M.Sc. Biochemistry
Kumaun University, Nainital
Syllabus (2020-21)

		Credits
SEMESTER – I		
1S1	Biochemistry	3 Credits
1S2	Cell & Developmental Biology	3 Credits
1S3	Molecular Biology	3 Credits
1S4	Microbiology and Industrial Applications	3 Credits
1S5	Biostatistics and Computer Applications	3 Credits
1S6	Seminar/Journal Club/Assignment	1 Credit
	Lab I- Biochemistry and Microbiology	4 Credits
	Lab II- Molecular Biology	4 Credits
	Total	24 Credits

SEMESTER- II		
2S1	Plant Biochemistry and Biotechnology	3 Credits
2S2	Analytical Techniques	3 Credits
2S3	Genetic Engineering	3 Credits
2S4	Molecular Genetics	3 Credits
2SB1	Nutritional Biochemistry	3 Credits
2S6	Seminar/Journal Club/Assignment	1 Credit
	Lab III: Plant Biotechnology	3 Credits
	Lab IV- Analytical Techniques	2 Credits
	Lab V- Genetic Engineering	3 Credits
	Total ------	24 Credits

SEMESTER-III		
3S1	Bioprocess Engineering and technology	3 Credits
3S2	Environmental Biochemistry & Biotechnology	3 Credits
3SB1	Metabolic Pathway	3 Credits
3S5	Immunology and Immunotechnology	3 Credits
3S6	Molecular Virology	3 Credits
3S7	Seminar/Journal Club/Assignment	1 Credit
	Lab VI- Immunology	4 Credits
	Project Proposal Presentation	2 Credits
	Total ------	22 Credits

SEMESTER-IV		
	Project/Thesis Work	20 Credits
	Total ----	20 Credits

DR. RAMESH CHANDRA

SEMESTER-I (M.Sc. Biochemistry)
Marks- (70+30) =100

– 3 Credits

1S1 Biochemistry

Unit- I
Chemical basis of life: Composition of living matter; Water- properties, pH, pKa,Titration curves of weak acids, Buffers, Handerson-Hasselbach equations, ionization and hydrophobicity; Emergent properties of biomolecules in water; Water as a reactant.

Unit-II
Proteins: Amino acids as building blocks of proteins and their chemical properties,pI and pKa values, Primary, Secondary, Tertiary and Higher order structure of Proteins, Protein Sequencing, Ramchandran Plot, Conjugated proteins- Glycoproteins, Lipoproteins, Heamproteins.

Unit-III
Enzymes: General principles of catalysis, Quantitation of enzyme activity and efficiency, Enzyme characterization and Michaelis-Menten kinetics, Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes

Unit-IV
Carbohydrates: Mono- Di- and Polysaccharides, Optical isomerism, Structure of Carbohydrates, Glycolysis, Gluconeogenesis, Pentose phosphate pathways, Citric acid cycle.

Unit V
Lipids: Classification and structural analysis of fatty acids, Glycerols, Waxes, Glycolipids, Phospholipids, Sphingolipids, Sterols, Lipoproteins, β-oxidation, Biosynthesis of Cholesterol and Fatty acids.

Unit- VI
Nucleic acids: Biosynthetic pathways of purines and pyrimidines, degradation pathways

Unit-VII
Bioenergetics- Basic principles; Equilibria and concept of free energy; Group transfer, concept of Entropy, Enthalpy and free energy , Oxidation and Reduction reactions, Electron Transport Chain, Oxidative phosphorylation; photosynthesis. Metabolic regulations including the role of hormones.

SEMESTER-I (M.Sc. Biochemistry)

Marks- (70+30) =100

1S2 Cell and Developmental Biology -3 Credits

Unit- I

Cell Theory and Methods of Study

Microscope and its modifications- Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

Membrane Structure and Function

Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit- II Organelles

Cellular compartments and intracellular sorting of proteins, ER & Lysosomes, peroxisomes, synthesis and sorting of proteins (lysosomal proteins, membrane proteins, secretory proteins).Nuclear transport.

Unit-III

Endo-membrane System and Cellular Motility

Organization of nucleus and nuclear membrane, structure and organization of chromatin. Cytoskeleton: Actin filaments and cell cortex, cilliary movements and cytoplasmic microtubules and intermediate filaments.

Unit IV

Cell Communication

General principle, Signal Molecules, Signaling through GPCRs, Second Messengers, Molecular Switches, Cells Sensitivity to a signal, IP3, Jak-STAT pathways, Cam Kinase-II, Receptor Tyrosine Kinase, Signaling in Plants

Unit-V

Differentiation of specialized cells

Stem cell differentiation. Differentiation of cancerous cells and role of proto-oncogenes

Plant Meristem Organization and Differentiation

Organization of shoot Apical Meristem (SAM); Organization of Root Apical Meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixes.

SEMESTER-I (M.Sc. Biochemistry)

Marks- (70+30) =100

1S3 Molecular Biology -3 Credits

Unit-I Genome Organization

Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive region; DNA methylation & Imprinting.

Unit-II DNA Structure; Replication; Repair & Recombination

Structure of DNA-A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept- lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA

Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing

Unit-IV Post Transcriptional Modification

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; IsoacceptingtRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co-and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit-V Mutation; Oncogenes and Tumor suppressor gene

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition-Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

SEMESTER-I (M.Sc. Biochemistry)

Marks- (70+30) =100

1S4 Microbiology & Industrial Applications **-3 Credits**

Unit I

Microbial Diversity & Systematics.

The Milestones in Microbiology: The discovery of microbial world by Antony van Leeuwenhocek, The controversy over spontaneous generation, Golden age of Microbiology. Criteria for classification of microorganism; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit II

Microbial Growth & Physiology

Cell Structure and Functions: Prokaryote cell, size, shape and arrangement of bacterial cells, Cell wall, External and Internal structures to the cell wall of Eubacteria. Ultrastructure of Archaea (Methanococcus); Unicellular Eukaryotes (Yeast). Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, methods of growth estimation, stringent response,Thermal death of a bacterial cell.Methods in Microbiology: Pure culture techniques, The theory and practice of sterilization, Principles of microbial nutrition, Construction of culture media, Enrichment of culture techniques, Pure culture and its maintenance

Unit III

Microbial Interactions and Infection

Host-pathogen interactions; Microbes infecting animals and plants; Disease reservoirs, Epidemiological terminologies, Infectious diseases transmission, Pathogenicity islands and their role in bacterial virulence.

Unit IV

Microbes and Environment

Salient features of extremophiles (halophiles, thermophiles, psychrophiles) archaeabacteria. Aerobic and Anaerobic bacteria, Phototrophic and Gliding bacteria, Prosthecate and budding bacteria. Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing;.

Unit V

Industrial Applications

Role of microorganisms in natural system and artificial system.Scope and importance of Microbiology in Biotechnology.Microbial fuel cells; Prebiotics and Probiotics; Vaccines. Microbial processes-production, optimization, screening, strain improvement, for the production of ethanol, organic acids, antibiotics etc. Basic principles in bioprocess technology; Media Formulation; Sterilization; Batch and continuous sterilization systems; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH.

SEMESTER-I (M.Sc. Biochemistry)
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1S5 Biostatistics and Computer Applications -3 Credits

1. Brief description and Tabulation of data and its graphical representation.
2. Measure of central tendency and description: Mean, Mode, Median, Range, Standard deviation, Variance, Idea of two types of errors and level of significance, Tests of significance (F and T test), Chi-Square tests.
3. Simple linear regression and Correlation.
4. Introduction of digital computers: Organizations, Low-level and High-level languages, Binary systems.
5. Flow charts and Programming techniques.
6. Introduction to data structures and data base concepts, Introduction to internet and its applications.
7. Introduction to MS-office software covering word processing, spread sheets and presentation software.
8. Introduction to Harvard graphics/Sigma plotter.
9. Computer oriented statistical techniques: Frequency table of single discrete variable. Bubble sort, Computation of mean, Variance and standard deviations, T-test, Correlation coefficient.
10. Bio-informatics- Internet access and using web search engines to access biological databases, sequence, structure and strain database, Secondary and sequence analysis of DNA, RNA and proteins.

SEMESTER-I (M.Sc. Biochemistry)

Lab on Biochemistry and Microbiology -4 Credits

General Biochemistry (Practical) - 2 Credits

1. Titration of Amino Acids.
2. Colorimetric determination of pKa.
3. Quantitative estimation of Proteins and Sugars.
4. Separation techniques- Centrifugation, Chromatography (Gel Permeation, Ion exchange, TLC, etc.)

Lab on Microbiology - 2 Credits

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods- slants and stab cultures, Storage of microorganisms.
4. Gram Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
6. Assay of antibiotics production and demonstration of antibiotic resistance.
7. Isolation and screening of industrially important microorganisms. Determination of thermal death point and thermal death time of microorganisms.

SEMESTER-I (M.Sc. Biochemistry)

Lab on Molecular Biology

-4 Credits

1. Plasmid DNA isolation and DNA quantitation
2. Restriction digestion
3. Preparation of competent cells
4. Agarose gel electrophoresis
5. Restriction Enzyme digestion of DNA
6. Purification of DNA from an agarose gel
7. DNA Ligation
8. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency
9. Restriction mapping of recombinant plasmid.
10. Polymerase Chain reaction
11. RFLP analysis of the PCR product

SEMESTER-II (M.Sc. Biochemistry)
Marks- (70+30) =100
2S1 Plant Biochemistry and Biotechnology – 3 Credits

Unit I
Plant Tissue Culture
Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.
Protoplast Culture and Somatic Hybridization
Protoplast isolation; Culture and usage; Somatic hybridization – methods and applications; Cybrids and somatic cell genetics.

Unit II
Agrobiology
Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid.
Genetic Transformation
Agrobacterium-mediated gene delivery; Cointegrate and binary vectors and their utility; Direct gene transfer- PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting.

Unit III-
Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance
Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

Unit IV
Somaclonal variations
Plants as Biofactories
Concept of biofactories; Fermentation and production of industrial enzymes, vitamins and antibiotics and other biomolecules; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation.

Unit V
Principals and applications of cryopreservation
Secondary product formation by cell suspension cultures
Culture media and environmental conditions supporting secondary product formation, Biotransformation of terpenoids, alkaloids and steroids by suspension and immobilized plant cell cultures.
Biosafety and containment practices

SEMESTER-II (M.Sc. Biochemistry)

Marks- (70+30) =100

2S2 Analytical Techniques **-3 Credits**

Unit-I

Basic Techniques

Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques.

Spectroscopy Techniques

Basic Principle, Instrumentation and Biological applications of: UV and Visible light absorption spectroscopy, Spectrofluorometry, CD and ORD, Atomic spectroscopy (Absorption and emission). Infrared spectroscopy, Raman Scattering, Application of FT-IR in the study of biomolecules, Nuclear Magnetic Resonance (NMR) spectroscopy, and EPR; Mass spectroscopy and mass analyzers like ion trap, quadrupole, magnetic sector, time of flight (ToF).

Unit-II

Chromatography Techniques

TLC and Paper Chromatography; Column chromatography Chromatographic methods for macromolecule separation-Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC.

Electrophoretic Techniques

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Native and SDS-PAGE electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit III

Centrifugation

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge- Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Application (Isolation of cell components); Analytical centrifugation.

Unit- IV

Radioactivity

Radioactive & stable isotopes; Radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Autoradiography; Applications of isotopes in biochemistry, Clinical application; Radioimmunoassay

Unit-V

Advanced Techniques

Protein crystallization; Enzyme and cell immobilization techniques;

SEMESTER-II (M.Sc. Biochemistry)

Marks- (70+30) =100

2S3 Genetic Engineering -3 Credits

Unit I

Basics Concepts

DNA structure and properties; Restriction enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphate, cohesive and blunt end ligation; Linkers; Adaptors; Homopolymer tailing, Labeling of DNA, Hybridization technique: Northern, southern and colony hybridization, fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA Protein Interactions; electrophoretic shift assay.

Unit II

Cloning Vectors

Plasmids; M13 mp vector; PUC19 and Bluescript vectors, Phagemids, Lambda vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Mammalian expression vectors & retroviral vectors; Prokaryotic Expression vectors with GST-, His- and MBP- tags; Affinity purification of recombinant fusion proteins; Inclusion bodies; Methodologies to reduce formation of inclusion bodies.

Unit III

Cloning Methodologies

Bacterial Transformation; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Phage display

Unit- IV

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR- reverse transcriptase, real time PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection.

Unit-V

Enzymatic DNA sequencing; Automated DNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; RNA interference and siRNAGene knockouts and Gene Therapy.

SEMESTER-II (M.Sc. Biochemistry)

Marks- (70+30) =100

2S4 Molecular Genetics -3 credits

Unit I

Bacterial Mutants and mutations

Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletion; tandem duplication); Reversion vs. suppression; Mutagenic agents; Molecular Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test)

Gene transfer in bacteria

History; Transduction- generalized and specialized; Conjugation- F, F', HFr; F transfer; Hfr- mediated chromosome transfer; Transformation- natural and artificial transformation; Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.

Unit II

Bacteriophages and Plasmids

Bacteriophage-structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology – copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid

Unit III

Mendelian Genetics

Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors – incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies – Genetic disorders of hemoglobin and their diseases.

Non Mendelian inheritance patterns

Mitochondrial inheritance; Genomic imprinthing; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits.

Unit IV-

Molecular Genetics of Lambda

The genome packaging, replication and recombination, Regulation of Lytic and Lysogenic Cycles

Unit V

Gene mapping and human genome project

Physical mapping; linkage and association

Population genetics and evolution

Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing; Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift

SEMESTER-II (M.Sc. Biochemistry)

Marks- (70+30) =100

2SB1 Nutritional Biochemistry -3 Credits

1. **Basic concepts:** Principal food components; Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate (BMR); Factors affecting BMR and its measurement; Resting metabolic rate. Measurement of energy requirements. Specific dynamic action of proteins.

2. **Elements of nutrition:** Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions. Formuladiets and crash diets; Formulation of balanced diets; Dietary standards: EAR, RDA, ADI, DRI, UL; Water as an essential nutrient; Food preservatives; Additives and antinutrients.

3. **Minerals and Vitamins:** Physiological roles of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Vitamins: Biochemical functions and Dietary sources, deficiency diseases associated with vitamin B complex, C, A, D, E and K vitamins.

4. **Malnutrition:** Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.

5. Nutrition in health and diseases: Dietary fat and heart disease and cancer; Atherosclerosis: risk factors and protective measures; **Obesity:** Definition, Genetic and environmental factors leading to obesity, Nutritional management of obesity; Diabetes: Types, and its Nutritional management; Nutrition and infection; Basics of nutrigenomics. **Starvation:** Definition, Protein metabolism in prolonged fasting.

SEMESTER-II (M.Sc. Biochemistry)

Lab on Plant Biotechnology (Practical) — 3 Credits

1. SOPs of Plant Tissue Culture laboratory
2. Preparation of media.
3. Surface sterilization of explants
4. Micropropagation of plants
5. Green house and hardening practices
6. Clonal fidality of regenerated plants.

SEMESTER-II (M.Sc. Biochemistry)

Analytical Techniques (Practical) — 2 Credits

1. Paper Chromatography of amino acids.
2. T.L.C of lipids.
3. Isolation of plasmid DNA from *E.coli.*
4. Agarose gel electrophoresis of isolated plasmid DNA.
5. Extraction and purification of protein from plant and animals.
6. SDS – PAGE of BSA and extracted proteins.

SEMESTER-II (M.Sc. Biochemistry)

Lab on Genetic Engineering – 3 Credits

1. Isolation of genomic DNA from *E. coli*
2. PCR amplification of bacterial/plant/animal-cell genomic region and analysis by agarose gel electrophoresis.
3. Preparation of plasmid DNA from *E.coli* DH5α and gel analysis.
4. Restriction digestion of vector (gel analysis) with Restriction endonucleases
5. a. Vector and Insert ligation
   b. Transformation in *E.coli* DH5α.
6. Plasmid isolation and confirming recombinant by PCR and RE digestion.
7. Transformation of recombinant plasmid in *E.coli* Laboratory strain.
8. Induction of recombinant protein with IPTG and analysis on SDS-PAGE.
9. Purification of protein on Ni-NTA/Glutathione/Mannose column and analysis of purified protein by SDS- PAGE.

SEMESTER-III (M.Sc. Biochemistry)

Marks- (70+30) =100

3S1 Bioprocess Engineering and Technology -3 Credits

Unit I

Basic principle of Biochemical engineering

Isolation, screening and maintenance of industrially important microbes; Microbial growth (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

Unit II

Concepts of basic mode of fermentation processes

Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation – Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation media; Measurement and control of bioprocess parameters; Scale up and scale down process.

Unit III

Downstream processing

Bioseparation- filtration, centrifugation, sedimentation, flocculation; Cell disruption; Storage and packaging; Treatment of effluent and its disposal.

Unit IV

Applications of enzymes in food processing

Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications

Unit V

Applications of Microbes in food process operations and production

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colors and flavors, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

SEMESTER-III (M.Sc. Biochemistry)

Marks- (70+30) =100

3S2 Environmental Biochemistry and Biotechnology - 3 Credits

Unit I

Introduction

Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of Biotech in environmental protection; Control and management of biological processes.

Unit II

Pollution

Environmental pollution; Source of pollution; Air, water as a source of natural resource; Hydrocarbons, substituted hydro carbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Green house effect; Impact of pollutants; Measurement techniques; Pollution of milk and aquatic animals.

Unit III

Control, remediation and management

Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes; Anaerobic filters; Anaerobic sludge blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment; Bioaugmentation; Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries.

Unit IV

Alternate source of energy

Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuels; Bioethanol and biohydrogen; Solid waste management.

Unit V

Environment and health in respect to genetics

Gene and environment; Effect of carbon and other nanoparticles upon health; Gene mutation; Genetic testing; Genetic sensors; Environmental pollution and children; Human biomonitoring.

SEMESTER-III (M.Sc. Biochemistry)

Marks- (70+30) =100

3SB1 Metabolic Pathway – 3 Credits

1. Metabolic pathways (*Brief overview*) and associated disorders: Characteristics of metabolic pathways; Strategies used to study metabolic pathways. Brief overview of Carbohydrate metabolism, Glycogen metabolism and its regulation; Glycogen storage diseases and other genetic defects in carbohydrate metabolism; Brief overview of Lipid metabolism, metabolism disorders related to lipid metabolism; Brief overview of amino acid metabolism, Amino acids as biosynthetic precursors, Inborn errors of amino acid metabolism; Brief overview of Nucleotide Metabolism, Inborn errors of nucleotide metabolism; *Porphyrin metabolism:* Biosynthesis and degradation of Heme; Genetic defects in heme metabolism.

2. Plant-Specific Metabolic Pathways: Photosynthesis and carbon fixation, Cyclic and noncyclic electron transport, C3, C4, and CAM pathways; Glyoxylate pathway, Photorespiration, Biosynthesis of Sucrose, starch and cellulose; *Plant secondary metabolism:* Significance of secondary metabolites, Major classes of secondary metabolites and their properties, Common metabolic precursors; Biosynthesis pathways of Phenolics, Alkaloids, Glycosides, and Terpenoids.

3. Unique Metabolic Pathways of Prokaryotes: Anaerobic respiration; Methanogenesis and reverse methanogenesis; Nitrogen fixation and properties of nitrogenase; Entner-Doudoroff pathway; Heterolactic, propionic, butyric and mixed acid fermentations; Chemoautotrophic fixation of carbon dioxide via Reductive acetyl-CoA pathway, Reductive TCA cycle, 3-Hydroxypropionate cycle and 4-Hydroxybutyrate cycle; Anoxygenic photosynthesis; Light-driven non-photosynthetic photophosphorylation. **Xenobiotic metabolism:** Significance; Phases of xenobiotic metabolism; Types of pathways involved.

4. Metabolome and Metabolomics: Definition, Significance of metabolome study, Methods of studying the metabolome, Application of mass spectroscopy and NMR-spectroscopy for microbolome analysis; Overview of Public database resources for spectrum based identification of metabolites

SEMESTER-III (M.Sc. Biochemistry)

Marks- (70+30) =100

3S5 Immunology and Immunotechnology – 3 Credits

Unit I- Immunology- fundamental concepts and anatomy of the immune system
Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; haematopoesis; Organs and cells of the immune system-primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT & CALT); Mucosal Immunity; Antigens and antigenicity – immunogens and immunogenicity, Immune modulators: Adjuvants, hapten- carrier system; Toxins and Toxoids. Major Histocompatibility Complex – MHC genes, MHC and immune responsiveness and disease susceptibility.

Unit II- Immune responses generated by B and T lymphocytes
Immunoglobulins- basic structure, classes & subclasses of immunoglobulins, antigenic determinants (Epitopes); Antigen-Antibody interaction, affinity, cross reactivity, specificity, Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Basis of self –non-self discrimination; Generation of antibody diversity; T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cytokines-properties, receptors and therapeutic uses.

Unit III- Antigen-antibody interactions
Precipitation, agglutination and complement mediated immune reactions; Antibodies as in-vitro and in-vivo probes; Advanced immunological techniques – RIA, ELISA, Western blotting, ELISPOT assay, Flow cytometry: Instrumentation and Applications; Identification of Immune Cells; Surface Plasmon resonance, Biosenor assays for assessing ligand–receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.

Unit IV- Vaccine Technology
Principles of Immunization, Techniques for analysis of immune response. General Idea of Active and passive immunization; Live, killed, attenuated, sub unit vaccines; recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Hybridoma, antibody engineering - chimeric and hybrid monoclonal antibodies; Transfusion of Immuno-competent cells; stem cell therapy; Cell based vaccines.

Unit V-Clinical Immunology
Immunity to Infection : Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; General Idea of Tumor immunology, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

SEMESTER-III (M.Sc. Biochemistry)
Marks- (70+30) =100

3S6 Molecular Virology – 3 Credits

Unit I
Structure of animal viruses and plant viruses; Classification of animal and plant viruses; Satellite viruses; Viroids; Virusoids, Prions etc.; Transmission of Viruses; Vectors for Virus transmission, Cell to cell and systemic movement of viruses. Impact of Viruses on Health and Economy:(Diseases causes by animal viruses and plant viruses; Economic loss due to important viruses); Bacterial Viruses: Lysogenic and Lytic Phages, Bacteriophage Typing.

Unit II
General Genomic organization of animal viruses; Replication and Life cycle of: Poliovirus, Human Immunodeficiency virus (HIV), Influenza Virus, Rabies Virus, Poxvirus, Herpesvirus and Hepatitis viruses; Introduction to Cancer causing viruses and their mechanism of host-cell transformation.

Unit III
General Genomic organization of plant viruses; Replication and Life cycle of plant viruses: Cauliflower Mosaic Virus (CMV), Tobacco Mosaic Virus (TMV), Rice Dwarf Virus, Citrus triesteza Virus.

Unit IV
Methods to diagnose animal virus infections: Electron microscopy, Tissue culture growth of viruses and Cytopathic effects, Virus quantitation assays, Viral serology: ELISA, neutralization assays; Molecular methods: hybridization, Real-time PCR, antiviral assays.

Unit V
Methods to study plant viruses; Infectivity assays – Sap transmission, insect vector transmission, agroinfection (using Agrobacterium); serological methods, immunelectrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (ISEM), Polymerase chain reaction; Gene silencing, and viral suppressors of gene silencing.

SEMESTER-III (M.Sc. Biochemistry)

Lab on Immunology – 4 Credits

1. Preparation of human blood smear and identification of cells.
2. Determination of blood groups.
3. Determination of Rh antigen.
4. Estimation of antiserum by Mancini method.
5. Estimation of antiserum by Ouchterlony method.
6. Antiserum titer determination by ELISA.
7. DOT ELISA for the presence of specific antigen.
8. Immunization, Collection of Serum.
9. Immunoelectrophoresis.
10. Immunodiagnostics (Demonstration using commercial kits).

SEMESTER-IV (M.Sc. Biochemistry)

Project/ Thesis work **-20 Credits**