Department of Biotechnology
Chaudhary Charan Singh University, Meerut

Programme Syllabus
Master of Science in Biotechnology
(M.Sc. Biotechnology)
Under Choice Based Credit System (CBCS)

(Effective from Academic Year 2020-21)

ABOUT OF THEDEPARTMENT

PROGRAMME OUTCOMES (PO's)

The M.Sc. Program of Biotechnology at Ch. Charan Singh University, Meerut, started in 1996, aims to train students in Biotechnology wherein engineering and technology principles could be used to probe biological questions or to develop technologies, devices and systems that require substantive expertise in Biology, Agriculture, Pharmaceutical, Industrial, as well as Clinical Research components. The students in this program acquire knowledge, critical thinking skills and experience in conducting cutting edge research. This program develops human capital for advanced scientific research and entrepreneurship. The syllabus of M.Sc. Biotechnology is designed in such a way that all the 16 courses have their own objectives and methodologies to achieve their respective course outcomes. All the papers combine theoretical inputs with specific practicals related to the needs of various fields of biotechnology teaching and research. To achieve the programme specific outcomes, teachers have to use various direct or indirect methods to achieve overall pedagogical objectives. Due to time limitations in semester system, it is very difficult to achieve all outcomes / targets at the same time. That is why, programme uses different simple and direct measurement tools to assess the extent to which course outcomes have been attained maximum. The new and advanced competency based curriculum emphasizes on the acquisition of competencies as a requisite for progression in the course. The programme adopted advanced and active learning process for the students to develop their skills. The achievement of competencies/pre-determined tasks of students is periodically assessed through internal and summative assessments. A record of activities completed and competencies acquired through each course of the programme is necessarily done to ensure the identification of fast and slow learner and also we recorded that what they gained from the key competencies. The programme periodically encourages student's participation in all the curricular activities organized by different governmental and non-governmental organizations and such activities forms an integral part of the formative/continuous assessment program. To measure course outcomes and attainment level of each student, the department conducts continuous assessment tests, written quizzes, oral quizzes, assignments, small projects, short training, seminar presentations, class discussions, lab practical knowledge in each course and at programme level, project work with dissertation is compulsory. The department finds the attainment level of each student on the basis of marks obtained in these tests, quizzes, seminar and assignments. Other co-curricular activities such as field visits, industrial trips, participation in social, environmental and ethics awareness in public domain are also considered for measuring / assessing the attainment of each course outcome and specific program outcome of each student. The targets thus set for the attainment of POs, PSOs and COs are updated every year. From time to time, the university authorities' takes stock of the attainment of programme and course outcomes and suggest corrective measures, which are then implemented by the department.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Postgraduate students will be able to demonstrate and apply their knowledge of cell biology, biochemistry, microbiology and molecular biology to solve the problems related to the field of biotechnology.

PSO2: Postgraduate students will be able to demonstrate and apply the principles of bioprocess engineering in the design, analysis, optimization and simulation of bioprocess operations.

PSO3: Students will be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

PSO4: Students will be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

PSO5: Student will be able to (a) Describe fundamental molecular principles of genetics; (b) Understand relationship between phenotype and genotype in human genetic traits; (c) Describe the basics of genetic mapping; (d) Understand how gene expression is regulated.

PSO6: Students will be able to (a) To elaborate concepts of biochemistry with easy to run experiments; (b) To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

PSO7 Students will be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

PSO8: Students will be able to gain hands on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

COURSE OUTCOMES (COs)

M.Sc. Biotechnology			
Semester	Course Name	Course Code	Course Outcome
I	Fundamentals of Genetics(Core Course)	CH-1595	CO-1: The students will be able to understand the classical and modern concepts of genetics. CO-2: Students are able to understand the basic principles of inheritance biology. CO-3: Students will be able to understand the sex linked inherited characters and diseases. CO-4: They will get in-depth knowledge about gene interaction, penetrance and expressivity. CO-5: The student will demonstrate proficiency in understanding the basic structure of atom and interpret the inheritance of characters by using linkage and crossing over.
	Cell Biology (Core Course)	CH-1596	CO-1: The student would be able to comprehend the cell organelle, cell membrane CO-2: The student would be able to signal transduction and its implications CO-3: The student would be able to cell cycle and its relevance CO-4: sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive
	Tools & Techniques in Biotechnology (Core Course)	CH-1597	CO-1: Enable the student to get sufficient knowledge in principles and applications of bio instruments. CO-2: The properties of biomolecules that are used for their analysis CO-3: The principle concepts in using analytical and preparatory techniques CO-4: How to quantify and assay for a biomolecules. CO-5: On successful completion of the course the students will be aware of microscopic techniques, electro physiological methods, biomolecules structure determination using spectroscopy, centrifugation and radiolabelling techniques.
	Bio-statistical Methods (Core Elective)	CH-1598	CO-1: Students will acquire independent ability to carry out statistical analysis of data and interpretation of results.

			CO-2: Students will be able to statistically analyze the phenotypic data of plant traits. CO-3: The students will recognize and examine the relationships between inputs and outputs in their agricultural field to make effective and profitable decisions. CO-4: Students will demonstrate an ability to engage in critical thinking by analyzing situations and constructing and selecting viable solutions to solve problems. CO-5: Student will be able to demonstrate the ability to analyse data and draw appropriate statistical conclusions. CO-6: Students will be well equipped to handle field level data for analysis and modeling purposes. They will learn how to draw a good sample from a population in order to draw valid inference. CO-7: Students will be able to develop strategies for experimental designs.
II	Cytogenetics and Molecular Genetics (Core Course)	CH-2595	CO-1: Explain the concepts of DNA replication, DNA damage and repair, and gene expression in eukaryotic and prokaryotic organisms. CO-2: Be able to take a family history and construct and interpret a pedigree. CO-3: Be aware of the different laboratory techniques to investigate genetic material and their advantages and limitations. CO-4: Be able to interpret a standard cytogenetic and molecular genetics. CO-5:Be able to understand Duplication and deficiencies, Translocation, Inversion, Trisomic and Tetrasomic,Monosomic and Nullisomic.
	Fundamentals of Biochemistry (Core Course)	CH-2596	CO-1: This course presents the chemical reactions or metabolic functions in the living system and their regulations. CO-2: To make the student to understood the concept of biochemical regulations CO-3: On successful completion of the subject the student should have understood: basic biomolecules, viz protein fats, enzymes and their relevance to biological molecular stabilization.
	Recombinant DNA	CH-2597	CO-1: Explain the basic principles and, the

	Technology and Genetic Engineering (Core Course)		tools and techniques of Genetic engineering CO-2: Describe the applications of genetic engineering in various fields. CO-3: Debate on ethical issues concerned with Genetic engineering
	Computer Applications and Bioinformatics (Core Elective)	CH-2598	CO-1: Students will understand computational basis of genetic analysis that use genome data sets in system biology. CO-2: Students will be able to explain about the methods to characterize and manage the different types of biological data. CO-3: Student will know about various biological databases that provides information about nucleic acids and protein. CO-4: Student will understand the basics of sequence alignment and analysis. CO-5: Students will be able to design and execute the programmes related to structural and functional aspects of genes and proteins.
	Trends in Biotechnology (Open Elective for Other PG students)	CO-6622	CO-1: The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. CO-2: Genetic engineering is a technology that has been developed based on fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.
III	General Microbiology (Core Course)	CH-3595	CO-1: The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society. On completion of this course, students would develop deeper understanding of the microbiology and its applications. CO-2: Explain the principle and application of various types of Microscopy. CO-3: Describe the structure and Classification, staining, culturing, physiology, of microorganism.
	Animal Biotechnology & Immunology (Core Course)	CH-3596	CO-1: Explain the concepts of innate and adaptive immune response and techniques for clinical diagnosis. CO-2: Illustrate the methodology to establish

			animal cell culture. CO-3: Describe the importance of engineering animal cells for the production of therapeutic proteins
	Biotechnology in Crop Improvement (Core Course)	CH-3597	CO-1: Ability to apply the concepts and principles of plant tissue culture techniques on research problems pertinent to crop improvement. CO-2: Dissemination of skills on usage of the acquired knowledge on practical biotechnology tools to augment agricultural research. CO-3: The knowledge required to execute, analyze and apply molecular marker systems for crop improvement. CO-4: Students will know about different mapping populations. CO-5: Establish different types of plant cultures. CO-6: Apply the technical skills learnt to establish nurseries for horticultural and agricultural crops. CO-7: Compare the pros and cons of transgenic plants on environment CO-8: Explain the concepts of intellectual property management and handling of GMOs.
	Plant Genetic Resources: - Conservation and Their Sustainable Use (Core Elective)	CH-3598	CO-1: Students will have knowledge on the conservation of biodiversity. CO-2: They will acquire knowledge on various organizations involved in conservation and their policies. CO-3: The students will have knowledge on plant quarantine regulations. CO-4: The students will be able to promote human capacity to appreciate, maintain, and promote utilization of plant genetic resources. CO-5: Students will understand different forms of IPRs and legislations related with IPRs. They will be well aware of Farmers' and Plant Breeders' rights.
	Environmental Biotechnology (Open Elective for Other PG students)	CO-7622	CO-1: This course aims to introduce fundamentals of Environmental Biotechnology. Apply the concepts of Biotechnology in Environmental Management. CO-2: Describe the concept of pollution management. CO-3: The course will introduce major groups

			of microorganisms tools in biotechnology and their most important environmental applications. On completion of course, students will be able to understand the use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.
IV	Advances in Nano-biotechnology (Core Course)	CH-4595	CO-1: Basic knowledge of nanoscience and its advancement in present time, future aspects of nanoscience CO-2: Introduction, Properties and Characterization of nanomaterials, use of quantum dots in biology CO-3: Study of Protein and Peptide based Nanostructures, DNA based Nanostructures, DNA based devices, nanosensors CO-4:Self assembling nanostructures, Synthesis and Assembly using Bio-Derived Templates. CO-5: Use of Pharmaceutically important nanomaterials for controlled drug delivery CO-6:Nanomaterials and Toxicity Evaluation at cellular level.
	Genomics and Proteomics (Core Course)	CH-4596	CO-1: Learning about genome, the types and significance of repeats in the genome. CO-2: Learn strategies for Whole Genome Sequencing. CO-3: Perform procedures for the De novo and reference based assembly, Genome finishing and annotation. CO-4: Perform ORF, ab initio and homology based Gene prediction. CO-5: Assessing genomic variations- using DNA marker systems. CO-6: Knowledge on DNA chips and their use in transcriptome analysis. CO-7: Learn about the role of mutants and RNAi in functional genomics. CO-8: Acquire skills in the techniques of Site directed mutagenesis, Transposon tagging and targeted genome editing technologies. CO-9: Perform protein 3D structure modelling and proteome analysis. CO-10: Understand protein- protein interaction by FRET, yeast two hybrid and co-immunoprecipitation.

	Bioethics Intellectual Property Rights, Biosafety and Research Methodologies (Core Course)	CH-4597	CO-1: Detailed description on global status of genetically engineered crops, Asimolar conference on rDNA technology. CO-2: Brief description on the concerns of GE crops – animal and human health, environment, agriculture, horizontal gene transfer and general concerns. CO-3: Principles of safety assessment of transgenic plants and sequential steps in risk assessment. CO-4: Concepts of familiarity and substantial equivalence CO-5: Environmental risk assessment and food and feed safety assessment. CO-6: International biosafety regulations, Cartagena protocol, OECD consensus documents and Codex Alimentarius CO-7: Indian biosafety regulations, Biosafety research trials and GM labeling. CO-8: Brief description on bioethics, ethical issues on GM crops, Nuffield council on bioethics.
	Industrial Biotechnology & Bioentrepreneurship (Core Elective)	CH-4598	CO-1: Entrepreneurial Development in Biotechnology on different topics based on interest of the students: Micropropagation of Commercially Important Crops, Secondary Metabolite Production from Plant Cell Cultures, Molecular Diversity Analysis of Plants and their Associated Organisms, Marker-assisted Introgression of Target Genes, Bioprospecting for Novel Biomolecules / Genes, Isolation and Characterization of Agronomically Important Genes, Genetic Transformation and Evaluation of Transgenic Plants for Stress Resistance, Recombinant Protein Production in Microbial Systems. CO-2: Students learns tools and techniques in various modules of biotechnology CO-3: Perform procedures for the De novo and reference based assembly, Genome finishing and annotation. CO-4: Develop ability to plan and perform experiments. CO-5: Inculcates the team learning environment when students are posed with challenging tasks.

			CO-6: Ability to formulate winning project proposals for establishing independent firms. CO-7: Knowledge on resource mobilization, cost analysis and economics of the project.
I-IV	Thesis Work		CO-1: The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers. CO-2: Students should be able to formulate a scientific question CO-3: Students should be able to present scientific approach to solve the problem CO-4: Students should be able to interpret, discuss and communicate scientific results in written form. CO-5: Students should be able to gain experience in writing a scientific proposal CO-6: Students should be able to learn how to present and explain their research findings to the audience effectively.

Ad-hoc Board of Studies (BoS) in Biotechnology
February 22, 2020

Syllabus of M.Sc. (Biotechnology) two years (4-sem) Progamme under CBCS from the Academic session 2020-21 (applicable only for CCS University campus) (**Annexure-1**)

Department of Biotechnology
Ch. Charan Singh University, Meerut

Syllabus as per CBCS (w.e.f. 2020-2021)
M. Sc. Biotechnology

Course Type	Name of Course	Course Code	Credits	Maximum Marks			
				Int.	Ext.	Prac.	Total
SEMESTER I							
Compulsory Core	Fundamentals of Genetics		4+1+0	40	40	20	100
	Cell Biology		4+1+0	40	40	20	100
	Tools & Techniques in Biotechnology		4+1+0	40	40	20	100
	Total		**15**				
Elective Core	Bio-statistical Methods		4+1+0	40	40	20	100
	Total		**5**				
Thesis Work	Component-I		**8**				---
	Total		**28**				**400**
SEMESTER II							
Compulsory Core	Cytogenetics and Molecular Genetics		4+1+0	40	40	20	100
	Fundamentals of Biochemistry		4+1+0	40	40	20	100
	Recombinant DNA Technology and Genetic Engineering		4+1+0	40	40	20	100
	Total		**15**				
Elective Core	Computer Applications and Bioinformatics		4+1+0	40	40	20	100
	Total		**5**				
Open Elective	Trends in Biotechnology		4+0+0				100
Thesis Work	Component-II		**12**				
	Total		**32**				**500**

SEMESTER III							
Compulsory Core	General Microbiology		4+1+0	40	40	20	100
	Animal Biotechnology & Immunology		4+1+0	40	40	20	100
	Biotechnology in Crop Improvement		4+1+0	40	40	20	100
	Total		**15**				
Elective Core	Plant Genetic Resources: - Conservation and Their Sustainable Use		4+1+0	40	40	20	100
	Total		**5**				
Open Elective	Environmental Biotechnology		4+0+0				100
Thesis Work	Component-III		**12**				
	Total		**32**				**500**
SEMESTER IV							
Compulsory Core	Advances in Nano-biotechnology		4+1+0	40	40	20	100
	Genomics and Proteomics		4+1+0	40	40	20	100
	Bioethics Intellectual Property Rights, Biosafety and Research Methodologies		4+1+0	40	40	20	100
	Total		**15**				
Elective Core	Industrial Biotechnology & Bioentrepreneurship		4+1+0	40	40	20	100
	Total		**5**				
Open Elective	---		---				---
Thesis Work	Component-IV		**8**				
	Total		**28**				**400**
M. Sc. Thesis	Component-I (C_1): Periodic progress and progress reports (15%)						
	Component-II (C_2): Results of work and draft report (15%)						
	Component-III (C_3): Final viva-voce and evaluation (70%) (a) The report evaluation (40%) (b) Viva-voce examination (30%)						

	Total credits in M.Sc. Thesis		**40**				**Satisfactory**
	Grand Total		**120**				**1600**

*In each semester, there shall be one joint external practicle examination carrying 80 marks based on all the four courses (20+20+20+20 marks) of compulsory and elective core.
#Minimum 36 credits are required for M.Sc. thesis.
^Non credit course (qualifying)
^Pattern of examination, passing marks, determination of CGPA/division shall be as per rules applicable in faculties of Sciences and Arts in university campus.

Semester I

FUNDAMENTAL OF GENETICS (Course-I)

Unit-I
Introduction: History of Genetics, its scope and significance, Mendel's experiments, Dominance, Segregation, Independent Assortment, Lethality and Interaction of genes. (4)

Unit-II
Linkage and crossing over: Linkage in higher eukaryotes, Coupling and Repulsion Hypothesis,
measurement of Linkage, Detection of linkage, Breakdown of Linkage, Four- strand crossing over, Three-Point Test cross, cytological basis of crossing over, Interference and Coincidence, Crossing over and Chisma formation, Factor affecting recombination frequencies. (4)

Unit-III
Genetics of Sex Determination and Differentiation: Sex-linked, Sex- limited and Sex-influenced traits in Drosophila and Human beings, Theories of Sex-determination-Chromosomal theory, environmental theory and genic balance theory, Sex- determination in dioeciously plants, Sex reversal and Gynandromorphs, Human sex anomalies (Klinefelter's Syndrome and Turner's Syndrome), brief idea of Dosage Compensation and Lyon's hypothesis. (6)

Unit-IV
Mutation and Mutagenic Agents: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, Detection of mutation in Drosophila (CIB method, Muller-5 method), Detection of mutation in plants and their practical application in crop improvement. (6)

Unit-IV
Multiple Alleles: Concepts of multiple alleles, self incompatibility alleles in Nicotiana, coat color in rodents, Blood group in Humans, antigen-antibody interaction in inheritance of A, B, AB and O blood groups, H-antigens, MNS system, Rh Factor, Epitasis and multiple allelism (Bombay blood group). (6)

Unit-V
Genetics of Inbreeding Depression and Heterosis: Definition and Historical aspects of heterosis and Inbreeding depression, manifestation and application of heterosis, apomixis and fixation of heterosis, application of molecular marker in heterosis breeding. (8)

Unit-VI
Extra -chromosomal Inheritance: Criteria for extra- chromosomal inheritance, plastid inheritance in Mirabilis, iojapa in corn, Kappa particles in Paramecium, Coiling in snails, male sterility in plants. (6)

Unit-VII

Biochemical Genetics: Inborn errors of Metabolism in man, eye transplantation in Drosophila, biochemical mutations in Neurospora, biosynthetic pathways and biochemical mutations. (4)

Unit-VIII

Concepts of Genes: Classical and modern gene concepts, Pseudoallelism, position effects, intragenic crossing over and complementation (cistron, recon, muton), Benzer's work on rII locus in T4 phases. (6)

CELL BIOLOGY (Course II)

Unit-I

Membrane structure and function: lipid bilayer; membrane proteins; Principles of membrane transport; ion channels and electrical properties of membranes. (6)

Unit-II

Cell junctions: Cell adhesion and the extracellular matrix; cell-cell adhesion; extracellular matrix of animals; structure and function of plant cell wall. (6)

Unit-III

Cytoskeleton: Nature of cytoskeleton; intermediate filaments; microtubules; cilia and centrioles; actin filaments; actin-binding proteins. (6)

Unit-IV

Genomes of cellular organelles: The genomes of nucleus, mitochondria and chloroplasts, chromosomal DNA and its packaging, Chromosome structure, Nucleosome concept. (6)

Unit-V

Vesicular traffic in the secretory an endocytotic pathways: Transport to lysosomes; Endosomes; endocytosis; transport to the cell surface; exocytosis; the molecular mechanisms of vesicular transport; Intracellular compartments and protein sorting; the transport of molecules in and out of the nucleus; the transport of proteins into mitochondria and chloroplasts; peroxisome; endoplasmic reticulum. (8)

Unit-VI

Cell signaling: General principles of cell signaling; signaling via G-protein-linked cell surface receptors; their structure, function, biochemical mechanism and relevance in drug discovery; signaling via enzyme-linked cell surface receptors, Concept of second messenger, Intracellular signal transduction pathways. (6)

Unit-VII

Cell cycle regulation and control: Mechanisms of cell cycle regulation, Programmed cell death including apoptosis, necrosis and autophagy. (6)

Unit-VIII

Cancer biology: Dysregulation of cell cycle during oncogenesis, concepts of tumor suppressor and oncogenes, regulation of telomerase, cancer diagnostics and prevention. (6)

TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (Course-III)

Unit-I

Microscopy: Principles, Resolving Power and applications of Light Microscopy, Electron Microscopy (SEM, TEM) and Confocal Microscopy, different fixation and staining techniques for microscopy. (6)

Unit-II

Centrifugation: Brief history, type and theory of centrifugation, types of centrifuges and centrifugation techniques, Types of rotors. (6)

Unit-III

Electrophoresis: - History, Principles, Application and factor affecting of electrophoresis with detail reference to Agarose, PAGE, PFGE, Capillary electrophoresis, continuous, 2D-PAGE, IEF. (8)

Unit-IV

Chromatography: - General principles and techniques of HPLC, LPLC, GLC, Adsorption Chromatography, partition chromatography, IEC, permeation Chromatography, Affinity Chromatography. (10)

Unit-V

Spectroscopy: - Introduction, theory and principles of different types of Spectroscopy (Visible, UV, IR) and their applications in biotechnology. (6)

Unit-VI

Nuclear and Mass Spectroscopies: - History, theory and principles, NMR and Mass spectrometers, Measurement by NMR and Mass spectrometers. (8)

Unit-VII

Radiolabeling techniques:

Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

BIO-STATISTICAL METHODS (Course-IV)

Unit-I

Presentation of Data: Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves. (6)

Unit-II

Measures of Locations and Dispersion: Mean, median, mode and their simple properties (with-out derivation) and calculation of median by graphs; range, mean deviation, standard deviation, standard error, coefficient of variation. (6)

Unit-III

Probability and Distributions: Random distributions; events exhaustive, mutually exclusive and equally likely; definition of probability (with simple exercises); definitions of binomial, Poisson and normal distributions; and simple properties of the above distributions (without derivation). (4)

Unit-IV

Correlation and Regression: Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes. (8)

Unit-V

Sampling: Concept of population and sample; random samples; methods of taking a simple random sample. (4)

Unit-VI

Tests of significance: Sampling distribution of mean and standard error; z and t-test (equality of means; paired and unpaired t-test); t-test for comparison of means when variances of two populations differ; Chi- square test for goodness of fit; independence of attributes, and homogeneity of samples; interrelation between t-test and F-Test (12)

Unit-VII

Experimental Designs: Principles of experimental designs; completely randomized, randomized complete block design (missing plot value in RBD); latin square designs; augmented block design; factorial RDB, Alpha Lattice design, simple factorial experiments (mathematical derivations not required); analysis of variance (ANOVA) and its use including estimation of LSD (CD) (10)

Semester II

CYTOGENETICS AND MOLECULAR GENETICS (Course-V)

PART-A: - Cytogenetics

Unit-I
Cell Division: Cell Cycle, differences between mitosis and meiosis, mechanism of chromosome moment, reduction division and equational division, double reduction. **(6)**

Unit-II
Duplication and deficiencies: Classification, methods of production, meiotic pairing and Phenotypic effects. (4)

Unit-III
Translocation: - Classification, methods of production, identification, meiotic pairing and role in evolution. (4)

Unit-IV
Inversion: Classification, methods of production, identification, meiotic pairing and crossing over in different regions, Role in evolution. (6)

Unit-V
Trisomic and Tetrasomic: - Classification, methods of production, Identification, meiotic pairing and utility in Chromosome mapping. (2)

Unit-VI
Monosomic and Nullisomic: - Methods of Production, Identification, meiotic behavior, monosomic analysis, alien additions/substitution lines. (2)

PART-B: - Molecular Genetics

Unit-VII
Genetic Material: DNA and RNA as genetic material (experimental evidences), structure of DNA(including Z-DNA and 5- hasisekharan's RL model), super coiling of DNA, Different type of RNAs and their roles, difference between DNA and RNA. (6)

Unit-VIII
DNA Duplication (in prokaryotes and Eukaryotes):- Unwinding proteins, Role of RNA Polymerases and DNA polymerases in prokaryotic and eukaryotic DNA replication, Semiconservative, Discontinuous and Bi-directional replication, RNA primers, Role of proteins in prokaryotic and eukaryotic DNA replication, Models of replication. (8)

Unit-IX
Organization of Genetic Material: Chromosome ultra structure and nucleosome concept, packing of DNA as nucleosomes in eukaryotes, techniques used for discovery of nucleosome, structure and assembly of nucleosomes, solenoid, phasing of nucleosomes, DNA concept and

C-value paradox, repetitive and unique sequences, overlapping, pseudo, crying and split genes, satellite DNA's, selfish DNA. (8)

Unit-X

Genetic Code (including mitochondrial genetic code):- Deciphering of code in vitro and in vivo (use of mutations-base replacement, frame-shift and suppressor mutation). (4)

FUNDAMENTALS OF BIOCHEMISTRY (Course-VI)

Unit-I

Introduction: Structure of atoms, molecules and chemical bonds, Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.), pH, buffer, reaction kinetics, thermodynamics, colligative properties. (4)

Unit-II

Composition, Structure and Function of Biomolecules: - Proteins, Carbohydrates, Lipids, Fatty Acids, Vitamins and Nucleotides. (6)

Unit-III

Major intermediary metabolic pathways, metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins. (10)

Unit-IV

Confirmation of Proteins: - Structure and function, Protein sequencing, Ramachandran's plot, domains, motif and folds (4)

Unit-V

Enzymology: - Enzymes, Principle of catalysis, enzymes and enzymes kinetics, Mechanism of enzymes action, enzyme activity and substrate specificity, enzyme regulation, coenzymes, Isozymes and allosteric enzymes, extremozymes engineering, nonaqueous enzymology. (12)

Unit-VI

Secondary metabolites: - Hormones, Alkaloids, Porphyrins. (6)

RECOMBINANT DNA TECHNOLOGY AND GENETIC ENGINEERING (Course-VII)

Unit-I

Genetic Engineering: - Definition and explanation, scope of GE, Concept and importance of GE, RDT in prokaryotes and eukaryotes, Restriction enzymes, modifying enzymes, Isoschizomers and cloning into mutagenesis, DNA Fingerprinting. (12)

Unit-II

Cloning and expression vectors:-Plasmid, Phage, M13, Phagemid, BAC, YAC, MAC, Expression vectors, Use of Promoters, Expression through Strong and Regulatable Promoters, Binary and Shuttle Vectors. (8)

Unit-III

Libraries and molecular probes: - Construction and Screening of genomic and cDNA libraries in plasmid, phage and cosmid, BAC libraries and assembly of BACs into contigs, Molecular probes and their preparation, labeling and applications, Southern, Northern, Western blotting, Chromosome walking, Chromosome jumping. (12)

Unit-IV

Polymerase Chain Reaction: - Basic principles and its modifications, designing of primers, Different schemes of PCR, application of PCR, RACEs, Electronic PCR (e-PCR), RT- PCR, Real- Time PCR (8)

Unit-V

Gene Sequencing: - Different methods of gene isolation, techniques for sequencing (Maxam & Gilbert degradation method, Sanger's Dideoxy method), Organo-chemical gene synthesis mechanism, cDNA using reverse transcriptase. (8)

Unit-VI

Analysis of DNA Polymorphism: RAPD, RFLP and AFLP, SSR, SNPs techniques. (2)

COMPUTER APPLICATIONS AND BIOINFORMATICS (Course-VIII)

Part A: Computers

Unit-I

Introduction to computers: Types, general characteristics, input/output units, memory, internal representation of data (binary, octal and hexa-decimal system, bits and bytes). 2

Unit-II

Brief idea of operating systems: Disc operating systems (DOS), UNIX and its versions (Linux), WINDOWS and its upgraded versions. 4

Unit-III

Introduction to networking: LAN (local area network), WAN (wide area network), MAN (metropolitan area network) including www (world wide web). 2

Unit-IV

Microsoft (MS) office and its applications: Introduction to MS Excel and its applications for statistical analyses with particular reference to agricultural data (tabular and graphical representation of data, analyses of variance, regression and correlation); introduction to MS Word and its application for document preparation; power Point and its application for preparing presentations. 6

Unit-V

Introduction to statistical packages: Introductory knowledge of SPSS (Statistical Package for the Social Sciences), SAS (Statistical Analysis Software) packages for statistical analysis of agricultural data, handling software for data analyses. 6

Part B: Bioinformatics

Unit-VI

An overview of bioinformatics: Introduction, objective of bioinformatics, kind of data used in bioinformatics, multiplicity of data and redundancy, major bioinformatics databases, data integration, data analysis. 4

Unit-VII

Sequence and structure databases: Nucleic acid data bases (EMBL, GenBank, DDBJ), protein data bases (SWISS-PROT, TrEMBL PIR-PSD, UNIProt as a single database), URLs (Uniform resource locators) of databases, SWISS-2DPAGE, KEGG, COGS, PROSITE, etc. Sequence cluster database (ProDom, Cluster, SYSTERS, ProtoMap); structure databases (CCDC, DSSP, SCOP, CATH, etc.). 6

Unit-VIII

Alignment of sequences: Introduction to sequence analysis, models for sequence analysis (local, global, end free space alignment and gap penalty), introduction to applications of dot matrices, application of FASTA and BLAST programmes (introduction, BLAST output, significance of BLAST results, recommended steps in BLAST, BLAST programmes), comparison between FASTA and BLAST programmes. 10

Unit-IX

Assembly of nucleotide sequences. 4

Unit-X

Access to literature: Bibliographic databases; (Boolean searching, limiting searches, history functions to combine different searches); databases (PubMed/MEDLINE; ISI Citation Database, Current contents®; BIOSIS Previews; Pascal; EMBASE; The Cochrane Reviews, AGRICOLA, Agripedia etc.); PubMed and other databases; on-line access to abstracts and full text of articles; online books; free and paid access). 6

Semester III

GENERAL MICROBIOLOGY (Course-IX)

Unit-I

Methods in Microbiology: Theory and practice of sterilization, Pure culture technique, Microbial nutrition, Preparation of culture media, Enrichment of culture techniques for the isolation of chemo-autotrophs, Chemo-heterotrophs and photosynthetic microorganisms, Microbial strain improvement. (7)

Unit-II

Microbial growth measurement: Growth curve, measurement of growth and growth yields, Synchronous growth, Continuous culture, Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Culture collections and maintenance of cultures. (7)

Unit-III

Microbial diversity: Classical and modern methods and concepts, Bergey's manual, Carl Woese's three domain concept based on 16s r-RNA gene sequencing, Ribotyping, Microbial fingerprinting from environmental samples, DGGE. (7)

Unit-IV

Bacteria: Purple and green bacteria, Cyanobacteria; Actinomycetes; Mycoplasma. (7)

Unit-V

Archaea: Halophiles, Methanogens, Thermophiles. (3)

Unit-VI Eukarya: Algae, Fungi, Slime molds, Protozoa. (5)

Unit-VII

Metabolic diversity: Photosynthesis in prokaryotes: Bacteriochlorophylls, plant chlorophylls, carotenoids and phycobillins; Nitrogen fixation, *nif*-gene organization and function. (7)

Unit-VIII

Microbial diseases: Microbial diseases, Host-parasite relationship, Disease reservoir and epidemics, Entry of pathogen into the host, Major adherence factors, Toxicity and invasiveness, Virulence factor and toxins; Anti-microbial agents: Antibiotics, Penicillins and cephalosporins, Broad spectrum antibiotics, Mode of action, Resistance to antibiotics, Antifungal drugs. (7)

BIOTECHNOLOGY IN CROP IMPROVEMENT (Course-X)

Unit-I

Plant organ, tissue and cell culture: - Somaclonal variation and its use in crop improvement, embryo culture and its utility in hybridization programmes, Anther culture, haploid production and their uses, micro propagation in horticultural crops and forestry and its uses, artificial seeds, techniques of protoplast culture, achievements, limitations, utility in improvement of crop plants. (12)

Unit-II

Biofertilizers, Bioinsecticides and Molecular Farming. Concept and utility (4)

Unit-III

Methods of Gene Transfer in Plants: *Agarobacterium* mediated gene transfer, direct DNA delivery methods (microinjection, macroinjection, particle gun, electrophoration etc.). (6)

Unit-IV

Hybridization: - Distant hybridization and Somatic hybridization in crop improvement. (4)

Unit-V

Transgenic Plants in dicots and monocots: - Utility of Transgenic in basic studies and in crop improvement (resistance for herbicides, viruses, insects and abiotic stresses, Biosafety issues including risks associated with transgenic crops, biosafety regulations, Evaluation of Transgenic plants as to their commercial value, Efficacy and Environmental concerns, Legislation for Transgenic plants, Economic viability of Transgenic plants. (8)

Unit-VI

Improvement of Nutritional quality of plants: - seed storage proteins e.g. Glycinin, Conglycinin, Legumin, Phytohaemaglutinin, Phaseolin, Prolamins, Albumins and Designerproteins, Engineering for vitamins and Iron-Deficiency, Engineering Traits related to hybrid seed Production (e.g. Male Sterility) (8)

Unit-VII

Plant genome Programs: - Impact of genetically modified crops and genomics research in agriculture and biology, Rice genome, Wheat genome and Pigeonpea genome sequencing programs and their integration in Crop Improvement.(8)

ANIMAL BIOTECHNOLOGY AND IMMUNOLOGY (Course-XI)

Part-A: Animal Biotechnology

Unit-I

Introduction: - Animal Tissue and Organ Culture, Plasma clot method, Raft method, Agar-gel method, Grid method, cyclic exposure to medium and Gas phase, advantages, limitations and applications, artificial skin. (6)

Unit-II

Cell Culture: - Substrate and suspension culture, Culture Media, natural and artificial, initiation of cell culture, sub-cultures, Evaluation and Maintenance of cell culture lines, Large scale culture of cell lines, Monolayer, Suspension culture, Immobilized cultures, Somatic cell fusion, mechanism and applications, cell culture products and their applications, Interferon's. (8)

Unit-III

Cloning: -In-vitro Fertilization and Embryo transfer, Application of Embryo transfer technology, Embryo transfer in cattle, , Animal cloning, Ethical and Social Issues relating to Human cloning, Transgenic and their future Prospective. (8)

PART B: Immunology

Unit-IV

Introduction: - History, concept and Scope of Immunology. (2)

Unit-V

Immunity: - Innate and Acquired immunity, Passive and Active Immunity, Lymph and organs, Humoral and Cell Mediated immunity, Specificity and Memory, Transplantation immunity, Major Histocompatibility Complex (MHC) and Complements. (6)

Unit-VI

Interactions: - Antigen-Antibody reactions, Antigen type-hapten, Immunoglobulin's (fine structure of IGg and diversity), serological reactions, Agglutination, Precipitation, Immunoelectrophoresis, ELISA, RIA, Immuno-electromicroscopy. (6)

Unit-VII

Hybridoma Technology: - Monoclonal antibody production, myeloma cell lines, Fusion of myeloma cells without antibody producing B-cells, selection and screening methods for positive hybrids, production, purification and characterization of monoclonal antibodies without Hybridoma, Genetic manipulation of immunoglobins. (6)

Unit-VIII

Diseases and Vaccines: - T-cell cloning, mechanism of antigen recognition by T-and B-lymphocytes, Genetic control of immune response, inflammation, hypersensitivity and autoimmunity, immunodiagnosis, AIDS, types of vaccines, Strategies for the development of vaccines, infectious diseases. (8)

PLANT GENETIC RESOURCES: - CONSERVATION AND THEIR SUSTAINABLE USE (Course-XII)

Unit-I
Biological species: Concepts and its limitation**.** (2)
Unit-II
Centers of Diversity and Centers of Origin. (2)
Unit-III
A brief idea of the evolution of crop plants: - Wheat, Barley, Rice, Maize, Cotton, Sugarcane, Potato, Cole crops, Rapeseeds and mustard. (6)

Unit-III
Biodiversity vs. Genetic Resources: - Definition and Explanation, alpha vs. beta biodiversity and methods of their study, present levels of Biodiversity and rate of loss of biodiversity, causes for the loss of biodiversity, uses of biodiversity, extent of biodiversity in plants, exploration and germplasm collection, introduction and exchange of PGR, Red Data Books and Endangered plant species. (8)

Unit-IV
Plant Genetic Resources: - Different kinds of PGR, Taxonomical Classification of PGR, Development of Basic, derived and molecular, core collections, principles of germplasm characterization, evaluation, maintenance and regeneration, Plant quarantine aspects- Sanitary and Phytosanitary Systems (SPS). (8)

Unit-V
Techniques for conservation of plant germplasm: - *In-situ* and *Ex-situ* methods of conservation, Cryopreservation of genetic materials. Gene banks and Cryobanks. (2)

Unit-VI
IPGRI, NBPGR, FAO and CGIAR: - Their role is conservation of PGR. (6)

Unit-VII
Future Harvest Centers and CBD: -A Brief Idea, CBD and Cartagena protocol. (6)

Unit-VIII
UPOV, Plant Breeders Rights (PBRs) and farmers Right (FRs), Protection of plant varieties and farmers right act (PPV and FRA) 2001. (4)

Unit-IX
PGR and IPRs (Intellectual Property Rights):- Patents, copyrights, Trademarks, GATT and TRIPs, Terminator and Traitor Techniques (v-GURT and t- GURT), Biodiversity Bill 2002, Geographic indicator bill. (6)

Semester IV

CONCEPTS OF NANO-BIOTECHNOLOGY (Course-XIII)

Unit-I

Introduction: - Concept, scope, vision, application, present and future prospects in biological sciences. (2)

Unit II

Applications of Quantum Dots in Biology: - An overview, Introduction, General properties and applications. (2)

Unit-III

Properties and Characterization of nanomaterials: Optical (UV-Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zetapotential), Surface and composition (ECSA, EDAX, AFM/STM etc), Vibrational (FT-IR and RAMAN), SERS, Magnetic, Electrical and Electrochemical. (8)

Unit IV

Protein and Peptide based Nanostructures: S-layers-Chemistry and structure, Assembly, recrystalisation, diagnosis- Engineered Nanopores- Methods of production-Supported bilayers and membrane arrays- Genetic Approaches- Microbial nanoparticles production- Magnetosomes- Bacteriorhodopsins- Nanoproteomics. (8)

Unit V

DNA based Nanostructures- DNA-protein nanostructures-Methods- Self assembled DNA nanotubes—Nucleic acid Nanoparticles, DNA as a Biomolecular template-DNA branching-Metallization- Properties, Probing DNA structure with Nanoparticles and Structural DNA nanotechnology, DNA nanomechanical devices, Nanosensors. (8)

Unit VI

Self assembling nanostructures- Self-Assembled Artificial Transmembrane Ion Channels-types, Methods, Self-Assembling Nanostructures from Coiled-Coil Peptides, Synthesis and Assembly using Bio-Derived Templates- Self-Assembling for Patterned Molecular Assembly. (8)

Unit VII

Pharmaceutically important nanomaterials for controlled drug delivery-

Physicochemical Principles of Nanosized Drug Delivery Systems- Nanotubes, Nanorods, Nanofibers, and Fullerenes/Carbon nanotubes**,** Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles, Liquid nanodispersions, Solid Lipid Nanoparticles (SLP), Biofunctionalsiation of SLP, Nanoparticles for crossing biological membranes, MEMS/NEMS based on Nanomaterials, Peptide/DNA Coupled Nanoparticles, Inorganic Nanoparticles For Drug Delivery, Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/anti viral), Anisotropic and Magnetic Particles (Hyperthermia). (10)

UNIT VIII

Nanomaterials and Toxicity Evaluation: Cyto-toxicity, Geno-toxicity, *In vivo* tests/assays etc.

(4)

GENOMICS AND PROTEOMICS (Course-XIV)

PART A: Genomics

Unit-I

Origin and Evolution of genomics: - Origin of genomics, the first DNA genomes, microcollinearity and lack of it, DNA based phylogenetic trees, genomes and human evolution, evolution of nuclear and organellar (mitochondrial and Chloroplast genome, the concept of minimal genome and possibility of synthesizing it. (6)

Unit-II

Molecular maps of genomes and comparative genomics: - Genetic maps, physical maps, EST and transcript maps, functional maps, comparative genomics and collinearity/synteny in maps.(4)

Unit-III

Whole Genome sequencing: - Whole genome shotgun sequencing, clone-by-clone or 'hiererchical stotgun' sequencing, microbial genomes (including yeast), plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human). (6)

Unit-IV

Annotation of whole genome sequence and functional genomics: - *In silico* methods, insertion mutagenesis (T-DNA and transport insertion), TILLING, management of data, gene expression and transcript profiling, EST contigs and unigene sets, use of DNA chips and microarrays. (6)

Unit-V

Pharmacogenomics: - Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, use of SNP in pharmacogenomics, pharmacogenomics and industry. (6)

PART B: Proteomics

Unit-VI

Study and Scope: - Introduction, definition concepts and approaches of proteomics studies and activities. (2)

Unit-VII

Quantitative and Qualitative proteome analysis technique: - Separation technique-2DPAGE, 2-DE (BN-PAGE), image analysis, Mass- spectrophotometery, LC-TMS, MALDI, and SALDI (6)

Unit-VIII

Protein interaction and Protein complex: - Protein interaction, DNA- Protein interaction, Yeast two hybrid system and their applications. (4)

Unit-IX

Drug Discovery and Development: - Current issues, drug targets, Drug efficacy, Drug toxicology, Protein chips and Antibody array. (4)

Unit-X

Cancer Proteomics: - An overview of cancer, origin and types of cancer, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth, proteomics in cancer research, techniques of proteomics in cancer research, future approaches of proteomics and cancer research. (6)

BIOETHICS, INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND RESEARCH METHODOLOGIES (Course-XV)

Unit-I

Bioethics: Ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia. Artificial reproductive technologies, prenatal diagnosis, Ethics in transplantation 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. (10)

Unit-II

Biosafety: Ethical issues concerning biotechnology, Primary containment for biohazards, Recommended biosafety levels for specific microorganisms, Biosafety guidelines for industrial operations with GMOs, Field trial of GM crops. (5)

Unit-III

Regulatory issues and National and International Regulations: Prospects and controvercies of gene therapy, health dilemmas, protection of consumers. International regulations – Cartagena protocol, National regulations. Containments – biosafety levels and category of rDNA experiments; field trials – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI). (7)

Unit-IV

Food safety and health issues of food crops: Environmental risk assessment and food and feed safety assessment, Balance of genetically altered and natural population in an ecosystem, Safety of modified crops, Livestock as food and their nutritional values, S ocial and economic effects: Biobusiness involving biotechnology and consumer acceptance of biotechnology; Control of key crops; Bioprospecting and exploitation of poor countries. (9)

Unit-V

IPR: Different forms of IPR; General concept of patenting; Indian Patent Act 1970; Current Indian patent law, rules and regulation. Basics of patents: types of patents; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application. (10)

Unit-VI

Preparation for Research: Orientation to lab and problem identification; Maintaining a lab notebook. Setting clear goals. Experiment designing, Designing and writing project proposals. (4)

Unit-VII

Scientific Communication: Writing Skills - Types of reports, Layout of a formal report, Full research articles, Brief communications, Letters, Case studies, Clinical trials, Review articles, commentaries, Referencing, Plagiarism, Choice of journals/books, Peer review process and problems. Ethical issues; Scientific misconduct. (5)

INDUSTRIAL BIOTECHNOLOGY & BIOENTREPRENEURSHIP (Course-XVI)

UNIT-I

Introduction, scope and historical development; Isolation of industrially important microorganisms, their maintenance and improvement through classical and genomic approaches, Media designs, sterilization for down stream processing, fed-batch and mixed cultures, and scale-up principles. Maintinance of microbes (12)

UNIT-II

Immobilization of enzymes and cells, and their application, growth rate analysis, estimation of biomass. Production of vaccines and antibiotics. (10)

UNIT-III

Fermented beverages, production of single cell protein, steroid transformation, silage production, waste water treatment. Computer simulations, Bio-ethanol, methanol and product formation in microbial culture. (12)

UNIT-IV

Human resource development, team building and team work for entrepreneurship, small scale set-up. (6)

UNIT-V

Support mechanism for Biotechnology entrepreneurship in India, communication, Preparation of proposal for funding, funding agencies of India. (10)

OPEN ELECTIVE COURSES

TRENDS IN BIOTECHNOLOGY

Unit-I

Enzymes useful in molecular cloning: Restrictionendonuclease, DNA ligases, polynucleotide kinase, klenow enzyme, DNA Polymerase- I, reverse transcriptase, alkaline phosphatase, terminal nucleotidyltransferase (4)

Unit-II

Cloning Vectors: PBR 322, Bacteriophage, Cosmid, Phagemid, Shuttle vectors (4)

Unit-III

Gene transfer techniques: Physical, Chemical and Biological methods (6)

Unit-IV

Labeling nucleic acids and blotting techniques (Southern, Northern, Western, Zooblot) (6)

Unit-V Polymerase Chain Reaction and its applications (2)

Unit-VI

Applications of recombinant DNA technologies- Agriculture, Medicine, Cloning. (4)

Unit-VII

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, immune modulators and vaccines, Transgenic animals, Production of proteins of Pharmaceutical value. (12)

Unit-VIII 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. (12)

ENVIRONMENTAL BIOTECHNOLOGY

Unit-I

Components of Environment – Hydrosphere, lithosphere, atmosphere and biosphere – definitions with examples; Interaction of man and environment; Environmental Studies as a multidisciplinary subject. (4)

Unit-II

Global Environmental Problems – Green House Effect, Acid rain, El Nino, Ozone depletion, deforestation, desertification, salination, biodiversity loss; chemical and radiation hazards. (4)

Unit-III

Environmental pollution and degradation – Pollution of air, water and land with reference to their causes, nature of pollutions, impact and control strategies; noise pollution; environmental damage by agriculture, perspectives of pollution in urban, industrial and rural areas. Habitat Pollution by Chlorinated Hydrocarbons (DDT, PCBs, Dioxin etc), Organophosphates, Heavy Metals, Die-offs, Endocrine disrupting chemicals, Nutrient pollution. (10)

Unit-IV

Environmental Management – Concept of health and sanitation, environmental diseases – infectious (water and air borne) and pollution related, spread and control of these diseases, health hazards due to pesticide and metal pollution, waste treatment, solid waste management, environmental standards and quality monitoring. (6)

Unit-V Environmental Protection Act – Environmental Laws, national movements, sustainable development, environmental policies, environmental economics, environmental ethics – holistic approach of environmental protection and conservation, IUCN – role in environmental protection. Concept with reference to UN – declaration, aim and objectives of human right policies with reference to India, recent north-south debate on the priorities of implementation, Environmental Protection Agency (EPA). (10)

Unit-VI

Bioremediation – Oil spills, Soil Pollution, Wastewater treatment, chemical degradation, heavy Metals.(8)