B.Sc. Industrial Microbiology (H) (6 semester duration)

Course Structure

First Semester

Course Code	Course title	Credit Hrs.
BTM -111	Biochemistry-I	3+0
BTM -112	Microbiology-I	3+0
BTM -113	Cell Biology	3+0
BTM -114	Biochemistry lab-I	0+2
BTM -115	Microbiology lab-I	0+2
BTM -116	Cell biology lab-I	0+2
BTM -117	Cell metabolism	3+0
BTM -118	Basic English	0+0

Second Semester

Course Code	Course title	Credit Hrs.
BTM -121	Biochemistry -II	3+0
BTM -122	Genetics	3+0
BTM -123	Microbiology-II	3+0
BTM -124	Biochemistry lab-II	0+2
BTM -125	Microbiology lab-II	0+2
BTM -126	Cytogenetics lab	0+2
BTM -127	Recombinant DNA Technology	3+0
BTM -128	Advanced uses of Computer	0+0

Third Semester

Course Code	Course title	Credit Hrs.
BTM -211	Molecular Biology	3+0
BTM -212	Biophysical chemistry	3+0
BTM -213	Instrumentation	3+0
BTM -214	Molecular biology lab	0+2
BTM -215	Biophysical techniques	0+2
BTM -216	Instrumentation lab	0+2
BTM-217	Plant and Animal Tissue Culture	3+0

Fourth Semester

Course Code	Course title	Credit Hrs.
BTM -221	Genetic engineering	3+0
BIM-222	Microbial Physiology & Metabolism	3+0
BTM -223	Immunology	3+0
BTM -224	Genetic engineering lab	0+2
BTM-225	Immunology lab	0+2
BIM -226	Microbial Physiology and metabolism lab	0+2
One month mandatory Industrial summer internship		

Fifth Semester

Course Code	Course title	Credit Hrs.
BIM-311	Medical Microbiology	3+0
BIM-312	Industrial Microbiology	3+0
BTM-313	Biostatistics and Bioinformatics	3+0
BIM-314	Medical Microbiology lab	0+2
BTM-315	Biostatistics, Computer application & Bioinformatics lab	0+2
BTM-316	Basic Fermentation technique	3+0
BIM-317	Industrial Microbiology lab	0+2

Sixth Semester

Course Code	Course title	Credit Hrs.
BIM-321	Food and dairy microbiology	3+0
BIM-322	Environmental Biotechnology, Bioethics, Legal Issues and Patenting	3+0
BIM-323	Microbial Biotechnology	3+0
BIM-324	Food and dairy microbiology/ lab	0+2
BIM-325	Microbial biotechnology lab	0+2
BIM-326	Project work	0+6

SEMESTER I

BTM -111: Biochemistry I (3+0)

1. Basic chemistry of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids
2. Amino acids: Classification and properties
3. Proteins: Classification based on structure and functions, structural organization of proteins (primary, secondary, tertiary and quaternary structures).
4. Photosynthesis: Structure of photosynthetic apparatus, Light and Dark reactions, C_3 and C_4 cycle
5. Lipids: Structure, properties, classification and functions

BTM -112: Microbiology I (3+0)

1. History of microbiology, Scopes in microbiology, Concept of microbial diversity
2. Microscopy: Fluorescence, Phase contrast, Electron Microscope
3. Introduction to eubacteria, archaea, Marine resource and diversity and eukaryotic microorganisms
4. Structural differences between Gram positive, Gram negative and archaea cells
5. Microbial growth: batch, continuous and synchronized cultures
6. Microbial nutrition: phototrophs, chemotrophs, heterotrophs
7. Microbial Media: simple, differential and selective
8. Pure culture technique: Isolation, preservation and maintenance of culture

BTM -113: Cell Biology (3+0)

1. Introduction: the Cell theory, structural organization of a prokaryotic and eukaryotic cell.
2. Plasma membrane: structural organization, function, transport across the membrane.
3. Cellular organelles: structure and functions of rough and smooth endoplasmic reticulum, Golgi complex, Protein Trafficking, Lysosome, Peroxisome, Vacuoles, Mitochondria, Chloroplast.
4. Nucleus and nucleolus, chromatin structure and organization
5. Cytoskeleton and extra cellular matrix
6. Cell divisions: Cell cycle and control of cell cycle, cell death (apoptosis and necrosis), cancer.

BTM - 114: Biochemistry lab-I (0+2)

1. Units of Biochemistry
2. Instruments/Equipments and Glass Ware Used in Biochemical Laboratory
3. Concentration of Solution
4. pH and It's determination
5. Buffer and It's uses
6. Qualitative tests of Carbohydrate
7. Estimation of glucose by O-Toluidine method.
8. Qualitative test of Amino acids
9. Qualitative test of Protein.
10. Estimation of Protein by Biuret method.
11. Titration of Mixture of strong and weak acids
12. Paper chromatography

BTM - 115: Microbiology lab-I (0+2)

1. Introduction To The Microbiology Laboratory
2. Microscope And Microscopy
3. How To Use Microscope
4. Control Of Microorganisms
5. Preparation Of Culture Media
6. Pure Culture Techniques
7. Isolation Of Pure Culture
8. Sampling Of Microorganism
9. Preparation Of Bacterial Smear
10. Morphological Characteristics Of Bacteria
11. Cultural Characteristics Of Bacteria
12. Simple Staining
13. Negative Staining Of Bacteria
14. Differential Staining Of Bacteria
15. Special Staining Of Bacteria (Endospore Staining)
16. Special Staining Of Bacteria
17. Motility Test By Hanging Drop Technique
18. Calibration Of Micrometer
19. Measurement Of Microorganism By Using Ocular Micrometer

BTM - 116: Cell biology lab (0+2)

1. Laboratory Safety

2. Osmotic Haemolysis
3. Plasmolysis: Study of plant cell in hypertonic solution
4. Study of plant cell types by cell maceration
5. Pipetting: Using micropipettors
6. Counting and determination of cell viability using haemocytometer
7. Paper chromatography
8. Mitosis in onion root tip cells
9. Meiotic cell Division in flower bud.

BTM – 117: Organic mechanism in biology (3+0)

1. Common Mechanisms in Biological Chemistry – Overview of Digestion, Absorption, Metabolism (Anabolism & Catabolism), Nutrition, Respiration, Excretion.
2. Carbohydrates metabolism: Glycolysis, Kreb's Cycle and Oxidative Phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Glyoxylate cycle.
3. Lipid Metabolism – Structures and roles of Fatty acids &Glycerols, beta oxidation of saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, energy yield, ketone bodies.
4. Amino acid Metabolism – Amino acid breakdown (amino acid deamination, Urea cycle, metabolic breakdown of individual amino acids – glucogenic&ketogenic amino acids), amino acids as biosynthetic precursors (haem biosynthesis & degradation, biosynthesis of

epinephrine, dopamine, seretonin, GABA, histamin, glutathione); biosynthesis of essential & non-essential amino acids.

5. Nucleotide Metabolism – biosynthesis of purine & pyrimidine (de novo & salvage pathway); degradation of purine & pyrimidine.

BTM – 118: Basic English (0+0)

BOOKS

CELL BIOLOGY

1. Molecular Biology of cell – Bruce Alberts *et al*., Garland Publications
2. Animal Cytology and Evolution – MJD, White Cambridge University Publications
3. Molecular Cell Biology – Daniel, Scientific American Books.
4. Cell Biology – Jack D.Bruke, The William Twilkins Company.
5. Cell Biology – Ambrose and Dorouthy M Hasty, ELBS Publications.
6. Fundamentals of Cytology – Sharp, Mc Graw Hill Company
7. Cytology – Wilson and Morrison, Reinform Publications

MICROBIOLOGY

1. Microbiology – Pelzer, Chan, Krieg, Tata McGraw Hill Publications.
2. Microbiology – Concepts and Application by Paul A.Ketchum, Wiley Publications
3. Fundaments of Microbiology- Frobisher, Sauders and toppan Publications.
4. Microbiology - Ronald M.Atlas
5. Introductory Biotechnology – R.B. Singh C.B.D. India (1990)
6. Industrial Microbiology – Casidal. E.Wiley Eastern Ltd.
7. Fundamentals of Bacteriology – Salley
8. Frontiers in Microbial technology – P.S.Bisen, CBS Publishers
9. General Microbiology- C.B.Powar, H.F. Daginawala, Himalayan Publishing House

BIOCHEMISTRY

1. Principles of Biochemistry- AlbertL. Lehninger CBS Publishers & Distributors
2. Biochemistry – Lubert Stryer Freeman International Edition.
3. Biochemistry – Keshav Trehan Wiley Eastern Publications
4. Fundamental of Biochemistry – Dr. A.C.Deb
5. Biochemistry- L.U. Satyanarayana, Books and Allied Pvt. Ltd.
6. Outlines of Biochemistry- Conn and Stumpf, Wiley Eastern Ltd., New Delhi.
7. Biochemistry-Voet and Voet, John Wiley and Sons.
8. Biochemical Methods- S. Sadasivam and A. Manickam, New Age International Publishers, New-Delhi.
9. Laboratory Manual in Biochemistry- J. Jayaraman, New Age International Publishers, New-Delhi.
10. Text Book of Practical Plant Chemistry- A. Buzarbarua, S. Chand and Co. New Delhi.

SEMESTER II

BTM -121: Biochemistry –II (3+0)

1. Human hormones: protein and steroid hormones, mechanism of hormone action.
2. Plant hormones: auxins, gibberellins, cytokinins, ethylene, abscisic acid
3. Vitamins: water and fat soluble vitamins, dietary source and deficiency syndromes
4. Enzymes: Classification, catalysis, mechanism of enzyme action, factors influencing enzyme activity, immobilization of enzymes, co-enzymes and cofactors, Isozymes.
5. Nitrogen metabolism and fixation of nitrogen in leguminous plants
6. Contractile protein, neurotransmitter

BTM -122: Genetics (3+0)

1. Mendel's laws of inheritance
2. Extension of Mendelism: Incomplete dominance, co-dominance, pleiotropy, multiple allelism, complementation and epistasis,
3. Linkage and crossing over
4. Sex determination and sex linked inheritance
5. Numerical and structural changes in chromosomes
6. Mutation and mutagenesis
7. Extra-nuclear inheritance
8. Population genetics: Hardy-Weinberg equilibrium, maintenance and establishment of the equilibrium

BTM -123: Microbiology II (3+0)

1. Bacterial genetics: conjugation, transformation and transduction
2. Microbial metabolism: photosynthesis, assimilation of inorganic nitrogen, phosphorous and sulphur
3. Viruses: Basic structure, classification, bacteriophages, lytic and lysogenic cycle, Viriods and prions.
4. Plant Microbe interactions
5. Mycoplasmas, Rickettsiae and Chlamydiae
6. Microbes and public health: Enterobacterioceae, Mycobacterium, Gonococci, Candida, Aspergillus, Variola, Varicella-Zoster, etc.
7. Microbes and pharmaceutical industry

BTM - 124: Biochemistry lab II (0+2)

1. Extraction and quantification of total lipids.
2. Estimation of Vitamin C from plant samples.
3. Preparation of starch from Potato and its hydrolysis by salivary amylase. Test of salivary amylase.
4. Estimation of total Protein (Lowry's method).
5. Preparation of acetate and phosphate buffers with different pH.
6. Extraction of casein from milk.
7. Effect of temperature / pH on enzyme activity
8. Assay of alkaline phosphatase.

BTM - 125: Microbiology lab II (0+2)

1. Generation time of bacteria(Growth curve)
2. Most probable number(MPN) of Coliforms in water
3. Isolation of pure culture by streak plate
4. Isolation of pure culture by pour plate method
5. Isolation of pure culture by pour plate method
6. Cultivation of anaerobes
7. Isolation and culture of rhizobium
8. Isolation and identification of *E.coli* from given water sample
9. Detection of extracellular bacterial enzyme production
10. Isolation of slime moulds
11. Antibiotic sensitivity testing
12. Germicidal effect of UV light on bacterial growth

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BTM - 126: Cytogenetics lab (0+2)

1. Basic sterilization techniques required for Media preparation & Cytological techniques.
2. Media preparation technique.
3. Blood Typing
4. Enumeration of WBC and RBC
5. Mitosis in hordeum vulgare
6. Mitotic aberration
7. Isolation of Lymphocytes
8. Demonstration of banding and Karyotyping with permanent slides.

BTM - 127: Recombinant DNA Technology (3+0)

1. Gene Recombination and Gene transfer : Bacterial Conjugation, Transformation, Transduction, Episomes, Plasmids, Microinjection, Electroporation, Microprojectile, Shot Gun method, Ultrasonication, Liposome fusion, Microlaser.
2. Polymerase chain reaction (PCR), RT-PCR
3. Changing genes: site-directed mutagenesis and Protein engineering: Primer extension is a simple method for site directed mutation, PCR based site directed mutagenesis, Random mutagenesis, Use of Phage display techniques to facilitate the selection of mutant peptides, Gene shuffling, production of chimeric proteins.
4. Molecular Markers – RFLP, RAPD, AFLP
5. Molecular detection techniques - Southern, Northern and Western hybridization.

BTM - 128: Advanced uses of Computer (0+0)

1. History and Generation of computer:-1st to 4th generation with their characteristics.
2. Basic concepts of computer
3. Introduction, different components of computer, basic design of computer.

4. Computer architects
5. Introduction to operating system
6. Algorithm and flow chart
7. Execution of a Program- spread sheet; data based concepts using MS-EXCEL, MS-POWER POINT and MS-WORD, Networking; LAN,MAN and WAN
8. Introduction to OS
9. Memory management –Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory.

BOOKS
GENETICS
1. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley and Sons Publications.
2. Genetics- M.W. Strickberger, Prentice Hall of India Pvt. Ltd., New- Delhi.
3. Fundamentals of Genetics- B.D. Singh

SEMESTER III

BTM -211: Molecular Biology (3+0)

1. Nucleic Acids: Nucleic acid as the genetic material, structure and aggregation of DNA and RNA, DNA double helix, different conformations of double helix, DNA supercoiling, denaturation and renaturation of DNA, C-value paradox, Cot value and curve, chemical complexity
2. DNA replication, DNA damage and DNA repair (SOS and excision repair)
3. Homologous recombination, site specific recombination and transposons
4. Transcription in prokaryotes and eukaryotes
5. Regulation of gene expression in prokaryotes: *lac* and *trp* operons
6. Genetic code
7. Translation in prokaryotes and eukaryotes

BTM -212: Biophysical Chemistry (3+0)

1. pH and Buffers
2. Chemical bonding: Ionic bond, covalent bond, hydrogen bond, peptide bond, Vander-Waals forces
3. Properties of water
4. Thermodynamics- the First law of thermodynamics, concept of internal energy, the Second law of thermodynamics, free energy, enthalpy, entropy, free energy in biochemical reactions, and in transport of non-ionic and ionic substances across the biological membranes.
5. Nucleic Acids: structure and aggregation of DNA and RNA, DNA double helix, different conformations of double helix, DNA supercoiling.
6. Concept of Protein folding: hydrophilic and hydrophobic amino acids

BTM -213: Instrumentation (3+0)

1. Principles of pH meter, dialysis
2. Principles of different types of centrifugation, ultracentrifugation, application of analytical centrifugation and density gradient centrifugation.
3. General principles of chromatography, adsorption chromatography, column, affinity, TLC, partition, ion exchange, gel filtration and permeation chromatography.
4. Principles and application of gel electrophoresis
5. Spectroscopic techniques: principles and applications of spectroscopy,
6. Radioisotope technique: nature of radioactivity, principles of radioisotopes and radiations, units, radioactive decay, detection and measurement of radioactivity.
7. Thermo cycler and its variants
8. Microscopy

BTM -214: Molecular Biology lab (0+2)

1. Extraction of genomic DNA from animal cell (whole blood)
2. Isolation of Genomic DNA from plant tissue
3. Isolation of genomic DNA from Bacteria
4. Isolation of genomic DNA using teaching kit (whole blood)
5. Quantitative estimation of DNA and RNA
6. Determination of molecular weight of DNA bands based on Agrose gel electrophoresis
7. Southern blotting
8. Isolation of Protein
9. Quantification of Protein.
10. SDS-PAGE

BTM -215: Biophysical Chemistry lab (0+2)

1. To determine the pH of unknown sample
2. To prepare Phosphate, Bicarbonate & Citrate buffer
3. Isolation of Casein protein by Isoelectric precipitation
4. Paper Chromatography of Amino acids
5. SDS PAGE
6. Spectrophotometric quantification of DNA sample

BTM -216: Instrumentation lab (0+2)

1. Calibration of pH meter.
2. Paper chromatography of amino acids/sugars.
3. TLC of sugars/amino acids.
4. Cellular fractionation and separation of cell organelles using centrifuge.
5. Validity of Beer's law for colorimetric estimation of creatinine.
6. Absorption spectrum of NAD & NADH.
7. Rocket immuno-electrophoresis

BTM -217: Plant and Animal Tissue Culture (3+0)

1. Introduction to Techniques - Introductory history, Laboratory organization, Media, Aseptic manipulation.

2. Basic concepts in cell culture - cell culture, Cellular Totipotency, Somatic Embryogenesis.

3. Growth Hormones - Plant cells (Composition of culture media, Growth hormones, Vitamins, Unidentified supplements, selection of media); Animal cells (substrate on which cells grow, Feeder layer on substrate, gas phase for tissue culture, media and supplements).

4. In vitro plant culture: approaches & methodologies - preparation steps for tissue culture, surface sterilization of plant tissue material, basic procedure for aseptic tissue transfer, incubation of culture.

5. Tissue culture methodologies - Plant cells (Callus Culture, Cell Suspension Culture, Organ Micro-culture, plant micro-propagation, Somatic Embryogenesis); Animal cells (Source of tissue, primary culture, differentiation of cells, growth kinetics, animal cell lines and their origin and characterization).

BOOKS

BIOPHYSICAL CHEMISTRY

1. Narayanan, P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi.
2. Roy R.N. (1999) A Text Book of Biophysics New Central Book Agency.

MOLECULAR BIOLOGY

1. Glick, B.T and Pasternak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrook et al (2000) Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA
6. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7. Karp.G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC
8. Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut

SEMESTER IV

BTM - 221: Genetic Engineering (3+0)

1. Introduction to Genetic Engineering: definition, history and scope.
2. Restriction enzymes- definition, characteristics and uses.
3. Cloning and cloning vectors: Plasmid vectors, λ vectors.
4. Construction and screening of Genomic DNA library and c DNA library.
5. DNA finger printing.
6. Nucleic acid sequencing: Di-deoxy and Chemical sequencing methods
7. Genetic engineering in animals: Production of transgenic mice, ES cells can be used for gene targeting in mice, Applications of gene targeting, Using Yeast to study Eukaryotic gene function, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immunemodulators and vaccines, Transgenic animals, Production of proteins of Pharmaceutical value.
8. Genetic engineering in plants: Use of Agrobacterium tumefaciens and Arhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

BIM - 223: Microbial Physiology and metabolism (3+0)

1. Metabolite Transport Diffusion: Passive and facilitated, Primary active and secondary active transport,Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.
2. Microbial Growth: Definition of growth, balanced and unbalanced growth, growth curve, themathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve.
3. Measurement of microbial growth: Measurement of cell numbers, cell mass and metabolic activity
4. Effect of the environment on microbial growth: Temperature- temperature ranges for microbial growth, classification based ontemperature ranges and adaptations, pH-classification based on pH ranges andadaptations, solutes and water activity, oxygen concentration, radiation and pressure.
5. Chemolithotrophic metabolism: Physiological groups of aerobic and anaerobic chemolithotrophs, Hydrogenoxidizingbacteria and methanogens.
6. Carbon dioxide fixation : Calvin cycle and reductive TCA cycle.

BTM -223: Immunology (3+0)

1. History and scope of Immunology
2. Types of Immunity: acquired and innate; Inflammation, cell mediated and humoral immunity
3. Cells, tissues and organs of the immune system
4. Antigen: antigenicity vs. immunogenicity
5. Immunoglobulin: structure, function and diversity; antigen-antibody reactions, concept of ELISA, Immuno Assay.
6. T cell and B cell maturation and activation
7. Cytokines, Interleukins, T Cell and B Cell defects**.**

BTM -224: Genetic Engineering lab (0+2)

1. Isolation of genomic DNA from bacteria, plant and animal tissue.
2. Isolation of plasmid DNA (*E. coli*).
3. Restriction digestion of DNA.
4. Separation of DNA by Gel Electrophoresis.
5. SDS-PAGE for protein profiling.
6. Isolation of chloroplast DNA.
7. Restriction digestion of DNA.
8. Demonstration of Replica plating technique.
9. Identification of Lac+ bacteria by blue white screening using IPTG.
10. Ligation of DNA.
11. Demonstration of Southern blotting.
12. Demonstration of western blotting.
13. Chemical mutagenesis and production of microbial mutants.

BTM -225: Immunology lab (0+2)

1. Antigen – antibody reaction
2. ABO-Blood grouping
3. Ouchterloney immunodiffusion.
4. Radial immunodiffusion.
5. Differential leukocyte count (DLC)
6. Blood film preparation.
7. ELISA (Kit).

BIM-226: Microbial Physiology and metabolism (0+2)

1. To study and plot the growth curve of E coli using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of Aspergillus niger by radial growth measurements.
3. To study the effect of pH on the growth of E. coli
4. To study the effect of temperature of Aspergillus niger by dry weight method.

Demonstration of the thermal death time and decimal reduction time of E. coli.

Books

GENETIC ENGINEERING

1. Glick, B.R and Padternak J.J (1994) Molecular Biotechnology, Principles and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C
2. Christopler, H. (1995) Gene Cloning and Manipulating, Cambridge University Press
3. Nicholl, D.S.T (1994) An Introduction of Genetic Engineering, Cambridge University Press.
4. Old, R.W. and Primrose, S.B. (1986) Principles of Gene manipulation, An introduction to genetic engineering (3rd Edition) Black well Scientific Publications
5. Lewin, B. (1994) Genes VI, New York, Oxford University Press.
6. Gene Cloning- TA. Brown, Blackwell Publisher
7. Molecular Cloning: A Laboratory Manual, Maniatis, Fritch and Samrock.

IMMUNOLOGY

1. William, E. Paul (1989) Fundamental immunology, 2nd Edition Raven Press, New York.
2. William, R. Clark (1991) The Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
3. Ivan, M, roitt (1994) Clackwell Scientific Publications, London

SEMESTER V

BIM-311 Medical Microbiology (3+0)

1. Normal microflora of the human body : Skin, throat, gastrointestinal tract, urogenital tract
2 Host-pathogen interaction :Definitions of invasion, pathogen, parasite, pathogenicity, toxigenicity, virulence, carriers and their types, nasocomial infections, opportunistic infections, septicemia, septic shock, transmission and spread of infection.
3. Sample collection, transport and diagnosis: Collection, transport and culturing of clinical samples, principles of differentdiagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).
4. Bacterial diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control): *Bacillus anthracis, Corynebacteriumdiphtheriae, Streptococcus pyogenes, Escherichia coli, Salmonella typhi and paratyphi, Shigelladysenteriae, Helicobacter pylori, Vibrio cholerae, Haemophilus influenza, Neisseria gonorrhoeae, Mycobacterium tuberculosis, Treponemapallidum.*
5. Viral diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control) Polio, Chicken pox, Herpes, Hepatitis, Rabies, Influenza with brief description ofbird and swine flu, Dengue, AIDS, Viral cancers. An overview of emerging viraldiseases: Japanese Encephalitis, Ebola, Marburg, SARS, Hanta, Nipah, Chandipura,Chikungunya.
6. Introduction to protozoan diseases: Malaria, Kala-azar, and Toxoplasmosis.
7. Introduction to fungal diseases: Different types of mycoses with particular reference to Dermatomycoses and Opportunistic mycoses.
8. Antimicrobial agents and drug resistance: Mechanism of action of important chemotherapeutic agents. Principles of drug resistance in bacteria.

BIM-312: Industrial Microbiology (3+0)

1. Introduction to industrial microbiology: Brief history and developments in industrial microbiology
2. Fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatchand continuous fermentations
3. Microbial production of industrial products (micro-organisms involved,media, fermentation conditions, downstream processing and uses)
4. Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, lipase, glucose isomerase, glucose oxidase), bioinsecticides (Bt) and Steroid transformations
5. Enzyme immobilization: Methods of immobilization, advantages and applications of immobilization, largescale applications of immobilized enzymes (glucose isomerase and penicillinacylase)

BTM-313: Biostatistics, Computer Application & Bioinformatics (3+0)

1. Introduction and principles of statistical sampling from a population.
2. Random sampling.
3. Frequency distributions and associated statistical measures.
4. Probability measures and probability distributions and Random variable.
5. Correlation, and regression analysis,
8. Hypothesis testing: T, F, Chi-square distribution and tests.
9. Analysis of variance and design of experiment CRD, RBD, LSD and Factorial experiment.
10. Basics about computer (DOS, window operations)
11. Introduction to bioinformatics.
12. Application of different software in solving biological problems
13. Database management and data analysis – use of different databases e.g. Pubme, TIGR, PDB database, Gene bank.
14. Gene and protein sequence analysis
15. Genomics, transcriptomics and proteomics – computer applications

BIM-314 Medical Microbiology (0+2)

1. To identify pathogenic bacteria (any three of *E. coli*, *Salmonella*, *Pseudomonas, Staphylococcus, Bacillus*) based on cultural, morphological and biochemicalcharacteristicsCultural characteristics on nutrient agar and in nutrient broth, Gram characteristic,motility, presence of endospore and capsule, IMViC, TSI, sugar fermentation,nitrate reduction, urease production, oxidase and catalase tests.
2. To study composition and use of important differential media for identification of pathogenic bacteria
3. EMB agar, McConkey agar, TCBS agar and Salmonella-Shigella agar (any two)
4. To perform antibacterial testing by Kirby-Bauer method
5. To study symptoms of the diseases with the help of photographs eg. Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis, kaposi's sarcoma), dermatomycoses (ring worms), kala-azar

BTM- 315: Biostatistics and Bioinformatics lab (0+2)

1. Practical work of simple Statistical programmes.
2. Practical on Biostatistics: based on theory papers.

3. Introduction to Computer application.
4. Introduction to software of enzymes, DNA and Proteins.
5. Internet basics.
6. Introduction to NCBI Web sites.
7. Introduction to Data bases.

BTM-316: Basic Fermentation Technique (3+0)

1. Principles of Microbial growth – introduction, the ways of growing microorganisms, ways to increase yield of microbes, Batch, fed-batch and continuous cultures (definition and kinetics).
2. Bioreactor / Fermenter – types & operation of Bioreactors, physico-chemical standards used in bioreactors, limitations of bioreactors, stages of fermentation processes, Media design for fermentation processes, Solid substrate fermentation, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static, Submerged andagitated fermentation), advantages & disadvantages of solid substrate & liquid fermentations.
3. Technology of Microbial cell maintenance – steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain), Strain preservation, maintenance and strain improvement by mutation of gene transfer processes
4. Downstream processing – extraction, separation, concentration, recovery & purification, operations (Insulin, Vitamins, Metabolites), Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid, α-amylase, protease penicillin, tetracycline and vitamin B12, with reference to easily available raw materials, Production of herbal drugs.

BIM-317 Industrial Microbiology (0+2)

1. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
   (a) Amylase
   (b) Amino acid: Glutamic acid
   (c) Organic acid: Citric acid
   (d) Alcohol: Ethanol
   (e) Antibiotic: Penicillin
2. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

BOOKS

PLANT BIOTECHNOLOGY

1. Ravishankar G.A and Venkataraman L.V(1997) Biotechnology: Applications of Plant Tissue and Cell Culture. Oxford and IBH Publishing Co., Pvt Ltd.
2. Bhan (1998) Tissue Culture, Mittal Publications, New Delhi.
3. Islan A.C (1996) Plant Tissue Culture, Oxford and IBH Publishing Co., Pvt. Ltd.
4. Lydiane Kyte & John Kelvins (1996) Plants from test tubes. An introduction to Micropropogation (3rd Edition) Timber Press, Partland.
5. Kumar H.D (1991) A Text Book on Biotechnology (2nd Edition). Affiliated East West Press Private Ltd. New Delhi.

6. Chrispeel M.J. and Sdava D.E. (1994) Plants, Genes and Agriculture, Jones and Barlett Publishers, Boston.
7. Reinert J. and Bajaj Y.P.S (1997) Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture, Narosa Publishing House.

ANIMAL BIOTECHNOLOGY

1. Elements of Biotechnology- P.K. Gupta., Rastogi publishers, Meerut.
2. Biotechnology- B.D.Singh, Kalyani Publishers, Ludhiana
3. A Text Book of Biotechnology- R.C. Dubey, S. Chand & Company Ltd.

BIOSTATISTICS

1. Bliss, C.J.K. (1967) Statistics in Biology, Vol. I Mc Graw Hill, New York.
2. Campbell R.C.(1974) Statistics for Biologists, Cambridge Univ. Press, Cambridge.
3. Daniel (1999) Biostatistics (3rd Edition) Panima Publications Corporation.
4. Swardlaw, A.C. (1985) Practical Statistics for Experimental Biologists, John Wiley and sons, Inc, NY
5. Khan (1999) Fundamentals of Biostatistics.

BIOINFROMATICS

1. Introduction to Bioinformatics - T.K. Attwood, D.J.P. Smith and S. Phukan, Pearson Education
2. Bioinformatics of genome regulation and structure - Kolchanov
3. Trends in Bioinformatics – P. Shanmughavel, Scientific Book Center.

SEMESTER VI

BIM-321 Food and dairy microbiology (3+0)

1. Foods as a substrate for microorganisms: Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general
2. Microbial spoilage of various foods: Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, cannedfoods
3. Principles and methods of food preservation : Principles, physical methods of food preservation: temperature (low, high, canning,drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processingand aseptic packaging, chemical methods of food preservation: salt, sugar, organicacids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins
4. Fermented foods: Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss,kefir, dahi and cheese, other fermented foods and probiotics.
5. Food borne diseases (causative agents, foods involved, symptoms andpreventive measures) Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum*and mycotoxins;Food infections:

Bacillus cereus, *Vibrio parahaemolyticus*, *Escherichia coli*,Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes*and*Campylobacterjejuni*
6. Food sanitation and control : HACCP, Indices of food sanitary quality and sanitizers
7. Water Potability: Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

BIM-322: **Environmental Biotechnology, Bioethics, Legal Issues and Patenting (3+0)**

1. Overview of the global environmental problems: Climate change, Energy crisis, use and abuse of plastics
2. Renewable and Non-Renewable resources of energy
3. Biofuels: Scope, source and production process
4. Bioremediation: Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents, Marine resources and diversity
5. Treatment of municipal and Industrial waste water
6. Biofertilizers and Biopesticides- Scope, production and uses.
7. Environmental concerns of Genetically Modified Microbes (GMOs), plants and animals
8. Biosafety regulations.
9. Intellectual property rights in biotechnology – patenting of life forms.
10. Moral and ethical issues in biotechnology.

BIM-323 Microbial Biotechnology (3+0)

1. Microbial Products: - Application of microbial biotechnology, production of primary and secondarymetabolites of industrial significance, A brief discussion about production of industrial products such asFuels: Ethanol, Methane;Alcoholic beverages: Beer, Wine.
2. Organic acids: Citric acid, Lactic acid;Antibiotics: Penicillin, Streptomycin;Amino acids: Glutamic acid, Lysine;Enzymes: Protease, Amylase and Lipases
3. Bioconversions: A brief account of steroid biotransformation ;Microbial Foods: Single cell proteins.Sewage waste water treatment: Technique and plants.;Biogas production
4. Biodegradation of xenobiotic compounds;Microbial technology in agriculture- Bioinsecticides, Bioherbicides, Biofungicides. Biotechnology ofmushroom cultivation.

BIM-324 Food and dairy microbiology lab (0+2)

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any pathogenic bacteria (*Staphylococcus* or *Salmonella*) from foodproducts.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.
7. Determination of potability and faecal contamination of water samples bypresumptive test/MPN test confirmed and completed tests.

BIM-325 Microbial Biotechnology lab (0+2)

1. Fermentation of fruit juices.
2. Demonstration of mushroom production (White button mushroom).
3. Isolation of *Azotobacter*from soil.
4. Isolation of *Rhizobium* from legume root nodules.
5. Preparation of biofertilizer from *Azotobacter*and *Rhizobium* in the laboratory.
6. Demonstration of nodulation ability of rhizobia by inoculation of the legume seeds.
7. Culturing and identification of a yeast (*Saccharomyces cerevisiae*) in the lab.
8. Demonstration of amylolytic and proteolytic activity by a mold/bacterium.
9. Demonstration of antibiotic sensitivity test.
10. Primary screening of amylase producing bacteria from soil

BBT-326: Project (0+6)

1. Project report.
2. Seminar and viva –voce on Project work.

BOOKS

FOOD AND INDUSTRIAL BIOTECHNOLOGY

1. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
2. Glaser A.N and Nilaido.H (1995) Microbial Biotechnology, W.H Freeman and Co.
3. Prescott and Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
4. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Crueger W. and Crueger A. (2000) A Text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology, Aditya Books (P) Ltd.
7. Food Microbiology – Adams and Moss
8. Food Microbiology – Fraizer and Werthoff
9. Food Fermentation – Microbiology, Biochemistry & Technology, Vol. I & II , Joshi and Pandey.

ENVIRONMENTAL BIOTECHNOLOGY

1. Biosafety and Bioethics – Joshi, R.M.: Eastern Book House.
2. Biotechnology in Environmental Management- Pathade, G.R., Eastern Book House.
3. Biodiversity and Environmental Biotechnology- Dwivedi, P and Kalita, M.C.