# SWAMI VIVEKANANDA UNIVERSITY

**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

## UG Biotechnology, Semester I

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Biochemistry & Metabolism | BBT1011 | 3 |
| | Biochemistry & Metabolism Lab | | 1 |
| Minor | Developmental Biology | BBT1021 | 3 |
| | Developmental Biology Lab | | 1 |
| Skill Enhancement Courses (SEC) | Enzymology | BBT1051 | 3 |
| Interdisciplinary course (IDC) | Digital Fluency of Education | ED1031 | 3 |
| Ability Enhancement Courses (AEC) | Communicative English | AEC1041 | 2 |
| Value Added Course (VAC) | a. Environmental Science | VAC1061 | 2 |
| | b. Understanding India | | 2 |
| **Total** | | | **20** |

**Course Name:** Biochemistry & Metabolism
**Course Code:** BBT1011

**Module-I: [10H]**
Introduction to Biochemistry: A historical prospective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

**Module-II: [10H]**
Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

**Module-III: [20H]**
Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+ , NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

**Module-IV: [20H]**
Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

**Learning outcomes**
1. This course offers a flexible path of personal and professional development that is suited for entry into a wide range of structure function study of Biomolecules.
2. This course makes you expertise in lot of instruments and make you a skilled person in different advanced biochemical techniques.

**Suggested Reading**
1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

**Course Name:** Developmental Biology
**Course Code:** BBT1021

**Module-I [10H]**
Gametogenesis and Fertilization: Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

**Module-II [20H]**
Early embryonic development: Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

**Module-III [20H]**
Embryonic Differentiation: Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

**Module-IV [15H]**
Organogenesis: Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

**Learning outcomes**
1. This course offers of various mechanisms of different developmental biological processes.
2. This course makes you expertise in lot of techniques related to different developmental stages.

**Suggested Reading:**
1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

**Course Name:** SEC - Enzymology
**Course Code:** BBT1051

**Module-I: [20H]**
Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

**Module-II: [15H]**
Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

**Module-III: [13H]**
Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative co-operativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-e.g., Fatty Acid synthase.

**Module-IV: [12H]**

Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes. Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution. Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding in-vitro & in-vivo.

**Learning outcomes**

1. This course offers various enzyme technologies related to enzyme activity.
2. This course makes you expertise in various fundamental studies of biochemistry.

**Course Name:** IDC - Digital Fluency of Education
**Course Code:** ED1031

**Course Name:** AEC - Communicative English
**Course Code:** AEC1041

**Course Name:** VAC - Environmental Science
**Course Code:** VAC1061

**Course Name:** VAC - Understanding India
**Course Code:** VAC1061

# SWAMI VIVEKANANDA UNIVERSITY

**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

## UG Biotechnology, Semester II

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Mammalian Physiology | BBT2012 | 3 |
| | Mammalian Physiology Lab | | 1 |
| Minor | Cell biology | BBT2022 | 3 |
| | Cell biology Lab | | 1 |
| Skill Enhancement Courses (SEC) | General Microbiology | BBT2052 | 3 |
| Interdisciplinary course (IDC) | Basics of Life Skill Education | ED2032 | 3 |
| Ability Enhancement Courses (AEC) | Modern Indian Language | AEC2042 | 2 |
| Value Added Course (VAC) | a. Environmental Science II | VAC2061 | 2 |
| | b. Digital Transformation | | 2 |
| | Internship | BBT2081 | 2 |
| **Total** | | | **22** |

**Course Name:** Mammalian Physiology
**Course Code:** BBT2012

**Module-I [15H]**

Digestion and Respiration: Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

**Module-II [15H]**

Circulation: Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

**Module-III [15H]**

Muscle physiology and osmoregulation: Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

**Module-IV [15H]**

Nervous and endocrine coordination: Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters. Mechanism of action of hormones (insulin and steroids) Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

**Course Name:** Mammalian Physiology Lab.
**Course Code:** BBT2012

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme

6. Determination of Haemoglobin

**Learning outcomes**

1. This course offers of various mechanisms of different physiological processes.
2. This course makes you expertise in lot of health care techniques as well as their quantitative estimation of cellular parameters.

**Suggested Reading**

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

**Course Name:** Cell Biology
**Course Code:** BBT2022
**Module-I: [10H]**
Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.
**Module-II: [15H]**
Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.
**Module-III: [20H]**
Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.
**Module-IV: [15H]**
Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

**Course Name:** Cell Biology Lab.
**Course Code:** BBT2022
1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.

6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

**Learning outcomes**
1. This course offers a flexible path of cellular mechanisms and various structure and functions of cellular compartments.
2. This course makes you expertise in lot of instruments and make you a skilled person in different advanced techniques of cell biology.

**Suggested Reading**
1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

**Course Name:** SEC - General Microbiology
**Course Code:** BBT2052
**Module-I [10H]**
Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms e.g., Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.
**Module-II [10H]**
Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.
**Module-III [20H]**
Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.
**Module-IV [20H]**
Control of Microorganisms: By physical, chemical and chemotherapeutic Agents Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food, Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

**Learning outcomes**

1. This course offers a flexible path of various aspects of microorganism's culture growth and control mechanisms.
2. This course makes you expertise in lot of microbial culture techniques as well as their identification and characterization.

**Suggested Reading**

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.

**Course Name:** Internship
**Course Code:** BBT2081
Students will be advised to do a small project on research/survey/review/case study during the credit hours.

**Course Name:** IDC - Basics of Life Skill Education
**Course Code:** ED2032

**Course Name:** AEC - Modern Indian Language
**Course Code:** AEC2042

**Course Name:** VAC - Environmental Science II
**Course Code:** VAC2061

**Course Name:** VAC - Digital Transformation
**Course Code:** VAC2061

# SWAMI VIVEKANANDA UNIVERSITY

**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

**UG Biotechnology, Semester III – NEP Syllabus**

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Genetics | BBT3011 | 3 |
| | Genetics Lab | BBT3011 | 1 |
| | Molecular Biology | BBT3012 | 3 |
| | Molecular Biology Lab | BBT3012 | 1 |
| Minor | General Chemistry | BBT3021 | 3 |
| | General Chemistry Lab | BBT3021 | 1 |
| Skill Enhancement Course | SEC: Biotechnology & Human Welfare | BBT3051 | 3 |
| Ability Enhancement Course | AEC: Communicative English | AEC3041 | 2 |
| Interdisciplinary Course | IDC: Educational Research | ED3031 | 3 |
| | Internship | | 2 |

**Course Name: Genetics**
**Course Code: BBT3011**

**Module-I: [12H]**
Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

**Module-II: [18H]**
Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition – unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequencesSINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

**Module-III: [15H]**
Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

**Module-IV: [15H]**
Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

**Course Name: Genetics Lab**.
**Course Code: BBT3011**

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body -Rhoeo translocation. 5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

**Learning outcomes**

1. This course offers heredity of living organisms involving alleles, genes and chromosomes.
2. This course makes you expertise in lot of techniques related to cell division and inheritance biology.

**Suggested Reading**

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

**Course Name: Molecular Biology**
**Course Code: BBT3012**

**Module-I: [15H]**
DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

**Module-II: [10H]**
DNA damage, repair and homologous recombination: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

**Module-III: [17H]**
Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

**Module-IV: [18H]**
Regulation of gene expression and translation: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation., Posttranslational modifications of proteins.

**Course Name: Molecular Biology Lab**
**Course Code: BBT3012**

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method.
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

**Learning outcomes**

1. This course offers molecular biological processes in living organisms and the regulation of gene expression.
2. This course makes you expertise in lot of techniques related to Molecular Biology experiments.

**Suggested Reading**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

**Course Name: General Chemistry**
**Course Code: BBT3021**

**Module I: Chemical Bonding [20H]**
General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications. Concept of resonance and resonating structures in various inorganic and organic compounds.
VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

**Module II: Stereochemistry [15H]**
Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis – trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

**Module III: Basic Organic Chemistry [15H]**
Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

**Module IV: Introduction to Green Chemistry [10H]**
What is green chemistry? Needs and goals of green chemistry. Limitations/ Obstacles in the pursuit of the goals of green chemistry.

**Course Name: General Chemistry Lab**
**Course Code: BBT3021**

1. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.
2. Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator.
3. Estimation of Cu (II) ions iodometrically using Na2S2O3.
4. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements)
5. Preparation and characterization of nanoparticles of gold using tea leaves.
6. Preparation of biodiesel from vegetable/ waste cooking oil.

**Learning outcomes**

1. This course offers general characteristics of chemical bonding, stereochemistry and organic reactions.
2. This course makes you expertise in quantitative estimation of various functional chemical groups.

**Suggested Reading**

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of
Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University
Press (1998).
6. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment.
American Chemical Society, Washington DC (2002).

**Course Name: SEC: Biotechnology & Human Welfare**
**Course Code: BBT3051**

**Module-I: [10H]**
Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.
**Module-II: [10H]**
Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.
**Module-III: [15H]**
Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.
**Module-IV: [12H]**
Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.
**Module-V: [13H]**
Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in E. coli, human genome project.

**Course Name: AEC: Communicative English**
**Course Code: AEC3041**

**Course Name: IDC: Educational Research**
**Course Code: ED3031**

# SWAMI VIVEKANANDA UNIVERSITY

**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

**UG Biotechnology, Semester IV – NEP Syllabus**

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Immunology | BBT4011 | 3 |
| | Immunology Lab | | 1 |
| | Recombinant DNA Technology | BBT4012 | 3 |
| | Recombinant DNA Technology Lab | | 1 |
| | Bioinformatics | BBT4021 | 3 |
| | Bioinformatics Lab | | 1 |
| Minor | Drug Designing & Development | BBT4051 | 4 |
| **Total** | | | **16** |

**Course Name: Immunology**
**Course Code: BBT4011**

**Module-I: [20H]**
Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

**Module-II: [15H]**
Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

**Module-III: [13H]**
Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

**Module-IV: [12H]**
Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

**Course Name: Immunology**
**Course Code: BBT4011**

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

**Learning outcomes**

1. This course offers immunological processes in living organisms and the regulation of immunoglobulin gene expression.
2. This course makes you expertise in lot of techniques related to immune assay experiments.

**Course Name: Recombinant DNA Technology**
**Course Code: BBT4012**

**Module-I: [15H]**

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

**Module-II: [20H]**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

**Module-III: [10H]**

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

**Module-IV: [15H]**

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, 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.

**Course Name: Recombinant DNA Technology Lab**
**Course Code: BBT4012**

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from E. coli
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR.

**Learning outcomes**

1. This course offers knowledge on various techniques related to Genetic engineering.
2. This course makes you expertise in molecular tools and applications related to recombinant technology.

**Suggested Reading**

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

**Course Name: Bioinformatics**
**Course Code: BBT4021**

**Module-I: [10H]**
History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

**Module-II: [20H]**
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

**Module-III: [20H]**
Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

**Module-IV: [10H]**
Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

**Course Name: Bioinformatics Lab**
**Course Code: BBT4021**

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.

6. Sequence alignment using BLAST.
7. Multiple sequence alignment using ClustalW.

**Learning outcomes**
1. This course offers knowledge on various tools and Databases related to Bioinformatics.
2. This course makes you expertise in molecular phylogeny and sequence comparison.

**Suggested Reading:**
1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. WileyBlackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

**Course Name: Drug Designing & Development**
**Course Code: BBT4051**

**Module I [10H]**
Introduction to The Drug Discovery/Development: Drug Discovery, Drug Development, Source of Drugs.

**Module II [15H]**
Approaches to New Drug Discovery: Drugs Derived from Natural Products, Existing Drugs as a Source for New Drug Discovery, Using Disease Models as Screens for New Drug Leads, Physiological Mechanisms: the Modern "Rational Approach" to Drug Design.
Approaches to Lead Optimization:
1. Bioisosteric replacement
2. Conformation restriction
    a. Increase selectivity, b. Increase affinity
3. Pharmacophore
4. Molecular dissection
5. Metabolic stabilization

**Module III [10H]**
Enzymes as Targets of Drug Design: Enzyme kinetics, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors.

**Module IV [10H]**
Receptors as Targets of Drug Design: Receptor Theory, Receptor Complexes and Allosteric Modulators, Second and Third Messenger Systems, Molecular Biology of Receptors, Receptor Models and Nomenclature, Receptor Binding Assays, Lead Compound Discovery of Receptor agonists and antagonists.

**Module V [10H]**
Prodrug Design and Applications: Definition, Applications, Prodrug Design Considerations, Prodrug Forms of Various Functional Groups, Ester prodrugs of compounds containing –COOH or –OH, Prodrugs of compounds containing amides Drug release and activation mechanisms:
1. Simple one-step activation

2. Cascade release/activation systems

**Learning outcomes**

1. This course offers general characteristics of drug designing and drug discovery.
2. This course makes you expertise in Rational Design of Enzyme Inhibitors, Computer-aided drug designing methods.

# SWAMI VIVEKANANDA UNIVERSITY

**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

**UG Biotechnology, Semester V – NEP Syllabus**

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Bio – Analytical Tools | BBT5011 | 3 |
| | Bio – Analytical Tools Lab | | 1 |
| | Genomics & Proteomics | BBT5012 | 3 |
| | Genomics & Proteomics Lab | | 1 |
| | Bioprocess Technology | BBT5013 | 3 |
| | Bioprocess Technology Lab | | 1 |
| | Quality Assurance & Quality Control | BBT5014 | 4 |
| Minor | Biostatistics | BBT5021 | 4 |
| **Total** | | | 20 |

**Course Name: Bio – Analytical Tools**
**Course Code: BBT5011**

**Module I [10H]**
Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

**Module II [15H]**
Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra- red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

**Module III [15H]**
Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

**Module IV [20H]**
Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

**Course Name: Bio – Analytical Tools Lab**
**Course Code: BBT5011**

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

**Learning outcomes**

1. This course offers knowledge on various chromatography and gel electrophoresis techniques related to analysis of biomolecules.
2. This course makes you expertise in molecular tools and applications related to recombinant technology and biochemical analysis.

**Suggested Readings:**

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

**Course Name: Genomics & Proteomics**
**Course Code: BBT5012**

**Module [15H]**

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

**Module II [15H]**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

**Module III [15H]**

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

**Module IV [15H]**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE.Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

**Course Name: Genomics & Proteomics Lab**
**Course Code: BBT5012**

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.

6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

**Learning outcomes**

1. This course offers knowledge on various tools for genome and proteome data analysis.
2. This course makes you expertise in molecular tools and applications related to genomics and proteomics techniques.

**Suggested Readings:**

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th
1. Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I
2. to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W.
3. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley
4. and Sons Inc.

**Course Name: Bioprocess Technology**
**Course Code: BBT5013**

**Module-I: [10H]**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

**Module-II: [20H]**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

**Module-III: [15H]**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

**Module-IV: [15H]**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

**Course Name: Bioprocess Technology Lab**
**Course Code: BBT5013**

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.

4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

**Learning outcomes**

1. This course offers knowledge on microbial techniques related to growth and production of microbial enzymes and other products.
2. This course makes you expertise in bioreactor designing and upstream and downstream processing of biological products.

**Suggested Reading:**

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

**Course Name: Quality Assurance & Quality Control**
**Course Code: BBT5014**

**Module 1: Introduction to QA and QC (1 Credit)**

- Definitions, Scope, and Importance of QA and QC in Biotech and Pharma
- Key Concepts: Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), and ISO Standards
- QA/QC Systems: Objectives, Components, and Workflow
- Risk Assessment and Management in Quality Processes

**Module 2: Regulatory Guidelines and Compliance (1 Credit)**

- Overview of Regulatory Authorities: USFDA, EMA, CDSCO, WHO
- Regulatory Guidelines: ICH Q8, Q9, Q10, and Q11
- Documentation Practices: Standard Operating Procedures (SOPs), Batch Records, and Validation Protocols
- Audits and Inspections: Types, Preparation, and Handling Non-Compliance

**Module3: Quality Control Techniques and Tools (1 Credit)**

- Analytical Methods for QC: Chromatography (HPLC, GC), Spectroscopy (UV-Vis, FTIR), and Mass Spectrometry
- Microbial and Sterility Testing in Biotech Products
- Validation Techniques: Process, Analytical, and Cleaning Validation
- Statistical Tools for Quality Control: Six Sigma, Control Charts, and Process Capability Analysis

**Module 4: Applications and Case Studies (1 Credit)**

- QA/QC in Biopharmaceuticals: Monoclonal Antibodies, Vaccines, and Biosimilars
- QA/QC in Food and Nutraceuticals: Standards and Testing
- Case Studies: Real-World Examples of Quality Failures and Lessons Learned
- Emerging Trends in QA/QC: AI in Quality Monitoring, Real-Time Release Testing (RTRT)

**Learning Outcomes:** Upon completing this course, students will:

1. Understand the fundamental principles of QA and QC in biotechnology and pharma.
2. Be familiar with global regulatory standards and their application in quality management.
3. Gain hands-on knowledge of QA/QC techniques and tools used in testing and validation.
4. Apply QA/QC principles to biomanufacturing processes and compliance audits.

**Course Name: Biostatistics**
**Course Code: BBT5021**

**Module-I: [12H]**
Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

**Module-II: [18H]**
Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

**Module-III: [18H]**
Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi- square test for goodness of fit and analysis of variance (ANOVA)

**Module-IV: [12H]**
Correlation and Regression. Emphasis on examples from Biological Sciences.

**Learning outcomes**
1. This course offers knowledge on quantitative analysis of experimental data.
2. This course makes you expertise in statistical tools and applications related to data analysis.

**Suggested Reading:**
1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford
1. University Press.
4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

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**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

**UG Biotechnology, Semester VI – NEP Syllabus**

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Plant Biotechnology | BBT6011 | 3 |
| | Plant Biotechnology Lab | | 1 |
| | Animal Biotechnology | BBT6012 | 3 |
| | Animal Biotechnology Lab | | 1 |
| | Microbial Biotechnology | BBT6013 | 3 |
| | Microbial Biotechnology Lab | | 1 |
| | Bioethics & Biosafety | BBT6014 | 4 |
| Minor | Active Pharmaceutical Ingredient (API) Production | BBT6021 | 4 |
| **Total** | | | **20** |

**Course Name: Plant Biotechnology**
**Course Code: BBT6011**

**Module-I: [10H]**
Anatomy: The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

**Module-II: [12H]**
Plant water relations and micro & macro nutrients: Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

**Module-III: [20H]**
Carbon and nitrogen metabolism: Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

**Module-IV: [18H]**
Growth and development: Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene). Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization.

**Course Name: Plant Biotechnology Lab**
**Course Code: BBT6011**

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by Tradescantia leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.

6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

**Learning outcomes**

1. This course offers various mechanisms of different plant physiological processes.
2. This course makes you expertise in lot of techniques related to quantitative estimation of various plant physiological processes.

**Suggested Reading**

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4 th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4 th edition, Sinauer Associates Inc .MA, USA

Course Name: Animal Biotechnology
Course Code: BBT6012

Module-I:
[10H]
Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.
Module-II: [10H]
Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.
Module-III: [20H]
Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.
Module-IV: [20H]
Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

**Course Name: Animal Biotechnology Lab**
**Course Code: BBT6012**

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA

8. Resolving DNA on Agarose Gel.

**Learning outcomes**

1. This course offers knowledge on various techniques related to transgenic animal development.
2. This course makes you expertise in molecular tools and applications related to recombinant technology.

**Suggested Reading:**

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California, USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

**Course Name: Microbial Biotechnology**
**Course Code: BBT6013**

**Module 1: Microbial Biotechnology and its Applications**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

**Module 2: Therapeutic and Industrial Biotechnology**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors

**Module 3: Applications of Microbes in Biotransformations**

Microbial based transformation of steroids and sterols No. of Hours: 6 Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

**Module 4: Microbial Products and their Recovery**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization

**Module 5: Microbes for Bio-energy and Environment**

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

**Module 6: RNAi**
RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions

**Module 7: Intellectual Property Rights**
Patents, Copyrights, Trademarks

**Course Name: Microbial Biotechnology Lab**
**Course Code: BBT6013**

1. Study yeast cell immobilization in calcium alginate gels 2.
2. Study enzyme immobilization by sodium alginate method 3.
3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium) 4.
4. Isolation of xylanase or lipase producing bacteria 5.
5. Study of algal Single Cell Proteins

**Suggested Reading:**

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, McGraw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications.
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press.
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4 th edition, ASM Press.
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science 9.
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

**Course Name: Bioethics & Biosafety**
**Course Code: BBT6014**

**Module-I: [15H]**
Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

**Module-II: [20H]**
Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc.

The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations
export potential etc.

**Module-III: [10H]**
Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

**Module-IV: [15H]**
Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

**Learning outcomes**
1. This course offers learning about various biosafety and bioethics.
2. This course makes you expertise in different case study dependent health hazards.

**Suggested Reading:**
1. Entrepreneurship: New Venture Creation: David H. Holt
2. Patterns of Entrepreneurship: Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

**Course Name: Active Pharmaceutical Ingredient (API) Production**
**Course Code: BBT6021**

**Module 1: Introduction to APIs and Manufacturing Processes (1 Credit)**
- Definition and Classification of APIs: Small Molecules, Biologics, and Peptides
- Overview of API Manufacturing Workflows: Raw Material Procurement, Synthesis, and Purification
- Key Techniques: Chemical Synthesis, Biocatalysis, and Fermentation
- Role of APIs in Drug Development and Therapeutics

**Module 2: Process Development and Optimization (1 Credit)**
- Principles of Process Design: Reaction Kinetics, Reactor Design, and Yield Optimization
- Scale-Up Considerations: Lab-Scale to Pilot-Scale and Commercial Production
- API Purification Techniques: Crystallization, Filtration, and Drying
- Process Analytical Technology (PAT) and Continuous Manufacturing

**Module 3: Quality Assurance, Regulatory Compliance, and Safety (1 Credit)**
- Good Manufacturing Practices (GMP) in API Production
- Regulatory Requirements: USFDA, EMA, WHO, and ICH Guidelines
- Quality Assurance and Quality Control in API Manufacturing
- Safety and Environmental Considerations in API Production

**Module 4: Emerging Trends and Case Studies (1 Credit)**

- Green Chemistry in API Manufacturing: Sustainable Processes and Waste Reduction
- AI and Machine Learning in API Process Optimization
- Biopharmaceutical APIs: Production of Monoclonal Antibodies, Vaccines, and Biosimilars
- Case Studies: Success Stories and Challenges in API Manufacturing

**Learning Outcomes**

Upon completing this course, students will:

1. Acquire knowledge of the science and engineering behind API production.
2. Understand process design, optimization, and scale-up in API manufacturing.
3. Demonstrate an understanding of quality assurance, compliance, and safety in API production.
4. Apply emerging technologies to optimize and innovate API production processes.

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**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

**UG Biotechnology, Semester VII – NEP Syllabus**

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Medical Coding | BBT7011 | 4 |
| | Clinical Data Management | BBT7012 | 4 |
| | Computational Aptitude | BBT7013 | 4 |
| | AI & Machine Learning | BBT7014 | 4 |
| Minor | Molecular Diagnostics | BBT7021 | 4 |
| **Total** | | | **20** |

**Course Name: Medical Coding**
**Course Code: BBT7011**

**Module 1: Fundamentals of Medical Scribing (1 Credit)**

- Introduction to Medical Scribing: Role and Responsibilities
- Anatomy and Physiology Overview for Medical Scribes
- Medical Terminology and Abbreviations
- Electronic Health Records (EHRs): Systems and Workflow
- Real-Time Medical Documentation: Patient History, Symptoms, and Treatments

**Module 2: Principles of Medical Coding (1 Credit)**

- Overview of Medical Coding: Purpose and Applications
- ICD-10-CM and ICD-11 Coding: Structure and Guidelines
- CPT and HCPCS: Procedure and Services Coding
- Coding for Different Specialties: Cardiology, Orthopedics, Oncology, etc.
- Error Minimization and Quality Assurance in Coding

**Module 3: Technology and Software in Medical Scribing and Coding (1 Credit)**

- Introduction to Medical Scribing Tools and Transcription Software
- Coding Software Platforms: 3M CodeFinder, EncoderPro, etc.
- Integration of Artificial Intelligence and Automation in Scribing and Coding
- Data Security and Confidentiality in Medical Records
- Case Studies: Implementing Technology in Real-Life Scenarios

**Module 4: Ethical, Legal, and Regulatory Aspects (1 Credit)**

- Health Insurance Portability and Accountability Act (HIPAA) Compliance
- Documentation Standards and Legal Considerations in Medical Records
- Billing and Reimbursement Processes in Healthcare
- Ethical Issues in Medical Scribing and Coding
- Global Coding Standards: Regional Variations and Challenges

**Learning Outcomes**

By the end of this course, students will:

1. Develop the ability to document medical encounters accurately and efficiently.
2. Gain competency in using ICD, CPT, and HCPCS coding systems for various medical procedures and diagnoses.
3. Demonstrate proficiency in medical coding software and EHR systems.
4. Understand the ethical and regulatory requirements for handling medical data.
5. Be prepared for careers in medical scribing, coding, and related roles in healthcare and biotech industries.

**Suggested Reading:**
1. *Essentials of Medical Scribing* by Alex McHugh.
2. *Step-by-Step Medical Coding* by Carol J. Buck.
3. ICD-10-CM/PCS Coding Handbook by Nelly Leon-Chisen.
4. HIPAA Guidelines and Regulatory Resources.
5. Online Tutorials for EHR and Coding Software.

**Course Name: Clinical Data Management**
**Course Code: BBT7012**

**Module 1: Introduction to Clinical Data Management (1 Credit)**
- Definition and Importance of CDM
- Overview of Clinical Trials and CDM in the Drug Development Lifecycle
- Key Stakeholders: Sponsors, CROs, and Regulatory Authorities
- Standard Operating Procedures (SOPs) and Good Clinical Data Management Practices (GCDMP)

**Module 2: Regulatory Guidelines and Ethical Considerations (1 Credit)**
- International Guidelines: ICH-GCP, US FDA, EMA, and Indian CDSCO
- Data Privacy and Protection: HIPAA, GDPR, and Indian IT Act
- Ethical Issues in Data Collection and Management
- Audits and Inspections in Clinical Data Management

**Module 3: CDM Process and Tools (1 Credit)**
- Data Collection and Case Report Forms (CRFs): Design and Standards
- Data Entry and Validation: Processes and Best Practices
- Overview of CDM Systems and Software (e.g., Oracle Clinical, Medidata RAVE, EDC tools)
- Data Cleaning, Query Management, and Database Lock

**Module 4: Advanced Topics and Applications (1 Credit)**
- Integration of CDM with Biostatistics and Data Analysis
- Handling Adverse Event Data and Serious Adverse Events (SAEs)
- Real-World Data (RWD) and Real-World Evidence (RWE)
- Emerging Trends: Artificial Intelligence and Machine Learning in CDM

## Learning Outcomes
Upon completion of the course, students will be able to:
1. Design and implement a clinical data management plan for clinical trials.
2. Demonstrate proficiency in using CDM tools and software.
3. Ensure compliance with ethical and regulatory standards for data management.
4. Analyze clinical data and generate comprehensive reports for regulatory submissions.
5. Understand emerging technologies in CDM and their applications in clinical research.

**Suggested Reading:**
1. Good Clinical Data Management Practices (GCDMP), Society for Clinical Data Management (SCDM).
2. *Principles of Clinical Data Management* by Richard K. Rondel et al.
3. ICH-GCP E6 (R2) Guidelines.
4. *Clinical Data Management* by Eleanor McFadden.

**Course Name: Computational Aptitude**
**Course Code: BBT7013**

**Module 1: Introduction to Computational Thinking (1 Credit)**
- Basics of Computational Thinking: Logical Reasoning and Problem-Solving
- Algorithm Design: Steps in Problem Formulation and Solution Design
- Understanding Flowcharts and Pseudocode for Logical Representation
- Applications of Computational Thinking in Biotechnology

**Module 2: Programming Fundamentals (1 Credit)**
- Introduction to Programming Languages: Python and R
- Basic Syntax, Variables, Data Types, and Operators
- Control Structures: Loops (for, while) and Conditional Statements (if-else)
- Functions, Modules, and Libraries for Efficient Coding

**Module 3: Algorithms and Data Structures (1 Credit)**
- Fundamental Algorithms: Sorting, Searching, and Recursion
- Data Structures: Arrays, Lists, Dictionaries, and Stacks
- Algorithm Optimization: Time and Space Complexity
- Case Studies: Biological Sequence Alignment and Phylogenetic Tree Construction

**Module 4: Applications in Biotechnology (1 Credit)**
- Data Analysis and Visualization using Python and R
- Applications in Genomics and Proteomics: Sequence Analysis and Protein Modeling
- Introduction to Machine Learning: Basics of Supervised and Unsupervised Learning
- Tools for Computational Biology: Biopython, BioPerl, and R Bioconductor

**Learning Outcomes**
Upon completing this course, students will:
1. Understand computational thinking and its role in solving biological problems.
2. Acquire basic coding skills in Python and R.
3. Develop and optimize algorithms for biological applications.
4. Utilize programming tools to analyze and interpret biological data.

**Course Name: AI & Machine Learning**
**Course Code: BBT7014**

**Module 1: Fundamentals of AI/ML in Biology (1 Credit)**
- Introduction to AI and ML: Definitions, Types (Supervised, Unsupervised, Reinforcement Learning)
- Key Concepts: Neural Networks, Deep Learning, and Natural Language Processing (NLP)
- Biological Data Types: Genomic, Transcriptomic, Proteomic, and Clinical Data
- Overview of AI/ML Tools: Python Libraries (Scikit-learn, TensorFlow, PyTorch), R Programming

**Module 2: AI/ML in Drug Discovery and Development (1 Credit)**
- Applications in Drug Target Identification and Validation
- AI in Virtual Screening, Molecular Docking, and ADMET Prediction
- Accelerating Drug Discovery Pipelines with Generative AI Models
- Case Studies: AI-Driven Drug Development (e.g., AlphaFold, BenevolentAI)

**Module 3: AI/ML in Biopharma Process Optimization (1 Credit)**

- Process Monitoring and Optimization in Bioreactors
- Predictive Models for Yield Optimization and Quality Control
- AI in Supply Chain and Manufacturing Processes
- Integration of AI in Biopharma 4.0 Frameworks

**Module 4: Emerging Trends and Ethical Considerations (1 Credit)**

- AI in Personalized Medicine and Precision Therapeutics
- Role of AI/ML in Synthetic Biology and Genetic Engineering
- Challenges in Data Privacy, Bias, and Interpretability in AI/ML Models
- Regulatory and Ethical Guidelines for AI Applications in Biopharma

**Learning Outcomes**

Upon completion of this course, students will:

1. Understand the principles of AI/ML and their applications in biology and biopharma.
2. Develop skills to analyze biological data using AI/ML techniques.
3. Apply AI/ML models to real-world problems in drug discovery and biopharma process optimization.
4. Critically evaluate ethical and regulatory considerations in AI/ML applications.

**Course Name: Molecular Diagnostics**
**Course Code: BBT7021**

**Module-I: [15H]**

Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

**Module-II: [15H]**

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

**Module-III: [18H]**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

**Module-IV: [12H]**

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

**Learning outcomes**

1. This course offers various molecular diagnostic techniques related to clinical pathology.
2. This course makes you expertise in various tools involved in microbial, immunological tests.

# SWAMI VIVEKANANDA UNIVERSITY

**Telinipara, Barasat – Barrackpore Road, Bara Kanthalia, West Bengal - 700121**

**UG Biotechnology, Semester VIII – NEP Syllabus**

| Category | Subject Name | Subject Code | Subject Credit |
|---|---|---|---|
| Major | Inheritance Biology | BBT8011 | 3 |
| | Inheritance Biology Lab | | 1 |
| Minor | Environmental Biotechnology | BBT8021 | 3 |
| | Environmental Biotechnology Lab | | 1 |
| | Research Proposal | BBT8051 | 12 |
| **Total** | | | **20** |

**Course Name: Inheritance Biology**
**Course Code: BBT8011**

**Module-I: [5H]**
Introduction to Genetics: Historical developments Model organisms in genetic analyses and experimentation: Escherichia coli, Saccharomyces cerevisiae, Neurospora crassa, Caenorhabditis elegans Drosophila melanogaster, Arabidopsis thaliana

**Module-II: [13H]**
Mendelian Principles: Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity

**Module-III: [9H]**
Linkage and Crossing over: Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping

**Module-IV: [9H]**
Extra-Chromosomal Inheritance: Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in Chlamydomonas, mitochondrial, mutations in Saccharomyces, Maternal effects – Shell coiling in Limnaea peregra Infectious heredity - Kappa particles in Paramecium

**Module-V: [15H]**
Characteristics of Chromosomes: Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome

**Module-VI: [3H]**
Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination.

**Module-VII: [3H]**
Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

**Module-VIII: [3H]**
Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

**Course Name: Inheritance Biology Lab**
**Course Code: BBT8011**

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying Rhoeo translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
6. Study of polytene chromosomes using temporary mounts of salivary glands of Chiromonas / Drosophila larvae
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait.

**Learning outcomes:** After completion of Bacteriology, the student will learn about the
1. History and basics of genetics and inheritance
2. Mendelian Genetics
3. Genetic behavior and its effect on phenotypes

**Suggested Reading:**
1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). I Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

**Course Name: Environmental Biotechnology**
**Course Code: BBT8021**

**Module I [15H]**
Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

**Module II [20H]**
Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phytoremediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

**Module III [13H]**
Treatment of municipal waste and Industrial effluents. Biofertilizers. Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

**Module IV [12H]**
Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

**Course Name: Environmental Biotechnology Lab**
**Course Code: BBT8021**

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

**Learning outcomes**
1. This course offers knowledge on biofuels, bioremediation and bioleaching.
2. This course makes you expertise in waste remediation processes and quantitative analysis of water sample.

**Course Name: Research Proposal**
**Course Code: BBT8051**

Students will be advised to do a small project on research/survey/review/case study during the credit hours.