Maulana Abul Kalam Azad University Of Technology

Department of BioTechnology

M.Sc Microbiology Syllabus
2019

Semester – I

Semester I

Code	Course Title	Contact Hrs./Wk	Credit
A	**Theory**	**L-T-P**	
MSMC-101	Biochemistry	3-0-0	3
MSMC-102	Laboratory Techniques	3-0-0	3
MSMC-103	Cell & Molecular Biology	3-0-0	3
MSMC-104	Biostatistics	3-0-0	3
MSMC-105	General Microbiology	3-0-0	3
B	**Practical**		
MSMC-191	Biochemistry & Analytical Techniques Lab	0-0-6	3
MSMC-192	Microbiology Lab	0-0-6	3
MSMC-193	Data analysis using statistical software	0-0-6	2
C			
MSMC-181	Seminar		1
Semester Total			**24**

MSMC101: Biochemistry credits 3

Unit 1: Basic chemistry for biologists

Formation of chemical bonds, molecular orbital (MO) theory and linear
combination of atomic orbitals (LCAO), basics of mass spectrometry, molecules, Avogadro number, molarity, chemical reactions, reaction stoichiometry, rates of reaction, rate constants, order of reactions, kinetic versus thermodynamic controls of a reaction, reaction equilibrium (equilibrium constant); light and matter interactions (optical spectroscopy, fluorescence, bioluminescence, paramagnetism and diamagnetism, photoelectron spectroscopy; chemical bonds (ionic, covalent, Van der Walls forces); electronegativity, polarity; VSEPR theory and molecular geometry, dipole moment, orbital hybridizations; acids, bases and pH - Arrhenious theory, pH, ionic product of water, weak acids and bases, conjugate acid-base pairs, buffers and buffering action etc; chemical thermodynamics - internal energy, heat and temperature, enthalpy (bond enthalpy and reaction enthalpy), entropy, Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; bond rotations and molecular conformations - Newman projections, conformational analysis of alkanes, alkenes and alkynes; functional groups, optically asymmetric carbon centers, amino acids, proteins, rotational freedoms in polypeptide backbone (Ramachandran plot).

Unit 2 :Protein Structure

Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies; Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding.

Unit 3: Enzyme

Enzyme catalysis – 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; restriction enzymes and nucleoside monophosphate kinase; regulatory strategies with specific example of haemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens.

Unit 4 :Glycobiology

Sugars-mono, di, and polysaccharides with specific reference to glycogen, amylose. lipids- structure and properties of important members of storage and membrane.

Unit 5 :Nucleic acid

nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure.

Unit 6: Bioenergetics

Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; Ca++ signaling pathways; glycolysis and gluconeogenesis; Citric acid cycle, entry to citric acid cycle, citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation, Photosynthesis – chloroplasts and two photosystems; proton gradient across thylakoid membrane.

Unit 7: Role of vitamins & cofactors in metabolism

Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation.

Texts/References:

1. M.T. Madigan and J.M. Martinko, Brock Biology of Microorganisms, 11th Edition, Pearson Prentice-Hall, 2006.
2. L. Stryer, Biochemistry, 4th Edition, Freeman, 2002.
3. G. Gottschalk, Bacterial Metabolism, 2nd Edition, Springer-Verlag, New-York, Berlin. 1986.

MSMC102: Laboratory Techniques credits 3

Unit1 :Chromatography Techniques - Paper Chromatography, Thin-layer chromatography, Displacement chromatography, Gas chromatography, High performance / pressure liquid chromatography, Ion exchange chromatography, Size-exclusion chromatography, Affinity chromatography.

Unit 2: Electrophoretic techniques and blotting techniques - Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Immunoelectrophoresis, Isoelectric focussing, Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis, Western blot, Eastern blot, Southern blot, Northern blot.

Unit 3 :Radioactivity - Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Applications of isotopes in biochemistry; Autoradiography.

Unit 4 :Centrifugation - Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge, Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Unit 5: Microscopy

Optical microscopy, Electron microscopy, Confocal microscopy

Unit 6: Advanced techniques

DNA and Amino acid Sequencing, DNA CHIP, Microarray, Substractive Hybridization, RNase protection assay, ELISA, Mass spectroscopy, Infra red spectroscopy, NMR, Circular Dichroism

MSMC103: Cell and Molecular Biology credits 3

Unit 1: organization of cell : Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.

Unit 2: Chromatin structure : Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin-Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, transcriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs), protein translation machinery, ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code.

Unit 3: Cellular signalling, transport and trafficking: Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.

Unit 4: Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans-membrane signalling; cell motility and migration; cell death: different modes of cell death and their regulation.

Unit 5: Manipulating and studying cells: Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins.

Unit 6: Genome instability and cell transformation: Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Unit 7:Mammalian genetics: Mendel's experiments, monohybrid and dihybrid cross, sexual reproduction applications of chi square test, deviation from Mendelian segregation, linkage, genetic map, Mendelism in human genetics: pedigree analysis, dosage compensation and sex determination, inheritance characteristics of sex-linked and autosomal traits,chromosome discovery, chromosomes as physical basis of inheritance, Polytene and lampbrush chromosomes, chromosomal aberrations and genetic load, sex-linked deleterious genes, extrachromosomal/non-Mendelian inheritance(episomes, mitochondria and chloroplasts), parental imprinting, Population Genetics-Variation and its modulation, effect of sexual reproduction on variation (Hardy-Weinberg Equilibrium), sources of variation, selection balanced polymorphism, random events.

Text/ Reference

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K.; Walter, P. (2008).Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
3. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.).Washington: ASM; Sunderland.

MSMC104: Biostatistics credits 3

Unit 1: Introduction to Biostatistics

Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, o give curves and pie diagram.

Unit 2 : Measures of central tendency: Mean, Median, Mode.

Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient
of variation. Correlation and regression: Positive and negative correlation and calculation of Karl-Pearsons co-efficient of correlation. Linear regression and regression equation and multiple linear
regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.

Unit 3 :Tests of significance

Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions, (concept without deviation) binomial, poison and normal (only definitions and problems) Computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test, correlation coefficient. Randomized block design, complete block design, Usage of Statistical software.

MSMC105: General Microbiology 3 Credits

Unit 1: Microbial Characteristics

Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, Microbial fermentation, Microbial energetics, biosynthesis of enzymes , activation energy, endergonic and exergonic reaction, autotrophic and heterotrophic generation of ATP, Photophosporylation, fermentation vs respiration, bacterial growth curve, bacterial culture methods; antimicrobial resistance.

Unit 2: Microbial diversity and taxonomy:

Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma; Archaea: Halophiles, Methanogens, Hyperthermophilic archaea, Thermoplasm; Eukaryotes: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes, Molecular Taxonomy, Identification and characterization of unknown microbes.

Unit 3: bacterial genetics:

Mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; Transposon, Prokaryotic gene expression.

Unit 4: Interaction of microbes with biotic and abiotic stress:
Antibiotic, Probiotic, Prebiotic, drug resistance, multiple drug resistance, Metal resistance, Host-pathogen interaction.

MSMC191: Lab on Biochemistry and Analytical Techniques — credits 3

1. To prepare an Acetic-NaAcetate Buffer system and validate the Henderson-Hasselbach equation.
2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
4. An enzyme purification theme (such as *E.coli* Alkaline phosphatase or any enzyme of the institutions choice).
   a) Preparation of cell-free lysates
   b) Ammonium Sulfate precipitation
   c) Ion-exchange Chromatagraphy
   d) Gel Filtration
   e) Affinity Chromatography
   f) Generating a Purification Table
   g) Assessing purity by SDS-PAGE Gel Electrophoresis
   h) Assessing purity by 2-D gel Electrophoresis
   i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.
5. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy).
6. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry

MSMC192: Lab on Microbiology — credits 3

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. 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.
8. Determination of thermal death point and thermal death time of microorganisms.

MSMB193: Data analysis using statistical software — credits 2

1. Introduction to different statistical software.
2. Determination of mean, median, mode of given data set.
3. Determination of standard deviation and standard error of a given data set.
4. Preparation of different types of graph from a given data set.

5. Determination of statistical significance of the experimental data: Paired and unpaired t test and p value determination
6. Nonparametric Mann-Whitney test, including confidence interval of difference of medians.
7. Wilcoxon test with confidence interval of median.
8. Usage of two and three way anova.
9. Kaplan-Meier survival analysis.

Semester II

Semester II

Code	Course Title	Contact Hrs./wk	Credit
A	**Theory**	**L-T-P**	
MSMC-201	Agricultural & Soil Microbiology	3-0-0	3
MSMC-202	Industrial Microbiology & Fermentation Technology	3-0-0	3
MSMC-203	Immunology	3-0-0	3
MSMC-204	Genetic Engineering	3-0-0	3
MSMC-205	Applied Bioinformatics	3-0-0	3
MSMC-206	Choice based courses (from MOOCS basket)		2
B	**Practical**		
MSMC-291	Genetic engineering lab	0-0-6	3
MSMC-292	Immunology lab	0-0-6	3
C			
MSMC-281	Seminar		1
Semester Total			**24**

MSMC201: Agricultural and soil Microbiology

credits 3

Unit I

History of soil microbiology, Soil microbiology- Stages of Soil Formation, Soil microbes, soil texture, structure, Soil pH, Conductivity etc.

Unit II

Microbial Metabolism - Biological N2-fixation by Free living anaerobic (Clostridium), facultatively anaerobic (Azospirillum) and aerobic (Azotobacter), N2-fixers associated with stem, root and leaf, Symbiotic N2-fixation in legumes and non- legumes by Rhizobium and Frankia, N2-fixation by cyanobateria. Requirement of ATP, O2-sensitivity and inhibition by ammonia and nitrogenous substance in the case of nitrogenase, The peculiarity of alternate nitrogenase of Streptomyces thermoautotrophicus.

Unit III

Biofertilizers and Biopesticides- Physical and Biological Nitrogen fixation- symbiotic and asymbiotic, mass production by Rhizobium, Azotobacter and Cyanobacteria, nitrifying ammonifying and photosynthetic bacteria, Denitrification of nitrate fertilizers to N2 and N2O (a green house gas) by denitrifying bacteria, free living and in association with Azolla, Phosphate solubilizing bacteria. Potash mobilizing bacteria, PGPR, Mycorrhiza, Soil anerobic methanogens in rice field. Integrated nutrient management.

Unit IV

Effect of soil pH and heavy metals on microorganisms, Microbial antagonism in soil, Biological control of soil-borne microbial pathogens. Biopesticides, integrated pest management, organic farming, organic village etc.

Unit V

Eco-friendly Microbes and their utilisation –Utilization of beneficial Microorganisms in Agriculture, Ice minus bacteria and microbial pesticides

MSMC202: Industrial Microbiology & Fermentation technology

credits 3

Unit I Introduction to industrial microorganisms - History of industrial microbiology, Isolation, screening and maintenance of industrially important microbes; microbial growth kinetics (with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics. (4 Lectures)

Unit 2: Methods in fermentation- Batch, fed-batch and continuous operations; chemostat and Turbidostat systems; immobilized cell systems; media formulation and optimization; sterilization of media and air; oxygen transfer and k_La in fermentation (6 Lectures)

Unit 3: Downstream process for microbial products- Separation of insoluble products : filtration, centrifugation, sedimentation, flocculation; cell disruption; Separation of soluble products: liquid-liquid extraction, precipitation, chromatography, reverse osmosis, crystallization , ultra and micro filtration; drying and packaging. (8 Lectures)

Unit 4: Fermented foods and beverages- Food ingredients and additives by fermentation; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours, flavours and alcoholic beverages; 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; probiotics, prebiotics and symbiotics. (10 Lectures)

Unit 5: Industrial products- Titre, yield and productivity; Raw materials for industrial production; Bioethanol, Baker's yeast, Lactic acid, Amino acids (L-Lysine and L-Glutamic acid), Citric acid, Penicillin, Glutathione, Insulin, Amylase, Protease, High-fructose corn syrup and Polio vaccine. (12 Lectures)

MSMC203: Immunology credits 3

Unit 1 : Fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); 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 - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Unit 2: Immune responses generated by B and T lymphocytes

Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; VDJ Recombination, B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Immunological basis of self - non-self discrimination; Kinetics of immune response, memory; $_{B}$ cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten- carrier system.

Unit 3: Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasma resonance, Biosenor assays for assessing ligand -receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptotosis, Microarrays, Transgenic mice, Gene knock outs, CD nomenclature, Identification of immune Cells; Principle of Immunofluorescence Microscopy, Flurochromes; Staining techniques for live cell imaging and fixed cells; Flow cytometry, Instrumentation, Applications.

Unit 4: Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

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; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation-Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency- Primary immunodeficiencies, Acquired or secondary immunodeficiencies. Immunoglobulin therapy, Specific and nonspecific immunotherapy for Asthma and allergic diseases.

Text/ Reference

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven,

MSMC204: Genetic Engineering credits 3

Unit 1: Tools for genetic engineering:

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes; hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

Unit 2: Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression: expression vectors, pMal, GST, pET-based vectors; Protein purification: His-tag; GST-tag; MBP-tag *etc.* Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri plasmids as vectors, yeast vectors, shuttle vectors.

Unit 3: PCR and cloning:

primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; TA cloning vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP, RAPD, AFLP, DNA microsatellite, DNA marker, Polymorphism, Positional cloning, functional cloning, therapeutic cloning.

Unit 4: cDNA analysis

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Unit 5: Gene silencing and genome editing technologies

Gene silencing techniques; Transposon and jumping gene, introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies (*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease

model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

Texts/References

1. Gene XII, Lewin's
2. Molecular cell Biology, David Baltimore and Harvey Lodish

MSMC205 : Applied Bioinformatics credits 3

Unit 1: Sequence-alignment related problems

Sequence databases; Similarity matrices; Pairwise alignment; BLAST; Statistical significance of alignment; Sequence assembly, Multiple sequence alignment; Clustal; Phylogenetics: distance based approaches, maximum parsimony.

Unit 2: Pattern analysis in sequences

Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Units 3: Structure-related problems

Representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; Structure classification (SCOP, CATH); Visualization software (Pymol, Rasmol etc.); Experimental determination of structures (X-ray crystallography, NMR); Structure databases; Secondary structure prediction; RNA structure prediction; Mfold; Protein structure prediction by comparative modelling approaches(homology modelling, threading); Ab initio structure prediction: force fields, backbone conformer generation by Monte Carlo approaches, side-chain packing; Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.); CASP; Protein-ligand docking; Computer-aided drug design (pharmacophore identification); QSAR; Protein-Protein interactions.

Unit 4: System-wide analyses

Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry; Protein arrays; Metabolomics:13C NMR based metabolic flux analysis

MSMC291: Lab On Genetic Engineering credits 3

1. Isolation of total genomic DNA from bacteria and plants samples.
2. PCR amplification of a candidate gene from the isolated genomic DNA and analysis of the PCR product by agarose gel electrophoresis.
3. Cloning of the PCR amplified product in pGEM-T Easy vector.
4. Preparation of *E. Coli* (DH5 α) competentcells.
5. Transformation of plasmid DNA in *E.coli* DH5α.
6. Screening of recombinant clones by blue white screening.

7. Designing of primers for directional cloning.
8. Cloning of a candidate gene by directional cloning method.
9. Plasmid isolation by Alkaline Lysis method.
10. Isolation of plant total protein from plant leaves and analysis of the isolated protein by SDS-PAGE.

MSMC 292: Lab on Immunology credits 3

1. Antibody titre by ELISA method.
2. Double diffusion, Immuno-electrophoresis and Radial Immunodiffusion. Complement fixation test.
3. SDS-PAGE, Immunoblotting, Dot blot assays
4. Demonstration of Phagocytosis of latex beads
5. Separation of mononuclear cells by Ficoll-Hypaque
6. Flowcytometry, identification of T cells and their subsets
7. Culture of Macrophage cell and demonstration of Phagocytosis of latex beads
8. Determination of Blood group of an individual and differential leucocyte count under a microscope.
9. Cryopreservation of cultured cells and cell revival.

MSMC 206: MOOCs

MSMC206A	**Bioreactor**
MSMC206B	**ıman molecular genetics**
MSMC206C	**Cell Culture Technology**
MSMC206D	**Introduction to research**
MSMC206E	**Novel Technologies for Food Processing and Shelf Life Extension**
MSMC206F	**Soil science and technology**
MSMC206G	**Integrated pest Management**
MSMC206H	**Health Research Fundamentals**
MSMC206I	**Applied Environmental Microbiology**
MSMC206J	**Immunology**
MSMC206K	***Environmental Remediation of Contaminated Sites***

Semester III

Semester III

Code	Course Title	Contact Hrs./wk	Credit
A	**Theory**	**L-T-P**	
MSMC-301	Virology	3-0-0	3
MSMC-302	Environmental Microbiology	3-0-0	3
MSMC-303	Medical Microbiology	3-0-0	3
MSMC-304	IPR, Biosafety & Bioethics	3-0-0	3
MSMC-305	Choice Based course (From Elective Basket)	2-0-0	2
MSMC-306	Choice Based course (From MOOCS Basket)		2
B	**Practical**		
MSMC-391	Applied Bioinformatics lab	0-0-6	3
MSMC-392	Fermentation technology lab	0-0-6	3
C			
MSMC-381	Project Proposal Presentation		2
Semester Total			**24**

MSMC301: Virology

credits 3

Unit 1. Nomenclature & classification systems of viruses and Morphology of Viruses

Structure of Viruses- Enveloped and Non enveloped viruses, Capsid symmetries – Icosohedral, Polyhedral and Helical, Structural components of virus –Protein - Envelope proteins, Matrix proteins and Lipoproteins, Genome – dsDNA, ssDNA, dsRNA, ssRNA (positive sense, negative sense and ambisense), linear, circular, segmented. Virus related agents, viroids and prions

Unit 2: Cultivation and assay of viruses

Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA. Assay of viruses – Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point) Genetic analysis of viruses by classical genetic methods.

Unit 3: Entry and Replication of viruses

Mechanism of virus adsorption and entry into host cell, Genome replication, Post transcriptional processing, Translation of viral proteins, Protein nucleic acid interactions and genome packaging Assembly, exit and maturation of progeny virions, Replicative strategies employed by animal DNA viruses. Replicative strategies employed by animal RNA viruses.

Unit 4: Pathogenesis of Viruses

Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

Unit 5: Control of Viruses and Emerging Viruses

Control of viral infections through vaccines, interferons and chemotherapeutic agents. Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.

MSMC 302: Environmental Microbiology

credits 3

Unit I Environmental factors

Introduction to environment; pollution and its control; pollution indicators; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; Influence on growth and distribution of Microbes, Temperature, Ph, Radiation, osmotic and salt stress etc, BOD, COD, POC, Ammonia, Nitrate, Phosphate etc.

Unit II Waste management

Solid and liquid waste management, water treatment plant, waste disposal system, Food spoilage, Food preservation and food safety management.

Unit III Biofuel

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi. Bioremediation and Phytoremediation.

MSMC 303: Medical Microbiology credits 3

Unit I

Classification of medically important microbes; Bacterial Genetic alterations and drug resistance; Structure and function of immune system including Immune response; Autoimmunity, Hypersensitivity and Immunodeficiency, Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases.

Unit II

Gram-positive cocci, disease produced by them and diagnostic approach; Gram-negative cocci, disease produced by them and diagnostic approach; Mycobacteriaceae, Actinomycetaceae and Corynebacteriaceae; Spore bearing and non-spore bearing anaerobes; Enterobacteriaceae including E coli, Salmonella, Shigella; Vibrio; Pseudomonas; Haemophilus, Bordetella, Brucella, etc

Unit III

Classification of medically important viruses, virus cultivation & demonstration;Viral multiplication, Bacteriophage & its application in medicine; Poxviridae,Adenoviridae, Herpesviridae; Hepatitis viruses; Picornaviridae, Rhabdoviridae;Retroviridae; Arboviruses; Oncogenic viruses, Preperation & standardizatiion of viral vaccine

Unit IV

Introduction to medical mycology; Superficial &subcutaneous mycosis; Systemic & opportunistic mycosis; Introduction to parasitic diseases; Protozoan parasites of the intestines

Unit V

Hospital Acquired infection control programe & biological waste management programme.

MSMC304: IPR, Biosafety & Bioethics credits 3

Unit I IPR

PATENTS Macro economic impact of the patent system Patent and kind of inventions protected by a patent. Patent document and protection inventions. Granting of patent Rights of a patent. Searching a patent. Drafting of a patent. Filing of a patent The different layers of the international patent system (national, regional and international options) COPYRIGHT

General Additional Reading: Latest editions of Designs Act, Copyright RELATED RIGHTS. Distinction between related rights and copyright. Rights covered by copyright.
TRADEMARKS What is a trademark. Rights of trademark. INDUSTRIAL DESIGNS Industrial design. Protection provided by industrial designs.

Unit II Bioethics

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

Unit III Biosafety

Biosafety and Biosecurity - introduction; historical background; Introduction to biological safety cabinets; primary containment for biohazards; biosafety levels, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.

MSMC391: Applied Bioinformatics Lab Credits 3

1 Downloading macromolecular sequences from the NCBI database in different file formats.
2 Creating a non-redundant database of sequences using CD-HIT.
3Identification of relatives from the database using BLAST search. Creation of a data-set on the basis of the E-value.
3 Using EMBOSS for local and global alignment of proteins.
4 Determination of domains present in proteins and comparison of domain architecture (DA) across different proteins.
5 Identification of repeats in proteins using Pfam.
6 Further identification of repeats left undetected by Pfam using multiple sequence analysis.
7 Construction of phylogenetic tree using PHYLIP.

MSMC392: Fermentation technology lab credits3

1. Production of ethanol by yeast and estimate titre, yield and its productivity.
2. Production of lactic acid by lactic acid bacteria, separation and calculation of titre, yield and

its productivity

3. Production of Baker's yeast and separation by filtration and centrifugation methods.
4. Production of amylase and measurement of its activity.

Semester – IV

Code	Course Title	Contact Hrs./wk	Credit
		L-T-P	
MSMC-481	Project Work		22
MSMC-482	Industry/ lab visit		1
MSMC-483	Journal Club		1
Semester Total			**24**

M.Sc Elective paper (MAKAUT, WB)

Elective Subjects:

MSMC 305A Environmental Biotechnology

Unit I
Introduction to environment:
Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit III
Bioremediation
Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT *etc.*), technological aspects of bioremediation (*in situ*, *ex situ)*. Application of bacteria and fungi in bioremediation, Phytoremediation:

Unit IV
Applications of environmental biotechnology **in agriculture**
Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (*e.g. Trichoderma, Pseudomonas fluorescens*); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

Unit V
Biofuels
Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

MSMC-305B Nanobiotechnology

Unit I
Introduction to nanobiotechnology
Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Unit II
Nano – particles
Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Unit III
Applications of nano – particles
Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

Unit IV
Nano – toxicity
Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life cycle assessment,

containment.

MSMC-305C Enzyme technology

Unit I

Enzymes, coenzymes and cofactors

Enzymes: Classification, mode of action, activation, specificity, Source of enzymes; production, isolation and purification of enzymes; Characterization in terms of pH, temperature, ionic strength, substrate and product tolerance, effects of metal ions; Coenzymes and cofactors: Coenzymes, classification of vitamins, role and mechanism of action of some important coenzyme (NAD+/NADP+, FAD, lipoic acid, tetrahydrofolate, B12-coenzyme), role of cofactors with specific examples.

Unit II

Enzyme kinetics

Enzyme as biological catalysts; Enzyme action, active site, functional group, enzyme substrate complex, cofactors, Michaelis-Menten equation, Km and Vmax, enzyme inhibition; order of reaction, methods of plotting enzyme kinetics data; Enzyme turnover number. competitive, non-competitive, uncompetitive, irreversible; order of reaction, methods of plotting enzyme kinetics data; determination of Kcat, Km, Vmax, Ki, Half life, activation and deactivation energy etc, Cross-linked enzyme aggregates, Cross linked enzymes, enzyme crystals, their use and preparation; Solution of numerical problems; Energy yielding and energy-requiring reactions; Calculation of equilibrium constants; Activation energy *etc.*; Multisubstrate enzymes and kinetics mechanisms; Enzyme induction, repression, covalent modification, Isoenzymes, allosteric effects.

Unit III

Applications of enzyme technology

Immobilized enzyme technology: Different techniques of immobilization of enzymes and whole cells; Advantages and disadvantages of immobilization; Kinetics of immobilized enzymes, design and operation of immobilized enzymes reactors; Type of reactors, classification, retention of enzymes in a reactor, kinetics of enzyme reactors; Reactor performance with inhibition, operation of enzyme reactors; case studies; starch conversion; APA production, biotransformations using soluble as well as immobilized enzymes; Calculation of diffusional resistances and Thiele's modulus, multi-step immobilized enzyme systems; Solution of numerical problems; Application and future of immobilized enzyme technology; Enzyme in organic solvents and ionic liquids: Various organic solvents and ionic liquids used in biocatalysis; Potential in organic solvents and ionic liquids; Applications of enzymes in analysis.

MSMC-305D Principles of Ecology

Unit I

The Environment

Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Unit II

Population Ecology

Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Unit III

Community Ecology

Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

M.Sc Elective paper (MAKAUT, WB)

Unit IV:
Applied Ecology
Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

MSMC-305E Research methodology and Writing

Unit I
History of science and science methodologies
Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology.

Unit II
Preparation for research
Choosing a mentor, lab and research question; maintaining a lab notebook.Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness. Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions;

Unit III
Scientific communication
Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

MSMC-305F Bioenterpreneurship

Unit I
Innovation and entrepreneurship in bio-business
Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Unit II
Bio markets: business strategy and marketing
Negotiating the road from lab to the market (strategies and processes of negotiation with financers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

Unit III
Technology management
Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of

foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

MSMC-305G Molecular diagnostics

Unit I
Genome: resolution, detection and analysis
PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF MS; Bioinformatics data acquisition & analysis.

Unit II
Detection and identity of microbial diseases
Direct detection & identification of pathogenic-organisms that are slow growing or currently lacking a system of *in vitro* cultivation as well as genotypic markers of microbial resistance to specific antibiotics.

Unit III
Detection of inherited diseases
Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: - Fragile X Syndrome: Paradigm of the new mutational mechanism of the unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in the growing number of familial cancer syndromes.

Unit IV
Molecular oncology
Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.

MSMC/MSMB/MSGN—305H Plant Molecular Biology

Unit I
Plant tissue culture
Plasticity and Totipotency, The culture environment, Plant Cell culture media, Plant growth regulators and function, Culture types- Callus, Cell-suspension culture, Protoplast culture, Root culture, Shoot tip and Meristem culture, Embryo culture, Somaclonal variation, Somatic Embryogenesis, Polyploidy, Androgenesis, Artificial Seed, *Agrobacterium* mediated transformation.

Unit II
Plant Transcription Factor
Introduction to Transcription factor structure and function, Methods to study transcription factor structure and function, Different plant specific transcription factors and their functions, Different Plant transcription factors and their functions.

Unit III
Plant Physiology
Molecular mechanism of seed germination, significance of ABA and GA in seed germination, light control on flower development, short day plants and long day plants, ABC model of flowering, plant stress physiology, drought stress, salt stress, biotic stress, viral stress.

M.Sc Elective paper (MAKAUT, WB)

Unit IV
Plant Disease
How pathogen attack plants, Mechanism of plant defence against pathogen, Effect of pathogen on plant physiological functions, causative agent of plant disease like virus, fungi, bacteria, nematodes etc.

MSMC 305 I : Food Microbiology
Unit I
History and development of Food microbiology: History of Microorganisms in Fooddevelopments: Common Food borne Bacteria, Molds. Sampling Method for detecting microbes, Physical, Chemical methods, Whole animal assays, Immunological methods. Importance and significance of microorganisms in food. Factors – Intrinsic and Extrinsic parameters - affecting the growth of microorganisms in food. Organisms involved, characteristic features.
Unit 2
Microbial Food Spoilage and Food borne diseases : Dynamics and significance of spoilage of different groups of foods – Cereal and cereal products, vegetables and fruits, meat, poultry and sea foods, milk and milk products, packed and canned foods. Spoilage and defects of fermented foods. Staphylococcal, Ecoli, Salmonellosis, shigellosis, Listerial infections. Mycotoxins, Aflatoxins Alternaria Toxins, Toxigenic Phytoplanktons and viruses
Unit 3 Preservation of food
Food preservation- High temperature, Low temperature- Significance of psychrophilic microbes in cold-stored and frozen foods, Drying, Modified atmosphere, Radiation, other food protection methods and Microbial Resistance. High voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide,
Unit 4 Food safety protocol
General principles of food safety risk management, recent concerns on food safety- Safe food alternatives (Organic foods), Good agricultural Practices (GAP), Food Indicators of water and food safety and quality- Microbiological criteria of foods and their Significance. The HACCP and ISO systems for food safety
Unit 5. Food Microbiology and Public Health Food Hazards, Significance of Foodborne Disease, Incidence of Foodborne Illness, Risk Factors Associated with Foodborne Illness, The Site of Foodborne Illness. The Alimentary Tract: Its Function and Microflora, The Pathogenesis of Diarrhoeal Disease