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

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

UNIT III **10**

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

UNIT IV **11**

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

Suggested books [Latest edition]

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

List of practicals

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

COURSE No. : MMB-201	RECOMBINANT DNA-TECHNOLOGY
Maximum marks: 80	Teaching hours: 45

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

UNIT I **11**

Introduction: History and scope of Recombinant DNA Technology

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

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

UNIT II **12**

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

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

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

UNIT III **11**

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

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

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

UNIT IV **11**

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

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

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

Suggested books [Latest edition]

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

List of practicals

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

COURSE No. : MMB-202	IMMUNOLOGY AND IMMUNOTECHNOLOGY
Maximum marks: 80	Teaching hours: 45

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

UNIT I **11**

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

UNIT II **12**

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

UNIT III **11**

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

UNIT IV **11**

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

Suggested books [Latest edition]

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

List of practicals

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

COURSE No. : MMB-203	**MYCOLOGY AND PHYCOLOGY**
Maximum marks: 80	**Teaching hours: 45**

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

Unit 1 **12**

Classification of fungi. General features, structure and cell differentiation (Hyphae and non-motile unicells, motile cells, spores, dormancy, growth of population and colonies). Life cycle of *Aspergillus*, *Penicillium*, Yeasts. Salient characteristics, nutrition, reproduction and significance of Myxomycotina (Plasmodiophomycetes, Myxomycetes); Mastigomycotina (Chytridiales, Peronosporales; Zygomycotina (Zygomycetes, Entomophthorales); Ascomycotina (Hemiascomycetes, Laboulberiomycetes); Basidiomycotina (Teliomycetes, Hymenomycetes); Deuteromycotina (Hypomycetes, Blastomycetes).

Unit 2 **11**

Heterothallism, sex hormones in fungi. Physiological specialization phylogeny of fungi, Lichens – ascolichens, basidiolichens, deuterolichens. Mycorrhiza – ectomycorrhiza, endomycorrhiza, vesicular arbuscular mycorrhiza. Effect of environment on fungal growth, prevention of fungal growth. Saprophytes, substrate groups and nutritional strategies substrate successions, fungal relationships with plants and animals. Fungi as insect symbiont, fungal diseases – mycoses systemic and subcutaneous, candidiasis, Pneumocystis, blastomyxoses, dermotophytosis.

Unit 3 **12**

Principles, criteria (pigments, flagellation, food reserve and eye spots) and systems of classification of algae. Cyanophyta: cell structure, heterocyst and akinete development, chromatic adaptation, thallus organization and reproduction. A brief account of thallus organization and reproduction in Chlorophyta, Phaeophyta and Rhodophyta; alternation of generation in Phaeophyta and post -fertilization development and site of meiosis in Rhodophyta. A brief account of Xanthophyta, Chrysophyta, Bacillariophyta, Pyrrophyta, Euglenophyta, Eustigmatophyta, Prasinophyta and Prochlorophyta

Unit 4 **10**

Distribution of algae, algal nutrition, algal thallus, algal reproduction, green algae, diatoms, euglenoids, brown *Rhodophyta*, *Pyrrophyta*, Algal ecology and algal biotechnology. Algae in diverse habitats, algal blooms and Phycoviruses. Algae as food, biofertilizers and source of phycocolloids. . Commercial potential of Spirulina, Dunaliella and Porphyra; hydrogen production by algae.

Suggested books [Latest edition]

1. Mehrotra RS and KR Aneja: An introduction to Mycology. New Age International publishers.
2. Introduction to Mycology: CJ Alexopoulos and CW Mims, Wiley Eastern Ltd, New Delhi.
3. Fundamentals of Mycology: JH Burnett, Publisher: Edward.
4. The Fungi: M. Charlile and SC Watkinson, Publisher: Academic Press.
5. Fundamentals of the fungi: E Moore – Landeekeer, Publisher: Prentice Hall.

List of practicals

1. Isolation of fungi by baiting method.
2. Culturing and morphological study of some common molds: *Rhizopus,Mucor, Penicillium, Alternaria, Trichiderma*
3. Identification of plat diseases: Apple scab, Citrus canker, Late blight of potato, Rust of wheat, Red rot of sugarcane, Green ear disease of Bajra, Leaf curl disease of peach
2. Morphological identification of mushrooms.
4. Study of mycorrhiza.
5. Study of the vegetative and reproductive feature of algae: *Oscillatoria, Spirogyra, Chlamydomonas, Spirullina, Nostac*
6. Isolation of algae from soil and water.
7. Cultivation of *Spirullina*.
8. Study of the symbiotic association of algae.

COURSE No. : MMB-204	MEDICAL MICROBIOLOGY
Maximum marks: 80	Teaching hours: 45

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

Unit I **10**

Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important microorganisms; Normal microbial flora of human body; role of resident flora; normal flora and the human host. Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressins, depolymerising enzymes, organotropisms, variation and virulence.

Unit II **12**

Classification of pathogenic bacteria: *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Cornebacterium, Bacillus, Clostridium,* Non sporing anaerobes, organisms belonging to *Enterobacteriacea*, Vibrios, Non fermenting Gram negative bacilli *Yersinia; Haemophilus; Bordetella, Brucella, Mycobacteria, Spirochaetes, Actinomycetes, Rickettsiae, Chlamdiae*

Unit III **10**

Brief account of protozoa (*Entamoeba, Giardia, Leishmani*a, *Trypanosoma, Plasmidium*) and helminths parasites (*Schistosoma, Taenia, Ascaris, Hookworms, Wuchereria*) of man and their diseases, Immunity to amoebasis, trypanosomiasis, leishmaniasis, malaria, filarasis, hookworm and ascariasis

Unit IV **13**

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules; passive prophylactic measures; nosocomial infections, common types of hospital infections, their diagnosis and control.

Suggested books [Latest edition]

1. Text of Microbiology: R. Ananthanarayanan and C.K.J. Panicker, Orient Longman.
2. Mackie and McCartney: Medical Microbiology Vol 1: Microbial infection, Vol 2: Practical medical microbiology. Churchill Livingstone.

List of practicals

1. Fixation of smears for microscopy by different staining techniques
   - Simple (Loeffer's polychrome methylene blue and Negative staining)
   - Gram's staining
   - Ziehl-Neelson method for AFB
   - Fluorochrome staining
   - Leishman's staining
   - Giemsa's staining
   - Special staining methods to demonstrate granules, capsules and spores
4. Isolation of pure cultures of normal flora of skin and their identification
5. Establishment of heamolytic activity of isolated bacteria
6. Testing of antimicrobial activity of skin on bacteria
7. Determination of dental caries susceptibility
8. Drug susceptibility testing by various methods

COURSE No. : MMB-205	VIROLOGY
Maximum marks: 80	Teaching hours: 45

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

Unit I **12**

General Virology: Brief outline on discovery of viruses, nomenclature and classification of viruses; distinctive properties of viruses; morphology and ultrastructure; capsids and their arrangements; types of envelopes and their composition-viral genome, their types and structures; virus related agents (viroids).

Unit II **10**

Bacterial Viruses: Bacteriophage structural organization; life cycle; one step growth curve; transcription; DNA replication; eclipse phase; production; burst size; lysogenic cycle; bacteriophage typing; application in bacterial genetics; brief details on M13, Mu, T3, T4 and Lambda P1.

Unit III **12**

General Methods of Diagnosis and Serology: Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; primary and secondary cell cultures; suspension cell cultures and monolayer cell cultures, Virus isolation, purification and virus titration, Quantification of cytopathic effect(s).

Unit IV **11**

Animal Viruses: Infectivity assay (plaque method, end point method), virus titration by Reed and Muench method Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA virurses: Picorna, Orthomyxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40 and Hepatitis viruses. Interferons and antiviral drugs.

Suggested books {latest edition]

1. Medical virology: Morag C and Timbury MC, Churchill Livingstone, London.
2. Introduction to Modern Virology: Dimmock NJ, Primrose SB, Blackwell Scientific Publications, Oxford.
3. Virology: Conrat HF, Kimbell PC and Levy JA: Edition Prentice Hall, Englewood Cliff, New Jersey.
4. Functional of plant virology: Mathews, RE, Academic Press, San Diego.
5. Diagnostic procedures for Viral and Rickettsial diseases: Lennetter, EH, American Public Health Association, NY.

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, Vero and HeLa cells].
3. Propagation of animal viruses using cell lines.
4. Detection of Hepatitis/ HIV using ELISA method.
5. Propagation of animal viruses using egg inoculation techniques.
6. Tissue culture and serological methods for identification of viruses.
7. Staining of smear and tissue sections for viruses and their effects.
8. Isolation and propagation of λ phage.
9. Detection of plant viruses with indicator hosts.
10. Physical characterization of plant viruses.
11. Infectivity assay of plant viruses.

COURSE No. : MMB-301	ENVIRONMENTAL MICROBIOLOGY & BIOTECHNOLOGY
Maximum marks: 80	Teaching hours: 45

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

UNIT I **12**

Aerobiology: Brief account of air borne transmission of microbes – viruses – bacteria and fungi, their diseases and preventive measures. Assessment of air quality. **Aquatic microbiology:** Water ecosystems – fresh water and marine habitats. Potability of water – microbial assessment of water quality, brief account of major water borne diseases and their control measures. **Soil** Microbiology: Classification of soils – physical and chemical characteristics, microflora of soil, a brief account of microbial interactions symbiosis – mutualism – commensalisms – competition – amensalism – synergism – parasitism – predation; Biogeochemical cycles (C, N, P & S).

UNIT II **11**

Solid Waste treatment: Wastes–types, characterization, solid waste treatment, saccharification, gasification, composting, utilization of solid wastes, foods (SCP, mushroom, yeast); fuel (ethanol, methane) and , Biofertilizers, compost, vermicompost.

UNIT III **11**

What is waste water? Waste water quality parameters, Objectives of waste water treatment, Aerobic treatment of waste water (Trickling Filters, Rotating Biological Contactors, Fluidized bed reactors, Activated Sludge, Oxidation Ponds), Anaerobic treatment of waste water (Anaerobic Contact Digesters, Packed Bed Reactors, Anaerobic Baffled Digesters, Up-flow Anaerobic Sludge Blanket Reactors), Advanced waste water treatment for removal of suspended solids, nutrients (N &P), oil and grease and dissolved inorganic substances, Emerging biotechnological and nanotechnological processes in waste water treatment.

UNIT IV **11**

Air, Water, Soil, Noise and Thermal pollution. Ozone depletion, Green house effect and acid rain. Bioremediation and biorestoration of contaminated lands. Bioaccumulation and biosorption of metals and biodegradation of pesticides; biodeterioration of paper leather, wood and textiles. Microbial Leaching and biomining, Microbes in petroleum extraction, Microbial desulfurization of coal, Biodegradation of chlorinated hydrocarbons and xenobiotic compounds. Molecular approach to environmental management, degradative plasmids, genetic exchange in xenobiotic chemicals, GMO and their impact on environment.

Suggested books [Latest edition]

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

List of practicals

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

COURSE No. : MMB-302	INDUSTRIAL MICROBIOLOGY
Maximum marks: 80	Teaching hours: 45

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

Unit I

Overview of industrial microbiology, Biotechnological innovations in the chemical industry, Industrial strains-Strategies for isolation, screening & selection, maintenance & preservation of industrially important microorganisms, approaches for the genetic improvement of industrial organisms, microbial growth kinetics, measurement of growth (cell number, direct and indirect methods), efficiency of growth and product formation, effect of environmental factors on growth, maintenance energy requirement and maximum biomass, growth yield, metabolite overproduction and growth efficiency.

Unit II

Media formulation. Sterilization, kinetics of thermal death of microorganisms, batch and continuous sterilization. Basic design and operation of fermenter, stirred tank, airlift fermenter, batch, fed batch, continuous and immobilized cell reactors. Aeration and agitation, power requirement, oxygen transfer kinetics, concepts of fluids-types and properties.

Unit III

Metabolic pathways and metabolic control mechanism, biocatalyst in organic chemical synthesis, industrial production of citric acid, enzymes, ethanol, biofuels, acetic acid, fermented food/beverages, Biopolymers. Bio-process technology for the production of recombinant vaccines, therapeutic proteins, antibiotics and diagnostics.

Unit IV

Large-scale production of protein/enzyme using recombinant microorganisms. Scale-up, economics of industrial processes-Total product cost, capital investment and profitability, Monitoring and control of environmental parameters in fermentation process, biosensors, downstream processing. Regulatory and IPR issues, Intellectual Property Rights, Licensing and Patenting of bio-product, GLP and GMP guidelines in fermentation processes.

Suggested books [Latest edition]

1. Biotechnological innovations in chemical synthesis: BIOTOL. Publisher.
2. Industrial microbiology: G Reed, CBS Publishers.
3. Biology of industrial microorganisms: A L Demain.
4. Principles of fermentation technology: Stanbury, Whitaker and Hall.
5. Fermentation: A practical approach. IRL.

List of practicals

1. Design and operation of a laboratory fermenter.
2. Determination of viability of cells in a yeast culture by Methylene Blue staining, plate count and Haemocytometer methods
3. Preparation of microbial growth curve in a batch culture.
4. Concentration of protein by ultra-filtration.
5. Determination of K_La by sulphite oxidation method.
6. Determination of thermal death rate constant and decimal reduction time for *E. coli*.
7. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein.
8. Production of Ethanol by simple/complex carbohydrate sources (media) using *Sachharomyces cerevisiae*.
9. Determination of quality of milk sample by methylene blue reduction test
10. Production of wine from Apple / Grape juices by *Sachharomyces cerevisiae*.

COURSE No. : MMB-303	COMPUTER AND BIOINFORMATICS
Maximum marks: 80	Teaching hours: 45

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

UNIT I **14**

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

UNIT II **11**

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

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

UNIT III **10**

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

UNIT IV **10**

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

Suggested books [Latest edition]

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

List of practicals

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

COURSE No. : MMB-304	ENZYME TECHNOLOGY
Maximum marks: 80	**Teaching hours: 45**

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

UNIT I **11**

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

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

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

UNIT II **10**

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

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

UNIT III **11**

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

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

UNIT IV **11**

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

Suggested books [Latest edition]

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

List of practicals

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

ELECTIVE PAPER(S)

COURSE No. : MMB-EL-301	METABOLIC ENGINEERING
Maximum marks: 80	Teaching hours: 45

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

UNIT I **10**

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

UNIT II **15**

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

UNIT III **10**

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

UNIT IV **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 ob lactic acid bacteria, riboflavin production by *Bacillus subtilis*, metabolic engineering of *Saccharomyces cerevisiae*.

Suggested books [Latest edition]

1. Metabolic Engineering: S Y Lee and E P Popoutsakis (Eds), Marcel Dekker, New York, USA.
2. Metabolic Engineering: G N Stephanopoulous, AA Aristidon and J Neilson, Academic Press, USA.

COURSE No. : MMB-EL-302	MICROBIAL GENOMICS & PROTEOMICS
Maximum marks: 80	Teaching hours: 45

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

Unit 1 **10**

Whole genome analysis, preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing, conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing.

Unit II **11**

Sequence analysis: computational methods, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure/function (PROSITE, PFAM, ProfileScan), DNA analysis for repeats (direct and inverted), palindromes, folding programmes. Use of Internet, public domain databases for nucleic acid and protein sequences (EMBL, GenBank), database for protein structures (PDB).

Unit III **12**

DNA microarray, printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expression using fluorescent labeled cDNA or end labeled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips.

Unit IV **12**

Proteome analysis: Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarray. Advantages and disadvantages of DNA and protein microarrays.

Suggested books [Latest edition]

1. The internet and the new biology - Tools for genomic and molecular research: Peruski Jr and Peruski.
2. DNA microarrays - A practical approach: Edited by Mark Schena.

COURSE No. : MMB-EL-303	FOOD TECHNOLOGY
Maximum marks: 80	**Teaching hours: 45**
Note: **The Examiner will set a total of nine (9) questions** covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks	

Unit I **10**

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

Unit II **12**

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

Unit III **13**

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

Unit IV **10**

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

Suggested books [Latest edition]

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

List of practicals

1. Microbiological examination of foods
2. Detection of number of bacteria in milk by standard plate count (SPC).
3. Determination of quality of milk sample by methylene blue reduction test
4. Microbiological assay of toxins
5. Detection of nicotinic acid by bioassay
6. Role of yeast in bread making
7. Production of wine from Apple / Grape juices by *Sachharomyces cerevisiae*.
8. Bio-transformation of sucrose into high fructose syrup by immobilized cell of *Saccharomyces cerevisiae.*

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

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

Referred Journal

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

Books

Demartino GN (1996). Purification of proteolytic enzyme. In: Proteolytic enzyme: a practical approach. Berjnon RJ and Bond JS (Ed. Or Eds.), IRL Press, New York, pp 120-180.

Theses

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

Website

www.elsevier.com

***** The Departmental Council will evaluate the dissertation and will conduct seminar and viva-voce examination of the student(s). The dissertation and viva-voce will carry 250 marks.