|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BTS 201** | **Biochemistry (B.Tech Biotechnology Semester III )** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **-** | **3** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To familiarize the students with basic Biochemistry** | | | | | | |
|  | **Course Outcomes** | | | | | | |
| **CO 1** | **The students will be able to understand the structure and functions of carbohydrates and proteins.** | | | | | | |
| **CO 2** | **The students will be able to write Michaelis Menten equation.** | | | | | | |
| **CO3** | **The students will be able to write glycolysis and Beta oxidation pathways.** | | | | | | |
| **CO 4** | **The students will be able draw schematic diagram of electron transport chain.** | | | | | | |

# UNIT – I

1. **Amino acids & Proteins –**Structure of amino acids. Peptide bonds. Different levels of structural

organization ofproteins. Basics of protein folding. Basics steps involved in protein purification. Ramachandran plot, alpha helix, beta plated sheets, domain motif and fold.

1. **Carbohydrates-Structure and functions:** Structures and properties of monosaccharides, oligosaccharidesandpolysaccharides.Ringstructureandmutarotation.distinguishing features of different disaccharides.Homo-andhetero-polysaccharides. Mucopolysaccharides

# UNIT – II

1. **Lipids-:** Classification of lipids and their general functions. Essential fatty acids.
2. **Nucleic Acids:** Structure and properties of purine and pyrimidine basis. Nucleosides and nucleotides. Biologically importantnucleotides.
3. **Enzymes kinetics** Nomenclature and classification of Enzymes. Activation energy and rate of reaction, mechanism of enzyme action and regulation of enzyme activity. Enzyme inhibition and concept of allostery. Michaelis-Menten equation.

**UNIT-III**

1. **CarbohydrateMetabolism:**GlycolysisandTCAcycle.Pentosephosphatepathwayanditssignificance. Gluconeogenesis pathway. Glycogenolysis, glycogenesis and control of glycogen metabolism. Energetics and regulation of carbohydrate metabolism.
2. **Lipid Metabolism:** Beta -oxidation of saturated fatty acids, oxidation of unsaturated and odd carbon fatty acids. Degradation of triacylglycerols by lipases. Biosynthesis, elongation and desaturation of saturated fatty acids. Biosynthesis of triacylglycerols and phospholipids.

# UNIT -IV

1. **AminoAcidMetabolism:**Generalreactionsofaminoacidsmetabolism-transamination,oxidativeand non-oxidativedeaminationanddecarboxylation.Generalpathwaysofaminoacidsdegradation.Ureacycle and itsregulations.
2. **Nucleic Acid Metabolism:** Catabolism, *de novo-*biosynthesis and salvage pathway.
3. **Mitochondrial oxidative phosphorylation:** Mitochondrial electron transport chain. Hypotheses of mitochondrial oxidative phosphorylation. Inhibitors and uncouplers of oxidativephosphorylation. Biochemical basis of human disease (diabetes)

# Text books

1 Biochemistry, 8th edition, by L. Stryer (2015). W.H. Freeman & Co. NY

2 Lehninger:PrinciplesofBiochemistry,7thedition,byDavidL.NelsonandM.M.Cox(2017)Maxmillan/ Worthpublishers

# References Books:

1 Biochemistry, 5th edition, by G. Zubay (2004). Wm.C. BrownPublishers.

1. Principles of Biochemistry, 5th edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (2012), Neil Patterson Publishers PrenticeHall.
2. Biochemistry,6thedition,byR.H.GarrettandC.M.Grisham(2016).SaunderscollegePublishing,NY. Sons,NY.
3. Fundamentals of Biochemistry , 4th edition by Donald Voet and Judith G Voet (2011) , John Wiley & Sons,NY
4. Harper’s Biochemistry, 31st edition, by R.K. Murray, P.A. Hayes, D.K. Granner, P.A. Mayes andV.W. Rodwell (2018). Prentice HallInternational.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BTS-203** | **MICROBIOLOGY (B.Tech. Biotechnology Semester III)** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **2** | **-** | **-** | **2** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **The course provides the students both conceptual and experimental background in the broad discipline of microbiology** | | | | | | |
| **Course outcome** | | | | | | | |
| **CO1** | **Student to learn the history and classification of microbiology** | | | | | | |
| **CO2** | **The students will be introduced to microbial diversity and various microbiological techniques** | | | | | | |
| **CO3** | **Emphasis has been laid on bacterial growth, nutrition, control, metabolism and Genetics.** | | | | | | |
| **CO4** | **Course also introduces the students to the Microbial ecology and relevance of microbes in the field of medicine, agriculture and industry.** | | | | | | |

**UNIT – I**

**Introduction to Microbiology:** History and Various branches of microbiology, Organization of Prokaryotic and Eukaryotic Cell Structure and Function, Viruses.

**Classification of Microorganisms**: Microbial Taxonomy- Criteria used including molecular approaches. Current classification of bacteria.

**UNIT – II**

**Diversity of Microbial World:** Microbial Evolution, Microbial Diversity.

**Control of Microbial Growth:** Effect of heat, sterilization, disinfectants, therapeutic agents, antimicrobial resistance, purification and preservation of microbes.

**Microbial Nutrition and Growth:** Types of growth media, growth phases, culture methods,

**UNIT – III**

**Microbial Metabolism:**Aerobic & anaerobic respiration, fermentation, Entner Duodruffs pathway, photosynthesis, nitrogen fixation

**Microbial Molecular Biology and Genetics**: Genome and gene structure, Replication, Expression, Regulation of gene expression (operon system), transformation conjugation and transduction

**UNIT - IV**

**Microbial Ecology:** Microbes from marine, freshwater and terrestrial environments, Microbial Interactions (Symbiotic, non-symbiotic), Pathogenic microbes

**Application of Microbiology:** Role of Microbes in agriculture, public health, medicine and industry

**Text Books/References:**

1. Prescott's Microbiology by Willey, Sherwood and Woolverton.

2. Brock Biology of Microorganisms by Madigan, Martinko, Stahl and Clark.

3. General Microbiology by Stanier, Ingraham, Wheelis and Painter.

4. Microbiology, M. Pelczar, E. Chan, N. Kreig, 5th ed, MGH.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BTS-205** | **Molecular biology (B. Tech. Biotechnology Semester III )** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | - |  | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To understand the basis of molecular biology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **To learn about genetic material and replication process.** | | | | | | |
| **CO 2** | **To learn about the process of transcription and gene expression.** | | | | | | |
| **CO 3** | **To know about the next step of transfer of genetic information by translation process.** | | | | | | |
| **CO 4** | **To learn about process of splicing.** | | | | | | |

**UNIT- I**

**1.Genes :** DNA/RNA as the genetic material. Double helical structure of DNA.Types of DNA.Super coiling and periodicity of DNA.Linking number of DNA. Euchromatin and heterochromatin, exons and introns, repetitive and non –repetitive DNA, C-value paradox.

**2. DNA Replication :**Origin of DNA replication. Bacterial and eukaryotic replicons.DNA polymerases.Mechanism and regulation of DNA replication in prokaryotes and eukaryotes.

**UNIT - II**

**3. Transcription:** Various RNA species and their properties.Transcription in Prokaryotes**:** RNA polymerases. Mechanism of transcription- initiation, elongation and termination.Role of sigma factor in transcription.

**Transcription in Eukaryotes:** RNA Polymerases. Downstream and upstream promoters. Techniques to define promoters- foot printing experiment. Mechanism of transcription.Interaction of upstream factors with basal apparatus. Post-transcriptional modifications of various RNA species.

**UNIT -III**

**4. Genetic Code:** Evidence for triplet code. Properties of genetic code, Wobble hypothesis.

**5. Protein Synthesis :**Structure of prokaryotic and eukaryotic ribosomes and their role in protein synthesis. Mechanism of initiation, elongation and termination of protein synthesis.Regulation of translation in prokaryotes and eukaryotes. Post translational modifications of proteins.

**UNIT -IV**

**6. Nuclear Splicing :**Lariat formation, Sn RNAs, cis-splicing and trans-splicing reactions. Catalytic RNA- Ribozymes- Ribonuclease P, small RNAs, group I &II introns.

**Text/Reference Books :**

1. Genes XI Lewin, Benjamin(2013)OUP, Oxford.

2. Genomes,2nded, Brown, T. A.(2002) John Wiley and sons ,Oxford

3. Molecular biology of cell 4thed Alberts, Bruce; Watson,J D(2002) Garland Science Publishing, New York.

4. Molecular cell biology 4th edLodish, Harvey and. Baltimore,D(2000) W.H. Freeman and Co., New York

5. Cell and Molecular Biology 8th ed, Robertis, EDP De &Robertis, EMF De(2002) lippincott Williams & Wilkins international student edition, Philadelphia.

6. Essentials of Molecular Biology 4th ed, Malacinski, G. M. (2003) Jones &Bartlet Publishers, Boston

7. Cell and Molecular Biology: concepts and experiments 3rd ed Karp, Gerald(2002) John Wiley and sons, New York.

8. The Cell-a molecular approach, 3rd ed Cooper, G M&Hausman, R E(2004) ASM Press, Washington D C

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BTS-207** | **Genetics and Cell Biology (B. Tech. Biotechnology Semester III )** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | - | **-** | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To familiarize the students with fundamentals of genetics and cell biology.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **To understand the basis of Mendelian inheritance along-with exceptions to this pattern of inheritance.** | | | | | | |
| **CO 2** | **To learn structural and molecular mechanism of gene aberrations and gene mapping using variable methods.** | | | | | | |
| **CO 3** | **Students will acquire knowledge of organizational and functional aspects of cell.** | | | | | | |
| **CO 4** | **Able to learn interaction of cells with outside environment through exchange of information and transport of molecules.** | | | | | | |

**UNIT I**

1. **Mendelian inheritance and its exceptions**; History of genetics, Reproduction as basis of heredity, Mendelian principal of genetics, Co-dominance (Blood group system), incomplete and complete dominance. Multiple alleles (skin color in Rabbits).Linkage phenomenon, types and detection.
2. **Polygenic Inheritance:** Nelsson- Ehle experiment, Yule experiment, Skin color in human beings, Numerical problems on Mendelian and polygenic inheritance.

### UNIT II

1. **Basic inheritance linked to sex chromosomes:** Sex limited, Sex Influenced and Sex Linked inheritance patterns, Sex Determination, Chromosomal Theory of inheritance, Pedigree analysis, Lethality Concept.
2. **Genome Mapping**: Physical mapping, Genetic mapping, Chromosomal mapping, Two point cross (*Neurospora crassa*) to map genes, Three point test cross mapping, Somatic cell hybrid for mapping, Human Genome project. Mapping in Prokaryotes and Eukaryotes.

**UNIT-III**

1. **Cell Division**: Mitosis, Meiosis, Phases of cell division. Cell cycle regulation along with checkpoints, Intracellular trafficking and cell death via apoptosis.
2. **Cell Signaling:** -Cell-cell interactions, Cell Receptors, Ligands and Trans-membrane signaling,

Signal Transduction pathways

### UNIT IV

1. **Mutations:** Introduction, types of mutation, application of mutations, Different modes of introducing mutations via mutagens, DNA Repair Mechanism (Photoreactivation, Mismatch repair).
2. **Problem Solving:** Numericals on Mendelian inheritance, Co dominance, Linkage, Pedigree analysis,

Gene mapping via two point and three point test cross, Polygenic inheritance and gene and genotype

frequency calculations.

### Text Books:

1. Concepts of Genetics: Klug, W.S. and Cumming, M.R., Pearson Education, Inc.
2. Principles of Genetics by Snustad, S. John Willey& sons Inc Hoboken,2003.
3. Molecular Biology of the cell: Bruce A., Alexander J., Julian L., Martin R.,

Keith R., Peter W.; 6th edition, New York: Garland Science, 2008.

1. Cell and Molecular Biology-Concepts and Experiments, Gerald Karp et al., John Wiley, 8th Edition,2015.

### Reference Books:

1. Fundamental of Genetics, Singh, B. D., Kalyani Publishers, New Delhi.

2.Basic Genetics.(2004),Miglani,G.S.,Narosa Publishing House,New Delhi.

3. Cell Biology:Organelle structure and Functions, Sadava, D.E., (2004), Panima Publications,   
New Delhi.

### Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided alongwith the syllabus

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BTS-211** | **Cell and Molecular biology Lab (B. Tech. Biotechnology Semester III )** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Practical** | **Minor Test** | **Total** | **Time** |
| **-** | - | **4** | **2** | **60** | **40** | **100** | **3 Hrs** |
| **Purpose** | **To understand the basis of cellular functions and basic techniques of molecular biology to grasp genetic material structure, organization and inheritance.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Student to learn the principals of cell cycle its regulation using microscopic evaluation** | | | | | | |
| **CO 2** | **To learn the basic histology of different organ systems and structures.** | | | | | | |
| **CO 3** | **Students will be able to isolate different biomolecules.** | | | | | | |
| **CO 4** | **Student will learn to compare the fingerprint database and amplify genomic material**. | | | | | | |

### Course Content:

1. To familiarize components of different types of microscope and principals.

1. Microscopic study of different stages of Mitosis using onion root tips and Meiosis using anther of bajra.
2. Microtomy: Histological study of various organ structures (Skin, Kidney, Liver, Ovary, Testes).
3. Isolation of genomic DNA and study of its quality and quantity spectrophotometrically.
4. Extraction of plasmid DNA and calculation of concentration and purity.
5. Estimation of size in bp of DNA using agarose gel electrophoresis.
6. Polyacrylamide gel electrophoresis and estimation of MW of proteins.
7. Extraction of RNA from animal and plant tissues.
8. Amplification of DNA by PCR.

10.Molecular marker based DNA fingerprinting.

### Reference Books:

1. Molecular biology:concepts and Experiments;Gerald Karp et al.,John Wiley,8th edition;2015.
2. Molecular cell biology. Lodish H, Berk,A., Zipursky,S.L. et al., New York: W.H.Freeman;2000.
3. Lewin”s GENES XII by Jocelyn E. Krebs, Elliott, S. Goldstein and Stephen ,T. Kilpatrick.

**Laboratory experiments.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BTS-213** | **Biochemistry Lab (B.Tech. Biotechnology ) Semester-III** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical** | **Total** | **Time** |
| **-** | **-** | **3** | **1.5** | **40** | **60** | **100** | **3 Hrs** |
| **Purpose** | **To learn the practical aspects of Biochemistry** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will be able to learn qualitative and quantitative estimation of biomolecules** | | | | | | |
| **CO2** | **Students will be able to learn quantitative estimation of protein.** | | | | | | |
| **CO3** | **Students will be able to extract total lipid content in the given sample.** | | | | | | |
| **CO4** | **Students will be able to extract nucleic acids from plant tissue.** | | | | | | |

1. Qualitative tests for carbohydrates.
2. Determination of reducing sugars by Nelson-Somogyi’s method.
3. Qualitative tests for amino acids.
4. Estimation of protein by Lowry’s method/Bradford method.
5. Qualitative tests for lipids.
6. Extraction and estimation of total lipid content in the given sample of oil seeds.
7. Extraction of total nucleic acids from plant tissues.
8. Estimation of DNA by diphenylamine reaction.
9. To study time course of reaction catalysed by alkaline phosphatase.
10. Estimation of lysozyme enzymatic activity.

**Text/ Reference Books**:

**1.** Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (2005), Cambridge University Press, Cambridge.

**2.** Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.

**3.** An introduction to Practical Biochemistry by David T. Plummer (2007), McGraw- Hill, Book Company, UK.

**4.** Biochemistry laboratory by Rodney Boyer 2nd edition (2012) Pearson education Inc. New Jersey

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BTS-215** | **MICROBIOLOGY LAB (B.Tech. Biotechnology Semester III )** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical** | **Total** | **Time** |
| **0** | **0** | **3** | **1.5** | **40** | **60** | **100** | **3 Hrs** |
| **Purpose** | **At the end of the course students will be aware about the conspicuous presence of microbes in the environment and their influence in our daily lives as part of food, soil, air environment and disease development.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will be able to operate microscopes and staining methods** | | | | | | |
| **CO2** | **Learning of Culture Media Preparation for Microbial Growth** | | | | | | |
| **CO3** | **Students will learn Pure Culture Techniques for maintenance and preservation of microbes.** | | | | | | |
| **CO4** | **Students will learn various aspects of Biochemical Tests used in Microbial Taxonomy** | | | | | | |

**LABORATORY EXPERIMENTS**

1. Microbial Good Lab Practices and Biosafety

2. Media preparation and sterilization

3. Microscopic examination of different groups of microorganisms

4. Total count and viable count determination

5. Microbial simple and differential staining methods

6. Isolation of pure culture and its preservation

7. Microbial Growth curve determination

8. Effect of physical and chemical environment on growth

9. Biochemical tests for Microbial identification

10. Antibiotic Sensitivity of Microorganisms

**Text Book/ References Books:**

**1.** Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition.Aneja, K.R. (2003), New Age International Publishers, New Delhi**.**

**2.**Microbiology- a laboratory manual. 4th edition.Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.

**3.** Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W. (1995) Academic Press, New York.

| **HTM-901** | **Universal Human Values II: Understanding Harmony (B.Tech Biotechnology III Semester)** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3.0** | **75** | **25** | **100** | **3 Hours** |
| **Purpose** | Purpose and motivation for the course, recapitulation from Universal Human Values-I | | | | | | |
| **Course Outcomes (CO)** | | | | | | | |
| **CO 1** | Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence. | | | | | | |
| **CO 2** | Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence. | | | | | | |
| **CO 3** | Strengthening of self-reflection. | | | | | | |
| **CO 4** | Development of commitment and courage to act. | | | | | | |

**Unit 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**

Purpose and motivation for the course, recapitulation from Universal Human Values-I ;

Self-Exploration–what is it ? -Its content and process;‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration ;

Continuous Happiness and Prosperity- A look at basic Human Aspirations ;

Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority;

Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario;

Methods to fulfill the above human aspirations: understanding and living in harmony at various levels.

**Unit 2 : Understanding Harmony in the Human Being - Harmony in Myself!**

Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’;

Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility,

Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer);

Understanding the characteristics and activities of ‘I’ and harmony in ‘I’;

Understanding the harmony of I with the Body: Sanyam and Health , Correct appraisal of Physical needs, meaning of Prosperity in detail;

Programs to ensure Sanyam and Health.

**Unit 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship

Understanding the meaning of Trust; Difference between intention and competence;

Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship;

Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals;

Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

**Unit 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence and Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order**

Understanding the harmony in the Nature

Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature;

Understanding Existence as Co-existence of mutually interacting units in all-pervasive space;

Holistic perception of harmony at all levels of existence;

Implications of the above Holistic Understanding of Harmony on Professional Ethics, Natural acceptance of human values, Definitiveness of Ethical Human Conduct;

Competence in professional ethics ; Case studies , Strategy for transition from the present state to Universal Human Order

**READINGS:**

**Text Book**

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

**Reference Books**

* 1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
  2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
  3. The Story of Stuff (Book).
  4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
  5. Small is Beautiful - E. F Schumacher.
  6. Slow is Beautiful - Cecile Andrews
  7. Economy of Permanence - J CKumarappa
  8. Bharat Mein Angreji Raj - PanditSunderlal
  9. Rediscovering India - by Dharampal
  10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
  11. India Wins Freedom - Maulana Abdul Kalam Azad
  12. Vivekananda - Romain Rolland (English)
  13. Gandhi - Romain Rolland (English)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PTC-202** | **INDUSTRIAL BIOTECHNOLOGY (B.Tech. Biotechnology) Semester -IV** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **2** | **-** | **-** | **2** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To learn the various aspects of Industrial Biotechnology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **To learn basic concepts of Fermentation Bioechnology** | | | | | | |
| **CO2** | **To learn the theoretical aspects of Process Technology for the production of various products** | | | | | | |
| **CO3** | **To learn the concepts of biopesticides, biofuels and biofertilizers.** | | | | | | |
| **CO4** | **To understand the concept of integrated strain improvement program.** | | | | | | |

**UNIT-I**

1. **Industrial Biotechnologyy:** Introduction andscope**.**Historical developments of industrial biotechnology.
2. **Principles of Fermentation Technology:** Upstream processing, the fermentation process, downstream processing, molecular biology and bioinformatics in industrial biotechnology. Concept of strain improvement.

## UNIT - II

1. **Production of Primary metabolites and alcoholic beverages** Organic acids, organic solvents and commodity chemicals, amino acids, nucleosides and nucleotides alcoholic beverages (wine andbeer).
2. **Production of Industrial Enzymes-** Amylase, protease, lipase, xylanase, stabilization of enzymes and cells, enzyme inhibitors, whole cell biocatalysis, enzyme immobilization techniques

## UNIT-III

1. **Production of industrial bioproducts:** Production technology of biopesticides, biofertilizers and biofuels.Single Cell Protein & Mushroom Culture, biopreservatives and biopolymers.
2. **Production of Pharmaceuticals.** Antibiotics (penicillin, streptomycin and tetracycline), Production of Vitamin E, K, B2 and B12,

**UNIT-IV**

1. **Non-ribosomal peptides and anticancer drugs**. Genetic engineering of microorganisms for production of non-ribosomoal peptides (NRPS) and polyketides (PKS), anticancerdrugs from microorganisms.
2. **Other Applications of microbes in industry.** Microbial bioconversions. Fermented food products. Microbial production of flavours. Microbial pigments in textiles and food industries.

## Text Books:

A Textbook of Basic and Applied Microbiology. Aneja, K. R., Jain, P. and Aneja, R. (2008). New Age International Publishers, NewDelhi

**ReferenceBooks:**

1. Industrial Microbiology.Casida Jr., L.E. (1968) New Age International (P)Ltd. New Delhi.
2. Prescott &Dunn’s Industrial Microbiology. Ed. E.G. Reed (1987).CBS Publishers, NewDelhi.
3. Biotechnology: A Textbook of Industrial Microbiology 2nd Edition. Crueger, W. and Crueger, A. (2000) Panima Publishing Corporation, NewDelhi.
4. Enzymes: Biochemistry, Biotechnology, Clinical chemistry. Palmer, T. (2000) Horwood publishingColphon.
5. Process engineering in biotechnology. Jackson, A.T. (1991) PrenticeHall.
6. Manual of Industrial Microbiology and Biotechnology 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press WashingtonD.C.

## Note: The Examiner will be given the question paper template and will have toset the question paper according to the template provided along with the syllabus

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PTC-204** | **Green Biotechnology and Pollution Abatement (B. Tech. Biotechnology Semester IV)** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **2** | - | **-** | **2** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To familiarize the students with fundamentals of Green Biotechnology and Pollution Abatement.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will learn different methods and principles for waste water treatment and solid waste management** | | | | | | |
| **CO 2** | **Students will understand novel biotechnological methods for degradation of xenobiotics and recalcitrant compounds** | | | | | | |
| **CO 3** | **Students will know how biotechnology can help in removal of the pollutants using bioremediation and phytoremediation.** | | | | | | |
| **CO 4** | **Developing an understanding of new trends of developing ecofriendly biproducts such as biopesticides, biofuels, renewable energy sources, development of stress-tolerant plants.** | | | | | | |

Unit I

Classification and Characterization of waste: Physicochemical Characteristics of waste. Waste material suitable for biological treatment **:** Biological Waste Treatment: Biological wastewater treatment: Principles and design aspects of various waste treatment methods using bioreactors: Solid waste management: landfills, recycling and processing of organic residues, minimal national standards for waste disposal.

Unit II

Biodegradation of Xenobiotic and Recalcitrant Compounds: Xenobiotic compounds–Definition, examples and sources. Recalcitrant Compounds-Definition, examples and sources. Biodegradation- Introduction, effect of chemical structure on biodegradation, recalcitrance, co metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of hydrocarbons.

Unit III

Bioremediation and Biorestoration: Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, In situ and Ex-situ technologies, Bioaugmentation, Biostimulation; Phytoremediation- Introduction and Types of phytoremediation; Advantages and limitations; Biorestoration: reforestation through micropropagation, Organic Farming, Biogas plant, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, , reforestation of soils contaminated with heavy metals.

Unit IV

Eco-Friendly Bioproducts from Renewable Sources: Fundamentals of composting and vermicomposting process: scientific aspects and prospects of biofuel production: bioethanol, biohydrogen and biodiesel; biofertilizers and biopesticides.

Biotechnology in Environment Protection: Current status of biotechnology in environment protection and its future, release of genetically engineered organisms in the environment.

##### Text Books/References:

1. Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications
2. Introduction to Wastewater Treatment- R. S. Ramalho, Academic Press.
3. Elements of Water Pollution Control Engineering – O.P. Gupta, Khannabooks.
4. Energy Technology – O.P. Gupta, Khannabooks, 2018.
5. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.
6. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.
7. Environmental Biotech, Pradipta Krimar, I.K. International Pvt. Ltd., 2006.
8. Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.
9. Biodegradation and Bioremediation 1999 (2nd edition). Martin Alexander, Elsevier Science & Technology.
10. Environmental Biotechnology by Bruce Rittmann and Perry McCarty.

**UNIT I**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PTC-206** | **Immunology and Advanced Diagnostic Techniques (B.Tech. Biotechnology Semester IV )** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **2** | **1** | **-** | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To learn the role of various components of immune system and their response against various diseases** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **The students will be able to learn the basic concepts of cells and organs related to immune system.** | | | | | | |
| **CO 2** | **Able to learn and understand various effector responses of body against an infection**. | | | | | | |
| **CO 3** | **To learn the concepts of various Immunological techniques** | | | | | | |
| **CO 4** | **To learn the immunological reasons behind various diseases with advanced molecular diagnostics**. | | | | | | |

**1. Introduction to Immune System:**  Innate and acquired immunity, cells and organs of immune System- B-Lymphocytes and T-Lymphocytes, primary and secondary lymphoid organs, humoral and cell mediated immune response.

**2. Immune System:** Antigens. Immunoglobulins- structure and function, antigenic Determinants (isotype, allotype, idiotype).

### UNIT II

**3. Generation of B and T Cell Responses:** Major histocompatibility complex. Antigen Processing and presentation.

**4.Immune Effector Responses:**  Cytokines. Complement system

### UNIT III

**5.Immunological Techniques:**  Immuno-precipitin reactions, agglutination reactions, ELISA, RIA, Immuno-fluorescence, FACS

**6.DNA Dignostics:** Radioactive and non radioactive nucleic acid hybridisation.

**UNIT IV**

**7.Immune System in Health and Disease:** Hypersensitive reactions. Auto immunity and immune response to infectious diseases. Immune response to transplants. Vaccines

**8.Molecular Diagnosis for Genetic Disorder:**  PCR/OLA Procedures for diagnosis heredity disease caused by mutation without affecting restrictions sites. Genotyping with FISH and related techniques. Detection of Mutation.

### Text Books:

1.Molecular Biotechnology: Principles and Applications of Recombinant DNA. 3rd Edition. Glick Bernard R.and Pasternak Jack J. (1998), ASM Press washington DC.

2.Kuby's immunology, 5th Edition. Goldsby, R A., Kindt, T.Jand Osborne B.A.(2003). W. H. Freeman and company, New york..

Reference Books:

1. Essential Immunology, 10th ed Roitt, Ivon; Delves, Peter (2001) Blackwell Scientific Publications Oxford.

2.Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York.

3.Immunology by Presscot.

### Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PT C-208** | **Recombinant DNA Technology (B.Tech Biotechnology 4th Semester)** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **2** | 1 |  | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **It is intended to impart basic undergraduate-level knowledge in the area of recombinant DNA technology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **The students will be able to learn about different enzymes in RDNA** | | | | | | |
| **CO2** | **The students will learn how to clone a gene and its selction.** | | | | | | |
| **CO3** | **Students will learn about sequencing techniques .** | | | | | | |

**UNIT I**

1. **Tools of Recombinant DNA:** Restriction endonucleases and their use in recombinant DNA technology. DNA/ RNA Modifying enzymes: Methylase, Alkaline phosphatase(e.g CIAP), Terminal deoxy nucleoside acetyl transferase,T4 Polynucleotide kinase. Blunt end ligation,Linkers Adapters,DNA labeling and detection.

**UNIT II**

1. **Cloning ,Expression and Promoter less Vectors:** Plasmid, Cosmids, Bacteriophages, Phagemids as vectors. Vectors for cloning large pieces of DNA. Creating and screening a gene library, cDNA library. Genetic transformation of prokaryotes. Basic strategies for cloning. Cloning DNA sequences encoding eukaryotic proteins. Selection and screening of cloned genes.

**UNITIII**

1. **Isolation of cloned genes:** Probes to locate clones and related genes. Identification and isolation of tissue specific cDNA. Procedures to analyze proteins encoded by cDNA clones.

DNA sequencing techniques. Analysis of eukaryotic DNA by chromosomal walking. Southern and Northern Blotting. Western Blotting. *In situ* hybridization.

**UNIT IV**

1. **Study of gene functions: Site** Directed mutagenesis. Identification of mutant clones.PCR, Use of PCR to construct genes encoding chimeric proteins.

**Text Books:**

1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.

2. Molecular Biotechnology: *Principles Application of Recombinant DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.

3. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.

4. An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| BTS-202 | Principles of Thermodynamic and Organic Chemistry (B.Tech.  Biotechnology, Semester IV ) | | | | | | |
| Lecture | Tutorial | Practi  cal | Credit | Major Test | Minor Test | Total | Time |
| 2 | 1 | - | 3 | 75 | 25 | 100 | 3 Hrs |
| Purpose | To familiarize the students with basic concepts of thermodynamic and organic chemistry. | | | | | | |
| Course Outcomes | | | | | | | |
| CO1 | The students will be able to know the basic concepts of naming of organic compounds and strength of solutions. | | | | | | |
| CO2 | Able to know about spatial arrangement of molecules and their bonding. | | | | | | |
| CO3 | Able to know about basic concepts of thermodynamics. | | | | | | |
| CO4 | Able to know about concept of free energy and equilibrium | | | | | | |

UNIT-I

IUPAC Nomenclature: Systematic IUPAC nomenclature of alkenes, alkynes, cycloalkanes, aromatics, bicyclic and polyfunctional organic compounds. Bond line notation.

Hyperconjugation : concept and consequences, Strength of solution (Normailty, Molarity, Molality, Mass percentage), mole concepts and related numerical problems..

UNIT-II

Bonding: Hydrogen bonding - Nature, type, stability and its importance in organic compounds. Tautomerism-Concept, Ring-chain tautomerism, Ring-chain isomerism, properties and reactions of keto-enol tautomers.

Stereo Chemistry : Classification of stereomers, diastereomers, separation of enantiomers, absolute configuration (R & S), projection formulae, stereochemistry of compounds containing two asymmetric C- atoms, Geometrical isomerism-concept, E & Z nomenclature and aldol condensation.

Purification and separation techniques (Solvent extraction and recrystallization)

UNIT –III

Thermodynamic parameters –internal energy, enthalpy; their relationship and their significance. First law of thermodynamics. Kirchoff’s Equation. Heat capacity at constant pressure and volume and their relationship. Concepts of Entropy, Second law of thermodynamics. Entropy changes for reversible and irreversible processes. Entropy of mixing.

Third Law of Thermodynamics. Numerical problems on Laws of Thermodynamics.

UNIT-IV

Basic concept of Equilibrium (Physical and chemical equilibrium), steady state conditions, Free energy and its relation with equilibrium constant, Chemical potential, Gibbs-Duhem equation and their application, Standard biochemical state and standard free energy changes and related numerical problems.

Text/Reference Books

1. Organic Chemistry V1:6th ed. Finar,I L(2003) Pearson Education, Delhi

2. Organic Chemistry V2:5th ed. Finar,I L(2003) Pearson Education, Delhi.

3. Organic Chemistry 6th ed. Morrison,R & Boyd,T.(2003) Pearson Education,

Delhi.

4. Organic Chemistry. Paula Yurkanis Bruice; Pearson Education, Delhi.

5. Principle of Organic Synthesis. Richard Norman and James M Coxon.

6. Organic Chemistry:Reactions & Reagents,37th ed. Aggarwal (2003) Goel

Publishing House,Meerut.

7. Organic Analytical Chemistry. Jagmohan (2003) Narosa pub. New Delhi.

Kinetics and Thermodynamics in Biochemistry : Bray & White.

8. Biophysical chemistry Vol. I : Edsall and Wyman

9. Non Equilibrium Thermodynamics in Biophysics : Katchalasky and Curran;

Harvard University Press.

10. Principles of Physical Biochemistry : Kensel. E.Van Holde, W. Curtis Johnson, P.

Shing Ho (2005) 2 nd edition, Prentice Hall

11. Physical basis of biochemistry: Foundations of molecular biophysics,

Bergethan, P.R.(2000) Springer.

LABORATORY EXPERIMENTS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PTC-210** | **Industrial Biotechnology Lab (B.Tech. Biotechnology ) Semester -IV** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical** | **Total** | **Time** |
| **-** | **-** | **4** | **2** | **40** | **60** | **100** | **3 Hrs** |
| **Purpose** | **To learn the Practical Aspects of Industrial Microbiology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Learning of Sterilization Techniques used in Microbiology Lab** | | | | | | |
| **CO2** | **Learning of Identification of industrially important microorganisms** | | | | | | |
| **CO3** | **Students will learn production of antibiotics and enzymes from microbes** | | | | | | |
| **CO4** | **Students will learn determination of microbial cell growth** | | | | | | |

1. Sterilization Techniques (Media, air &water)
2. Construction of various fermenters ( bioreactors)
3. Identification of industrially important microorganisms e.g. molds, yeasts and bacteria.
4. Production of various products in the lab. Alcohol, wine, cellulase, protease and bread.
5. Isolation of antibiotic producing microorganisms from thesoil.
6. Penicillin production and testing of antimicrobialactivity.
7. Isolation of streptomycin-resistant mutants by replica platingmethod.
8. Isolation of UV induced auxotrophic mutants. 9.Determination of cellgrowth.
9. Production of organic acids (Citric and lactic) bymicroorganisms.
10. Production of industrially important enzymes (protease, amylase) by microorganisms.

Reference Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology. Aneja,K.R.(2003) 4th Edition. New Age International Publishers, NewDelhi.
2. Fermentations & Biochemical Hand Book: Principles, Process Design andEquipment. HC Vogel andNoyes(1983).
3. Microbiology Labortary Manual. Cappuccino, J. and Sheeman, N.(2000),4th Edition, Addison Wesley,California.
4. Manual of IndustrialMicrobiology and Biotechnology. 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PTC-212** | **Immunology and Advanced Diagnostic Techniques Lab (B.Tech. Biotechnology) Semester -IV** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical** | **Total** | **Time** |
| **-** | **-** | **2** | **1** | **40** | **60** | **100** | **2 Hrs** |
| **Purpose** | **To learn the practical aspects of Immunology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will be able to learn basic techniques in handling laboratory animals.** | | | | | | |
| **CO2** | **Learning of techniques for purification and detection of immunoglobulins.** | | | | | | |
| **CO3** | **Students will learn the technique of Immunoprecipitation and Agglutination.** | | | | | | |
| **CO4** | **Students will learn the principles of ELISA.** | | | | | | |

**LABORATORY EXPERIMENTS**

1. Routine techniques in handling laboratory animals: feeding, cleaning and bleeding procedure for mice and rabbit.

2. ABO blood group typing

3. Estimation of heamoglobin in blood sample

4. Detection of antigen/antibody from test sample

5. Purification of immunoglobulins.

6. Immunoprecipitation techniques

7. Agglutination techniques

8. ELISA

**Reference Books**:

1. Using Antibodies: A Laboratory Manual. Harlow &Lane(1998) Cold Spring Harbor Lab Press.

2. Immunological Techniques Made Easy. Cochet, et al.(1998)Wiley Publishers,Canada.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PTC-214** | **Recombinant DNA Technology Lab(B. Tech. Biotechnology Semester IV )** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical** | **Total** | **Time** |
| - | - | 4 | **2** | **40** | **60** | **100** | **3 Hrs** |
| **Purpose** | **To learn the experiments of Recombinant DNA Technology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **The students will be able to digest, ligate and amplify the DNA** | | | | | | |
| **CO2** | **The students will learn how to design primers** | | | | | | |
| **CO3** | **Students will learn techniques of DNA extraction from gel.** | | | | | | |

**LIST OF EXPERIMENTS**

1. Restriction Digestion

2. Ligation

3. Primer design

4. Isolation of genomic DNA

5. Gene amplification by PCR

6. Transformation

7. Verification of cloned DNA

8. Induction of expression

9. Verification of protein expression

10.Extraction of DNA from gel

**References Book:**

1.Molecular Cloning – A laboratory manual 3rd Edition Vol. 1-3. Sambrook J. and Russell D.W. (2001) Cold Spring Harbor laboratory Press, New York

2. Molecular Biology-Principles and Practices. Singh, N. and Siwach, P. Luxmi Publications, Delhi

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ATU-202** | **Environmental Sciences (B.Tech. Biotechnology Semester IV)** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | 0 | **0** | **0** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | To learn the multidisciplinary nature, scope and importance of Environmental sciences. | | | | | | |
| **Course Outcomes (CO)** | | | | | | | |
| **CO1** | Students will be able to learn the importance of natural resources. | | | | | | |
| **CO2** | To learn the of structure and functions of ecosystems. | | | | | | |
| **CO3** | Will be able to understand the biodiversity and its conservation methods. | | | | | | |
| **CO4** | The students will be able to understand the relation between human population and environment. | | | | | | |

**UNIT- I**

**The Multidisciplinary nature of environmental studies:**  Definition; Scope and Importance, Need for public awareness.

**Natural resources and associated problems**. Forest resources: Use and Over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems.Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

**UNIT II**

**Concept of an ecosystem:** Structure and function of an ecosystem. Producers, consumers and decomposers.Energy flow in the ecosystem.Ecological succession.Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of thefollowing ecosystem: Forest ecosystem, Grassland ecosystem**,** Desert ecosystem**,** Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

**Biodiversity and its Conservation:** Introduction-Definition: genetic, species and ecosystem diversity.Biogeographical classification of India.Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.Biodiversity at global, National and local levels.India

as a mega-diversity nation. Hot-spots of biodiversity.Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT-III**

**Environmental Pollution:** Definition- Causes, effects and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards

Solid waste Management: Causes, effects and control measures of urban and industrial wastes.Role of an individual in prevention of pollution.Pollution case studies.Disaster management: floods, earthquake, cyclone and landslides.

**Social Issues and the Environment:** From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation, Consumerism and waste products.

Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. - Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

**UNIT-IV**

**Human Population and the Environment**: Population growth, variation among nations. Population explosion-Family welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of information Technology in Environment and human health. Drugs and their effects; Useful and harmful drugs; Use and abuse of drugs; Stimulant and depressant drugs. Concept of drug de-addiction. Legal position on drugs and laws related to drugs.Case Studies.

**Field Work (Practical).** Visit to a local area to document environmental assets-river/forest/grassland/ hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc. (Field work equal to 5 lecture hours).

**Suggested Books:**

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.

2. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad -380013, India, Email: mapin@icenet. net (R).

3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.

4. Clerk B.S., Marine Pollution, Clanderson Pross Oxford (TB).

5. Cunningham, W.P.Cooper, T.H. Gorhani, E & Hepworth, M.T.2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p.

6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.

7. Down to Earth, Centre for Science and Environment (R).

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.**