Rev: 04

SYLLABUS

For

3 YEARS BSC BIOTECHNOLOGY PROGRAMME

(Revised Syllabus Approved by Academic Council)

Dept. of Applied Biology

JUNE, 2018

UNIVERSITY OF SCIENCE &TECHNOLOGY, MEGHALAYA

Techno City, 9th Mile, Baridua, Ri-Bhoi, Meghalaya, 793101

PSO1. The objective of the Bachelor's Programme in Biotechnology is to increase the understanding of Biological Sciences with the implementation of technology on different living systems like plants, animals and microbes.

PSO2. It provides the opportunity in the field of research and engineering sectors such as food technology, nutrition, medicines, health care, forensic sciences etc.

PSO3. It increases the understanding of the Cytological, Biochemical and Physiological aspects of living organisms as well as the different technical aspects required for their study.

PSO4. It helps in understanding the technical aspects related to the improvement of crop plants and live-stocks and their by finding a solution at the time of population explosion.

PSO6. It helps in understanding the potential of biological agents in obtaining product of human interest and how some of the microbes are industrially exploited for obtaining such products.

SEMESTER WISE DISTRIBUTION OF COURSE

SEMESTER-I

Course Code	Course Title	Course Code	Credit	Nature of the Course	Marks Allotted		
					Internal	End Semester	Total
BBT 101	Biochemistry and Metabolism	**C-1**	**4**	**T**	**30**	**70**	**100**
BBT 102	Cell Biology	**C-2**	**4**	**T**	**30**	**70**	**100**
BBT 103	Communicative English	**AECC-1**	**4**	**P**	**30**	**70**	**100**
BBT 104	Biotechnology and Human Welfare	**GE-1**	**4**	**P**	**30**	**70**	**100**
BBT 105	Practical on Biochemistry & Metabolism and Cell Biology	**P-1**	**4**	**P**	**30**	**70**	**100**
Total			**20**	**-**	**150**	**350**	**500**

SEMESTER-II

Paper Code	Title	Course Code	Credit	Nature	Marks Allotted		
					Internal	End Semester	Total
BBT 201	Mammalian Physiology	**C-3**	**4**	**T**	**30**	**70**	**100**
BBT 202	Microbial and Plant Physiology	**C-4**	**4**	**T**	**30**	**70**	**100**
BBT 203	Environmental Studies	**AECC-2**	**4**	**P**	**30**	**70**	**100**
BBT 204	Developmental Biology	**GE-2**	**4**	**P**	**30**	**70**	**100**
BBT 205	Practical on Mammalian Physiology and Microbial & Plant Physiology	**P-2**	**4**	**P**	**30**	**70**	**100**
Total			**20**	**-**	**150**	**350**	**500**

SEMESTER-III

Paper Code	Title	Course Code	Credit	Nature	Marks Allotted		
					Internal	End Semester	Total
BBT 301	Genetics	**C-5**	**4**	**T**	**30**	**70**	**100**
BBT 302	General Microbiology	**C-6**	**4**	**T**	**30**	**70**	**100**
BBT 303	Chemistry-1	**C-7**	**4**	**P**	**30**	**70**	**100**
BBT 304	Molecular Diagnostics	**SEC-1**	**4**	**P**	**30**	**70**	**100**
BBT 305	Bioethics and Biosafety	**GE-3**	**4**	**P**	**30**	**70**	**100**
BBT 306	Practical on Genetics, General Microbiology and Chemistry-1	**P-3**	**4**	**P**	**30**	**70**	**100**
Total			**20**	**-**	**150**	**350**	**500**

SEMESTER-IV

Paper Code	Title	Course Code	Credit	Nature	Marks Allotted		
					Internal	End Semester	Total
BBT 401	Molecular Biology	**C-8**	**4**	**T**	**30**	**70**	**100**
BBT 402	Immunology	**C-9**	**4**	**T**	**30**	**70**	**100**
BBT 403	Chemistry-2	**C-10**	**4**	**P**	**30**	**70**	**100**
BBT 404	Enzymology	**SEC-2**	**4**	**P**	**30**	**70**	**100**
BBT 405	Entrepreneurship Development and IPR	**GE-4**	**4**	**P**	**30**	**70**	**100**
BBT 406	Practical on Molecular Biology, Immunology, Enzymology and Chemistry-2	**P-4**	**4**	**P**	**30**	**70**	**100**
Total			**P-3**	**-**	**150**	**350**	**500**

SEMESTER-V

Paper Code	Title	Course Code	Credit	Nature	Marks Allotted		
					Internal	End Semester	Total
BBT 501	Industrial Fermentations	**C-11**	**4**	**T**	**30**	**70**	**100**
BBT 502	Recombinant DNA Technology	**C-12**	**4**	**T**	**30**	**70**	**100**
BBT 503	Plant Biotechnology	**DSE-1**	**4**	**P**	**30**	**70**	**100**
BBT 504	Bioinformatics and Biostatistics	**DSE-2**	**4**	**P**	**30**	**70**	**100**
BBT 505	Practical on Industrial Fermentations, Recombinant DNA Technology, Bioinformatics and Chemistry 3	**P-5**	**4**	**P**	**30**	**70**	**100**
Total			**P-4**	**-**	**150**	**350**	**500**

SEMESTER-VI

Paper Code	Title	Course Code	Credit	Nature	Marks Allotted		
					Internal	End Semester	Total
BBT 601	Bio Analytical Tools	**C-13**	**4**	**T**	**30**	**70**	**100**
BBT 602	Genomics and Proteomics	**C-14**	**4**	**T**	**30**	**70**	**100**
BBT 603	Environmental Biotechnology	**DSE-3**	**4**	**P**	**30**	**70**	**100**
BBT 604	Animal Biotechnology	**DSE-4**	**4**	**P**	**30**	**70**	**100**
BBT 605	Practical on Bio Analytical Tools, Environmental Biotechnology and Plant Biotechnology	**P-6**	**4**	**P**	**30**	**70**	**100**
Total			**20**	**-**	**150**	**350**	**500**

C: Core Courses;
GE: Generic Elective;

AECC: Ability Enhancement Compulsory Course;
SEC: Skill Enhancement Courses;
DSE: Discipline Specific Elective

GENERIC ELECTIVE SUBJECTS (any one per semester in semesters 1-4)

1. Entrepreneurship Development
2. Bioethics and Biosafety
3. Biotechnology and Human Welfare
4. Developmental Biology

SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)

1. Molecular Diagnostics
2. Drug Designing
3. Enzymology
4. Basics of Forensic Science
5. Industrial Fermentations

DISCIPLINE CENTRIC SUBJECTS (any two per semester in semesters 5-6)

- Bioinformatics
- Animal Biotechnology
- Medical Microbiology
- Animal Diversity I
- Plant Diversity I
- Animal Diversity II
- Plant Diversity II
- Plant Biotechnology
- Environmental Biotechnology
- Intellectual Property Rights
- Microbial Physiology
- Biostatistics
- Ecology and Environment Management
- Evolutionary Biology
- Chemistry 3
- Chemistry 4

SEMESTER-I

BBT 101 **Biochemistry and Metabolism** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To understand the chemical basis of cellular life as well as the internal chemistry of biological systems of animals and plants.

CO2. To get foundational knowledge for higher concepts in the fields of research related to cell biology, molecular biology, genetics, material sciences, regenerative sciences, neuroscience, psychology, kinesiology, etc.

CO3. To understand the actual chemical concepts of biology through the functioning of various body processes and physiology using bio-molecules.

CO4. To understand the concept of enzymes, its kinetics and importance in metabolism and other physiological reactions inside the cell.

CO5. To understand the underlying concept of metabolism of carbohydrates and its importance in animal physiology.

Course Content

UNIT I: Fundamentals of Biochemistry:

1. Amino acids & Proteins**:** Structure and 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.
2. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

UNIT II

1. Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.
2. Nucleic acids: Structure and functions. Physical and chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B and Z – DNA, denaturation and renaturation of DNA.

UNIT III

1. 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.
2. 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.

UNIT IV

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

BBT 102 **Cell Biology** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To have the concept of cell theory; structural organization and functions of prokaryotic and eukaryotic cells as well as their comparative account.

CO2. To get an insight into the structural organization and functional roles of important cell organelles including plasma membrane, endoplasmic reticulum, golgi complex, lysosome, peroxisome, vacuoles and mitochondria.

CO3. To understand the structural organization and functional roles nucleus, the controlling centre of a cell.

CO4. To understand the structural organization and functional roles of cytoskeleton that gives specific shape and structure to a cell.

CO5. To get an insight into various stages of cell cycle that regulates proper organization in cellular organisms. It also deals with the abnormalities during cell division process leading to cancer like problem.

Course Content

UNIT I: Introduction to cell

1. Cell theory, Structural organization of prokaryotic cell, eukaryotic cells and their function.
2. Comparative characters of prokaryotes and eukaryotes.

UNIT II: Plasma membrane

1. Structural organization of cell membrane, plasma membrane and their function
2. Mechanism of transport across the plasma membrane, Sodium Potassium pump, Glucose transport, transport of ions in neuron.

UNIT III: Cell organelles; structure & function

1. Endoplasmic reticulum, golgi complex, lysosome, peroxisome and vacuoles, mitochondria; role of mitochondria in oxidative reactions and electron transport chain. Chloroplast and its role in photosynthesis.

UNIT IV: Nucleus

1. Nucleus- Structure, organization and function, Nuclear envelope, role of nuclear pore in transport across the envelope, nucleoplasm and nucleolus, Chromatin structure and organization.

UNIT V: Cytoskeleton

1. Microtubule and microfilaments:
2. Intermediate filaments and Extra cellular matrix

UNIT VI: Cell cycle & cell division

1. Cell cycle and its phases, Cell divisions and Cell death
2. Cell cycle- control and regulation and cancer.

Suggested Readings:

1. Bruce Alberts *et al*. *Molecular Biology of cell*. Garland Publications
2. Daniel. *Molecular Cell Biology*. Sceintific American Books.
3. Jack D. Bruke. *Cell Biology*. The William Twilkins Company.
4. Old and Primrose. *Principles of Gene Manipulations*. Black Well Scientific Publications.
5. Ambrose and Dorouthy M Hasty. *Cell Biology*. ELBS Publications.
6. Sharp. *Fundamentals of Cytology*. Mc Graw Hill Company.
7. Wilson and Marrision. *Cytology*. Reinform Publications
8. Smith. *Molecular Biology*. Faber and Faber Publications
9. EDP Roberties and EMF Roberties. *Cell and Molecular Biology*. Sauder College.
10. Gardener EJ, Simmons MJ and Snustad DP. *Principles of Genetics*. John Wiley and Sons Publications.

BBT 103 **Communicative English** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To enhance reading and writing abilities mainly focusing academic and day to day uses.

CO2. To develop the idea of grammar usage (determiners, tenses, voice, direct and indirect speech, punctuation, word formation idioms and phrases) in developing communicating skills.

CO3. To get an insight into the format of official correspondence, Letter (formal and informal), Circular and Notice.

CO4. To develop the skill in writing Cvs/Resume, Essay, e-mail, Blog, Story and Paragraph which act as a source of communication at different platforms.

CO5. To develop the skill in writing comprehension and précis that enables the students to understand a particular passage and express opinions in their own language.

Course Content

Unit 1: Literary Texts (Poetry)

This particular unit will help the students to enjoy, understand and interpret poems and develop a taste for fine poetry. The texts that have been chosen to be included are as follows:

- "The Poison Tree" by William Blake
- "The Daffodils" by William Wordsworth
- "If" by Rudyard Kipling.

Unit 2: Literary Texts (Prose)

This particular unit will help the students to foster a taste for literary prose pieces. The texts that have been chosen to be included are as follows:

- "The Stolen Bacillus" by H.G. Wells.
- "The Verger" by Somerset Maugham.
- "Shooting an Elephant" by George Orwell.

Unit 3: Grammar and Usage:

- Determiners, Tenses, Voice, Direct and Indirect Speech, Punctuation, Word Formation, Antonyms and Synonyms, Homophones, One-word substitution.
- Idioms and Phrases

Unit 4: Writing Skills:

This part would include areas like official correspondence, Letter (Formal and Informal), Circular, Notice, Writing Cvs/ Resume, Essay writing, e-mail writing, Blog writing, Story Writing, Paragraph writing.

The second section of this part will include **Comprehension** and **Precis Writing** that will enable the students to understand a particular passage and then express their opinions in their own language. This will enhance the student's reading and writing abilities.

Suggested Readings:

- Nilanjana Gupta, *Communicate With Confidence,* Anthem Press.
- V. Shyamala, *Effective English Communication for You,* Emerald Publisher.
- Krishnamohan and Meera Bannerji, *Developing Communication Skills.*
- R.K. Madhukar, *Business Communication,* Vikash Publishing house Pvt. Ltd.
- Shalin Sharma, *Concepts of Professional Communication,* Acme Learning
- Daniel Jones, *English Phonetics.*
- R.K. Bansal and Harrison, *Spoken English for India,* Sec. Ed. Madras Orient Longman.
- Donald Treadwell and Jill B. Treadwell, *Public Relations Writing,* Sec. Ed. Sage Publications, Inc.
- P.D. Chaturvedi and Mukesh Chaturvedi, *Business Communication Concepts, Cases and Applications,* Sec. Ed. Manipal Press Limited.
- Sarah Trenholm and Arthur Jensen, *Interpersonal Communication,* Sixth Ed. Oxford University Press.
- Pulak Bhattacharyya (ed), *Musings- II: A Collection of English Prose*, Book Land Publishers.
- David V. Erdman(ed), *The Complete Poetry and Prose of William Blake*, Anchor Publishers.
- Maugham,Somerset, 65 Short Stories,Heinemann: London,1988[rpt] *Henry Reed(ed), The Complete Poetical Works of William Wordsworth, Troutman and Hayes Publishers.*

BBT 104 **Biotechnology and Human Welfare** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To understand biotechnological application in deriving products from plant and animal sources as well as the challenges of extracting compounds in a Comprehensive Product Development Plan.

CO2. To get an insight in to the Biotechnological application in the field of agricultural including developing genetically modified organism (GMO) and transgenic plants.

CO3. To understand the biotechnological in understanding and protecting the environment mainly through the development of biodegradable polymer.

CO4. To get the basics of forensic science in solving crimes, paternity testing using DNA finger printing technique.

CO5. To explore the scope and role of Medical Biotechnology in healthcare industry such as multiple uses of antibodies and vaccines.

Course Content

UNIT I

1. Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II

1. Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III

1. 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.

UNIT IV

1. 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.

UNIT V

1. Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E. coli*, human genome project.

BBT 105 **Practical on Biochemistry and Metabolism and Cell Biology** **Practical** **Credit: 4**

This course enhances the practical application of the concept based on the theory courses of the semester. After successful completion, this course enables students

CO1. To get the idea of preparing of biochemical solution of different strength including Stock Solution, PPM, Per cent, Normal, Molar and Millimolar solutions.

CO2. To get an insight into the biochemical methods for the estimation of carbohydrates, proteins and amino acids- both quantitatively and qualitatively.
It also helps students to develop the idea of separation of plant pigments and amino acids using chromatographic methods of TLC/ Paper chromatography.

CO3. To understand the different stages of cell division process of mitosis and meiosis– chromosome staining in root tip and flower bud. It also deals with the various other cellular processes like plasmolysis, dialysis etc.

CO4. To understand the mechanism of fermentaion through the production of ethanol using Baker's yeast as a part of industrial application of microbes.

CO5. To learn the molecular methods of isolation and analysis of DNA from biological samples using agarose gel electrophoresis.

Course Content

Biochemistry and Metabolism:

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry**: (i)** Verification of Beer's law, estimation of protein. (**ii)** To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Quantitave tests for Carbohydrates, lipids and proteins

Cell Biology:

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.

Biotechnology and Human Welfare

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentaion using Baker’s yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

SEMESTER-II

BBT 201 **Mammalian Physiology** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To understand the mechanism of digestion and respiration in human.

CO2. To understand the composition and circulation mechanism of blood and the working mechanism of heart in this process.

CO3. To understand the structure of muscles and their contraction and relaxation mechanism. It also gives an insight in to the underlying principle of osmoregulation and modes of excretion.

CO4. To understand the mechanism of nerve impulse and synaptic conduction associated with the process.

CO5. To get an insight in to different endocrine glands, their structure and function as well as the types of hormones released by such glands that control various biological activities in human.

Course Content

UNIT I: Digestion and Respiration

1. Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids.
   Composition of bile, Saliva, Pancreatic, gastric and intestinal juice
2. Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation

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

UNIT III: Muscle physiology and osmoregulation

1. 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.
2. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: Nervous and endocrine coordination

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

BBT 202 **Microbial and Plant Physiology** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To explore the different groups of microbes like chemolithotrophs, hydrogen oxidizers, methanogens etc. based on their environmental adoptation.

CO2. To understand the different groups of microbes based on their nutritional requirement and mode of nutrition.

CO3. To understand the stages of photosynthesis mechanism like dark and light reactions in plants and microbes.

CO4. The course deals with the study of different metabolic processes in plants and microbial growth and development.

CO5. (0.25) The principle and mechanism of Nitrogen metabolism and fixation is dealt in this course. Along with this different phytohormones and their functions, and mechanism photoperiodism and also explained.

Course Content

UNIT I:

1. Nutritional classification of microorganisms based on carbon, energy and electron sources,
2. Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport,
3. Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

UNIT II:

1. Effect of the environment on microbial growth
2. Temperature- temperature ranges for microbial growth, classification based on temperature
3. ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism,
4. Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT III:

1. Photosynthesis- Photosynthesis pigments, anoxygenic and oxygenic photosynthesis, concept of two photo systems, photosynthetic pigments photphosphorylation, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation.
2. Carbon dioxide fixation, calvin cycle, CAM plants, photorespiration, compensation point.

UNIT IV:

1. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.
2. Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)
3. Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization

BBT 203 **Environmental Studies** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To get an insight in to the multidisciplinary nature of environmental studies and its importance in other branches of sciences mainly to create public awareness regarding environment.
It highlights the natural resources and associated problems in terms of non-renewable sources describing the role of an individual in conservation of natural resources.

CO2. To have the concept of an ecosystem, it's structure and function with special emphasis on energy flow and ecological succession process.

CO3. To have an idea about the concept of biodiversity at global, national and local levels; threats to biodiversity and conservation strategies.

CO4. To get an insight in to the burning issue of environmental pollution describing the concept of pollutants, cause, effects and control measures of air, water, soil, noise, thermal and nuclear pollution.

CO5. To understand the social issues related to the environment describing human role in biodiversity destruction and its conservation as well as the ethical and legal (Environment Protection Acts) issues related to the environment.

Course Content

UNIT I: Multidisciplinary nature of environmental studies:

1. Definition, scope and importance environmental studies. Relationship of environmental science with other branches of sciences. Need for public awareness regarding environment.

UNIT II: Natural Resources:

Renewable and non-renewable resources:

1. Natural resources and associated problems. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

UNIT III: Ecosystems

1. Concept of an ecosystem. Structure and function of an ecosystem. Concept of producers, consumers and decomposers. Energy flow in the ecosystem. Food chains, food webs and ecological pyramids. Ecological succession.

UNIT IV: Biodiversity and its conservation

1. Definition of genetic, specific and ecosystem diversity.
2. Hot-spots of biodiversity. Biodiversity at global, National and local levels. India as a mega-diversity nation. Bio-geographical classification of India. Endangered and endemic species of India.
3. Threats to biodiversity. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT V: Environnemental Pollution

1. Definition and sources of environmental Pollution. Concept of pollutants. Cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear hazards. Disaster management: floods, earthquake, cyclone and landslides.

UNIT VI: Social Issues and the Environment

1. Conservation strategies: Water conservation, rain water harvesting, watershed management. Wasteland reclamation.
2. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
3. Environmental ethics: Issues and possible solutions. Environment Protection Acts: a conceptual approach.

UNIT VII: Human Population and the Environment

1. Population explosion and Family Welfare Programme. Environment and human health. Value Education. Women and Child Welfare. HIV/AIDS.
2. Role of Information Technology in Environment and human health.

UNIT VIII: Field work

1. Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain.
2. Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural.
3. Study of common plants, insects, birds.
4. Study of simple ecosystems-pond, river, hill slopes, etc.

(Field work Equal to 5 lecture hours)

Suggested Readings:

Textbooks-

1. Agarwal, K.C. (2001). Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Dey, A.K. Environmental Chemistry, Wiley Eastern Ltd.
3. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Saunders Co. USA.

References-

1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, India, (R)
2. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
3. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
4. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
5. Down to Earth, Centre for Science and Environment (R)
6. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press. 473p

7. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
8. Heywood, V.H &Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
9. Jadhav, H &Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub.House, Delhi 284 p.
10. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced ed. 639p.
11. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
12. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
13. Rao M N. &Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd.
14. Sharma B.K., 2001. *Env. Chemistry*. Geol Publ. House, Meerut. Survey of the Environment, The Hindu (M)
15. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell. Science (TB)
16. Trivedi R.K., Handbook of Env. Laws, Rules Guidelines, Compliances and Stadards, Vol I -II, Env. Media (R)
17. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
18. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

(M) Magazine
(R) Reference
(TB) Textbook

BBT 204 **Developmental Biology** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To understand the basics of the process by which the living organisms grow and develop from a single cell.

CO2. To acquaint on how continuity of life is maintained from one generation to another which involves genetic control of cell growth and development leading to cell differentiation and morphogenesis.

CO3. To understand the technical aspects related to artificial insemination and in vitro fertilization.

CO4. To get an insight in to the process of crop development using breeding approaches that can contribute to the efforts of achieving sustainable food security in times of over population.

CO5. To have the concept of embryology that can be helpful in early diagnosis and treating diseases at embryonic level.

Course Content

UNIT-I

1. Introduction to developmental biology; the early experimental embryologists; scopes and applications, Basic concepts in embryology; genetics in respect of development.

UNIT-II

1. Microsporogenesis and microspore, development of the male gametophyte, gametogenesis in flowering plants.
2. Megasporogenesis and development of the female gametophyte (types of embryo sac development)
3. Fertilization, Development of the endosperm, development of the embryo (types of embryo development)
4. Apomixis, polyembryony, Embryogenesis in higher plants.

UNIT-III

1. Germ cells; formation of germ cells; spermatogenesis, spermiogenesis, structure of a mature sperm, various types of sperms.
2. Oogenesis; structure of ovum, eggs of various animals, types of eggs, influence of yolk on early development.

UNIT-IV

1. Fertilization; process of fertilization, Artificial insemination, polyspermy

UNIT-V

1. Embryogenesis, Morphogenesis, cellular basis, changes during morphogenesis

UNIT-VI

1. Role of molecular biology in cell differentiation, Laying of body axis planes, cellular polarity.

Suggested Readings:

1) Singh Pande Jain Embryology of Angiosperms, Rastogi publications, First edition 2003
2) Mohan P.Arora Embryology, Himalaya Publishing House, 2006.
3) Veer Bala Rastogi Embryology, Kalyani Publishers, Ludhiana, 2002.
4) Scott F. Gilbert Developmental Biology, Sinauer Associates, Inc.; Ninth edition.2008.

BBT 205 Practical on Mammalian Physiology and Microbial & Plant Physiology Practical Credit: 4

This practical course enhances the concept various physiological processes in mammals, plant and microbes. After successful completion, this course enables students

CO1. To understand the principle and mechanism of blood group determination following slide agglutination.

CO2. To develop the concept related to estimating RBC count in mammalian blood as well as the normal level of haemoglobin which is a part of common diagnostic system.

CO3. To learn the principle and procedure of separating photosynthetic pigments by paper chromatography method.

CO4. To understand the mechanism of symbiosis between rhizobacteria and leguminous plant with the help of root nodules.

CO5. To study the different phases of growth in microbes as well as the effect of physical factors like pH and temperature on their growth.

Course Content

Mammalian Physiology

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

Microbial and Plant Physiology

1. Separation of photosynthetic pigments by paper chromatography.
2. Demonstration of aerobic respiration.
3. Preparation of root nodules from a leguminous plant.
4. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
5. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
6. To study the effect of pH on the growth of *E. coli*
7. To study the effect of temperature of *Aspergillus niger* by dry weight method.
8. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

SEMESTER-III

BBT 301 **Genetics** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To understand the concept of gene (basic unit of genetic character) and the basic principle of genetics (inheritance of characters) as well as the concept of how mutation in gene can alter characters in an individual.

CO2. To familiarize with concept of inheritance of characters from parental line to the offspring following both Mendelian and non-Mendelian pattern.

CO3. To explore the multifactorial pattern of inheritance including the concept of chromosome structure and variation in chromatin organization.

CO4. To develop the concepts of linkage, sex determination and sex linked inheritance that helps to understand the different sex influenced diseases in man and their pattern of inheritance.

CO5. (0.25) To understand the phenomenon of organellar inheritance, genome evolution and mutation and their influence in hereditary diseases.

Course Content

Unit I

1. Introduction to genetics, Mendel's laws of inheritance, Law of dominance
2. Law of segregation, Law of independent assortment- dihybrid cross, mechanism of independent assortment, Drosophila as a model in genetics

Unit II

1. Phenomenon of dominance, phenomenon of dominance in plants, application of phenomenon of dominance in animals, Mechanism of dominance.
2. Variation in dominance relation- incomplete dominance, codominance, pleiotropy, multiple allelism, complementation and epistasis.
3. Back cross, test cross, monohybrid and dihybrid test cross, multihybrid cross, deviations from mendal's dihybrid phenotypic ratio.

Unit III

1. Genetic interaction- types of interaction and lethal genes,
2. Linkage and crossing over, Sex determination and sex linked inheritance, Genetically inherited disorders.

Unit IV

1. Numerical and structural changes in chromosomes, Mutation and mutagenesis, mutagens (chemical and biological)

Unit V

1. Concept of Extranuclear inheritance, Cytoplasmic and mitochondrial mode of inheritance.

Unit VI

1. Population genetics- Hardy- Weinberg equilibrium, genetic drift.

Suggested Readings:

1. Daniel J Fairbanks, The Continuity of Life, Brooks/Cole Pub., 1999
2. E.J.Gardener, M.J.Simmons and D.P.Snustad Principles of Genetics, John Wiley and Sons Publications.
3. B.D. Singh Fundamentals of Genetics, Kalyani publishers, Ludhiana, ed 6th (2002)
4. Gardner, Principle of Genetics.

BBT 302 **Biotechnology and Human Welfare** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To explore the fascinating world of microorganism and their role (both beneficial and harmful) in day to day life.
It imparts knowledge on the various phases and contribution of different Scientists how Microbiology established itself as a separate branch of Science.

CO2. To understand the different categories of microbes and sub-microbial groups with their position in the tree of life (classification), their characteristic features and importance.

CO3. To become familiarize with the different technical aspects [isolation, cultivation, observation (microscopy), and identification] of studying microbes.

CO4. To get an insight on the existence of microbes in different spheres of the environment and how the microbes are affected/induced in these environments or *vice versa*.

CO5. To get the basic idea about the industrial application of different microbes for the production of single cell protein, beverages, industrial enzymes and genetically modified (GM) foods.

Course Content

UNIT I

1. Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II

1. Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III

1. 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.

UNIT IV

1. 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.

UNIT V

1. Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E. coli*, human genome project.

BBT 303 **Chemistry-1: Conceptual Organic Chemistry** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To understand the concept of Stereochemistry with the help of Fischer, Newmann and Sawhorse projection and Wedge formulae.

CO2. To acquaint with various conformations of ethane, butane, ethane-1,2-diol and cyclohexane with reference to relative stability of different conformations in terms of energy difference.

CO3. To understand the mechanism of addition reactions with the help of hydrogenation, hydrohalogenation, hydroxylation and ozonolysis in alkenes, alkynes, aldehydes and ketones.
It also help in understanding the mechanism of substitution and elimination reactions among organic compounds.

CO4. To understand the mechanism of oxidation reactions occurring in aromatic side chain compounds, alcohols, aldehydes and ketones and the rules governing such mechanisms.

CO5. To understand the mechanism of catalytic hydrogenation, electrolytic and other reduction reactions occurring in aldeydes, ketones, carboxylic acids and their derivatives and nitro compounds.

Course Content

Unit I: Stereochemistry

1. Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type.
2. **Conformations**: Restricted rotation about single bonds, Various conformations of ethane, butane, ethane-1,2-diol and cyclohexane. Relative stability of different conformations in terms of energy difference.
3. Concept of Geometrical and Optical Isomerism. Relative and absolute configuration**.**

Unit II:

Addition Reactions

1. **Alkenes and Alkynes**: Hydrogenation, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydroxylation (cis and trans), ozonolysis. Reactivity of alkenes vs alkynes.
2. **Aldehydes and ketones**: (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition- elimination reactions with ammonia and its derivatives.
3. **Name reactions**: Aldol, cross Aldol, Claisen, Knoevengel, Cannizzaro, cross Cannizzaro.

Substitution Reactions

4. Concept of Free radical, Nucleophilic and Substitution substitution reactions.

Elimination Reactions

5. Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination).
6. Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution

Unit III:

Oxidation

1. **Aromatic side chain**: Oxidation with potassium permanganate, potassium dichromate
2. **Alcohols**: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation.
3. **Aldehydes**: Oxidation with potassium permanganate, chromic acid and Tollen's reagent
4. **Ketones**: Oxidation with potassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer–Villiger oxidation

Reductions

1. **Aldeydes and Ketones**: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner
2. **Carboxylic acids and their derivatives**: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction.
3. **Nitro compounds**: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

Suggested Readings:

1. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Pearson Education.
3. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand
4. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
5. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*; Wiley: London, 1994.
6. T. W. Graham Solomon's *Organic Chemistry*, John Wiley and Sons.
7. P.S. Kalsi, *Stereochemistry, Conformation and Mechanism,* John Wiley and Sons.
8. D. Nasipuri, *Stereochemistry of Organic Compounds*, New Age International Publishers.

BBT 304 **Molecular Diagnostics** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To explore the various immunoassays techniques for molecular level diagnosis of diseases and disorders.

CO2. To understand the different molecular approach for proper diagnosis of different diseases in man.

CO3. To understand the resistance mechanisms developed in different microbes against chemotherapeutic agents and their resistance profile.

CO4. To develop the concept on antimicrobial susceptibility testing methods and to check the antibiotic susceptibility profile of pathogenic microbes.

CO5. To have the concept on application of latest automated instruments for proper identification of pathogenic microbes.

Course Content

UNIT I: Enzyme Immunoassays:

1. 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.
2. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology.

UNIT II: Molecular methods in clinical microbiology

1. Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology
2. 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.

UNIT III

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

UNIT IV

1. GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.

BBT 305 **Bioethics and Biosafety** **Theory** **Credit: 4**

After successful completion, this course enables students

CO1. To understand the fundamentals of bioethics and ethical issues related to molecular technologies.

CO2. To have the concept on the ethical issues concerned with clinical trials, medical errors, negligence etc.

CO3. To understand the safety issues and ethical use of animals in the laboratory.

CO4. To get an insight into the good laboratory practices in different biological laboratories.

CO5. To get an insight in to the guidelines and precautions on using radioisotopes in laboratory practices.

Course Content

Unit I: Foundation of Bioethics

1. Definition, historic evolution, codes and guidelines, universal principles.
2. Bioethics – Necessity of Bioethics. Different paradigms of Bioethics – National & International.
3. Ethical issues against the molecular technologies.

Unit II: Clinical ethics

1. Sanctity of human life and the need to preserve human life; issues related to prenatal screening, clinical trials (Phase I/II/III/IV) studies.
2. Medical error and medical negligence; remedies against medical negligence, protection and compensation related to it.

Unit III:

1. Ethical use of animals in the laboratory

Unit IV:

1. Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.

Unit IV:

1. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs-Concerns and Challenges;
2. Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs;
3. Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit V:

1. AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

Suggested Readings:

1. Sateesh MK (2010) *Bioethics and Biosafety*, I. K. International Pvt. Ltd.
2. Sree Krishna V (2007) *Bioethics and Biosafety in Biotechnology*, New age international Publishers.

BBT 306 Practical on Genetics, General Microbiology and Chemistry-1 Practical Credit: 4

This practical course is based on the laboratory methods for the study of microbes, inheritance pattern of various traits and basic chemical analysis. After successful completion, this course enables students

CO1. To understand the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
Students also learn the basics of preparing common microbial media used for isolation and maintenance of microbial isolates.

CO2. To get an insight into the laboratory techniques for the isolation and enumeration of microorganisms from fro different environmental spheres like soil, water and air.
Students also learn the basics of isolating bacteria in pure cultures by streaking method and determination of bacterial growth curve.

CO3. To understand the basis of Mendelian principle of inheritance as well as the stages of division in vegetative and reproductive cells.

CO4. To determine purity of organic compounds by crystallization using polar and non-polar solvents and estimating their optical activity by using polarimeter

CO5. To learn the use of Kjeldahl apparatus for estimating the melting points of organic compounds.

Course Content

Genetics

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.

Chemistry-1

1. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
3. Determination of optical activity by using polarimeter.
4. Carry out the following preparations using 0.5-1 g of starting compound. Recrystallize the product and determine the melting point of the recrystallized sample. **(Any three)**
   a. To prepare acetanilide by the acetylation of aniline.
   b. To prepare p-bromoacetanilide.
   c. Benzolyation of aniline or β-naphthol by Schotten-Baumann reaction
   d. Hydrolysis of benzamide or ethyl bezoate.
   e. Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde.
   f. Nitration of nitrobenzene.
   g. Oxidation of benzaldehyde by using alkaline potassium permanganate.

Molecular Diagnostics

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
   A kit-basd detection of a microbial infection (Widal test)

Suggested Readings:

1. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Org. Chem, 5th ed.*, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Longman, London & New York.
3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. *College Practical Chemistry*, Universities Press.

SEMESTER-IV

BBT 401: Molecular Biology Theory Credit: 4

After successful completion, this course enables students

CO1. To get an insight in to the molecular basis of biological activity between biomolecules in the various systems of a cell.

CO2. To have the basics of DNA, RNA, and proteins; their structure and interactions within the cell to promote growth, division and development.

CO3. To understand the different mechanism DNA replication adopted in prokaryotic and eukaryotic system.
It also highlights the factors inducing and inhibiting replication.

CO4. To get an insight in to the wide range of mechanisms required for the regulation of transcription, translation and expression of gene in prokaryotic and eukaryotic system.

CO5. To understand the responses to environmental or physiological changes or alterations of cell function brought about by mutation.
It also highlights the molecular basis for cancer and other related abnormalities and the molecular tools and techniques to study such abnormalities.

Course Content

UNIT- I: Basic concepts of Genetic Information

1. Nucleic acids as genetic information carriers, experimental evidences.
2. Primary structure of nucleic acids and their properties. Highly repetitive, moderately repetitive and unique DNA sequences, Classes of RNA, secondary and tertiary structure.
3. Secondary structures of nucleic acids, anti-parallel strands, base composition, base equivalence, base pairing and base stacking, types of DNA, structural characteristics, chirality and cot curve.

UNIT II: DNA Replication

1. DNA replication in prokaryotes: Conservative, semiconservative and dispersive types, DNA polymerases, enzymes and protein factors involved in replication.
2. Mechanism of replication in eukaryotes, inhibitors of replication.

UNIT III: Transcription, Translation and Regulation of Gene Expression

1. Transcription in prokaryotes and eukaryotes, RNA polymerases; promoters, differences in transcription termination, post translational modifications.
2. Genetic code: Basic features of genetic code, biological significance of degeneracy, Wobble hypothesis; gene within genes and overlapping genes, mechanism of translation in prokaryotes and eukaryotes, ribosome assembly.
3. Regulation of Gene Expression in Prokaryotes and eukaryotes, Enzyme induction and repression, operon concept, Lac operon, Trp operon, eukaryotic gene arrangements.

UNIT-IV: Mutation and Repair

1. Mutation: molecular basis of mutation, types of mutation, dominant and recessive mutations, spontaneous and induced mutations.
2. Mutagenicity testing: Correlation of mutagenicity and carcinogenicity: Ames testing, Random and site directed mutagenesis. DNA Repair- Types and evidences.

Suggested Readings:

1. Glick, B.T and Pastermak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA,Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrooket al (2000) Molecular Cloning Volumes I, II, & III Cold Spring Harbor Lab. Press, New York, USA

6. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7. Karp.G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC
8. Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut.

BBT 402: Immunology Theory Credit: 4

After successful completion, this course enables students

CO1. To familiarize with the concept of non-specific (innate) and specific (acquired) resistance mechanism developed in man against pathogens and other non-self factors which is the basis of this course.

CO2. To get an insight into the formation, types, organization and functional specificity of different cellular and organ level components conferring resistance in man.

CO3. To familiarize with the nature, types and function of antigens that induce immunological response in man and how the product of this response (antibody, B and T cells) help in neutralizing them (agglutination and precipitation reactions).
It also deals with the different diagnostic and serological approaches for the study of interaction between an antigen and its specific antibody including Widal Test, immunodiffusion, Immuno-electrophoresis, ELISA, RIA etc.

CO4. To have the concept of different mediators/cell signaling molecules (complement, cytokines: interferons, Interleukins, heamatopoetins and chemokines) associated with immunological responses as well as their biological consequences.

CO5. To understand the immune disorders (hypersensitivity, autoimmune disorders, oncogenesis etc.) and induced immunity (vaccination) to overcome such abnormalities.

Course Content

UNIT-I

1. History of immunology.
2. Types of immunity: Innate and Acquired immunity; Cells and Organs of the immune system.

UNIT-II

a) Antigen – Antigenecity, Immunogenecity, Epitopes, Haptens, Adjuvants; MHC self antigen – Class and structure.
b) Antibodies- Structure, classes and function, Isotype, Allotype, and Idiotype; Genetic diversity of antibody class
c) Antigen and antibody interaction, affinity and avidity, cross reactivity, precipitation and agglutination reaction; Cytokines.

UNIT-III

1. Complement system.
2. Allergy and Hypersensitivity – type – I, II, III and IV their clinical manifestation; Autoimmune disorders; Immunity to Bacteria & Virus.

UNIT-IV

1. Transplantation – Allograft rejection, Graft vs Host rejection, Immunosuppressor drugs.
2. Single Radial Immuno-diffusion, Immuno-electrophoresis, Electro immuno-diffusion; Principle and applications of RIA and ELISA
3. Tumor immunology.

Suggested Readings:

1. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman,2002.
2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
3. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
4. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4 t h Edition-, Blackwell Publishing, 2002

BBT 403 **Chemistry-II: Chemical Bonding, Transition Metals and Coordination Chemistry**

Theory **Credit: 4**

After completion, this course enables students

CO1. To understand the structure of molecule following valence bond approach as well as the concept of resonance in various organic and inorganic compounds. It also gives an idea VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

CO2. To get an idea on various intermolecular forces like van der Waals forces, Hydrogen bonding and their effects on melting point, boiling point and solubility of compounds.

CO3. To have the concept on transition elements specifically their electronic configuration, variable valency, color, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for with special reference to Mn, Fe and Cu.

CO4. To understand the concept of Valence Bond Theory with reference to inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu; their structural and stereoisomerism with coordination numbers 4 and 6.

CO5. To understand the concept of Crystal Field Theory with reference to crystal field effect for weak and strong fields and crystal field stabilization energy.

Course Content

Unit 1: The covalent bond and the structure of molecules

1. Valence bond approach, Concept of resonance in various organic and inorganic compounds.
2. Hybridization and structure, equivalent and non-equivalent hybrid orbitals, Bent's rule and its applications.
3. VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

Unit 2: Molecular Orbital Approach

1. LCAO method, symmetry and overlap for s-s, s-p and p-p combinations.
2. MO treatment of homonuclear diatomic molecules of 2^{nd} period (B2, C2, N2, O2, F2) and heteronuclear di-atomic molecules (CO, NO) and their ions.

Unit 3: Intermolecular forces:

1. van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.

Unit 4: Transition Elements (3*d* series)

1. General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.
2. Concept of Lanthanoids and actinoids.

Unit 5: Coordination Chemistry

1. Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.
2. Drawbacks of VBT. IUPAC system of nomenclature.

Unit 6: Crystal Field Theory

1. Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry.
2. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry.
3. Jahn-Teller distortion, Square planar coordination.

Suggested Readings:

1. James E. Huheey, *"Inorg. Chemistry: Principles of structure and reactivity"*, Prentice Hall, IV Edition.
2. D. S. Shriver and P.A. Atkins, *"Inorganic Chemistry"*, Oxford University Press, IV Edition.
3. Alan G. Sharpe, "*Inorganic Chemistry"*, University of Cambridge, III Edition.
4. J. D. Lee, *"A New Concise Inorganic Chemistry"*, ELBS IV Edition
5. Grey L. Miessler and Donald A. Tarr, *"Inorganic Chemistry"*, Prentice Hall, III Edition.
6. B. Douglas, D. H. McDaniel and J. J. Alexander, *"Concepts and Models of Inorganic Chemistry", John Wiley and Sons, III Edition.*
7. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd., 2008.

BBT 404: Enzymology Theory Credit: 4

After successful completion, this course enables students

CO1. To have the concept of different terminologies in understanding enzymes as well as their historical perspective.

CO2. To familiarize with basics of enzymes, their kinetics, inhibition and their applications in various fields.

CO3. The course provides the basic understanding of enzyme classification, nomenclature and synthesis.

CO4. The course highlights the concepts of Enzyme kinetics and mechanism of inhibition, units and underlying principle of measurement of enzyme activity.

CO5. The students can earn the knowledge of different applications of enzymes in various industry and medical field.

Course Content

UNIT-I

1. Concept and historical background of enzymes, IUB enzyme classification, significance of numbering system.
2. Definitions- holoenzyme, apoenzyme, coenzyme, cofactor activators and inhibitors. Monomeric and oligomeric enzymes; multi-enzyme complex and enzyme specificity.

UNIT-II

1. Enzyme catalysis: Role of cofactors in enzyme catalysis. Nature of non enzymatic and enzymatic catalysis, Measurement and expression of enzyme activity, enzyme assay.
2. Role of non protein organic molecules and inorganic ions, coenzyme, prosthetic group, Role of vitamins as coenzyme.

UNIT-IV

1. Enzyme purification: Methods of isolation, purification and characterization of enzymes.
2. Enzyme kinetics: Factor effecting enzyme activity- enzyme and substrate concentration, Michaelis-Menten equation; Lineweaver Burk's plot.
3. Reversible and irreversible inhibition; competitive and non-competitive inhibitions; determination of Km and Vmax in presence and absence of inhibitors; allosteric enzymes. Kinetics of immobilized enzymes.

UNIT-V

1. Industrial and clinical applications of enzymes.
2. Industrial applications; production of glucose from starch, cellulose and dextran; use of lactase in dairy industry; production of glucose-fructose syrup from sucrose.Use of proteases in food; detergent and leather industry; medical application of enzymes; use of glucose oxidase in enzyme electrodes.

Suggested Readings:

1. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
2. Glaser A.N and Nilaido.H (1995) Microbial Biotechnology, W.H Freeman and Co.
3. Prescott and Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers Distributors.

4. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Albert L. Lehninger Principles of Biochemistry- CBS Publishers & Distributors
6. Lubert Stryer Biochemistry –Freeman International Edition.
7. Keshav Trehan Biochemistry Wiley Eastern Publications

BBT 405: Entrepreneurship Development and IPR Theory Credit: 4

After successful completion, this course enables students

CO1. To have the basic concepts on entrepreneurship that can guide the students for becoming a good entrepreneur as they are ushered to know market, excise and other development processes.

CO2. To understand of importance of market concept in entrepreneurship.

CO3. To have knowledge on Intellectual Property in protecting one's idea, concept or a product.

CO4. To have an understanding on Patent, Geographical indication, Copyright, Trademark, and Trade secret to become aware of protecting innovations and noble work.

CO5. To gain knowledge on Indian Patent Law, World Trade Organization and its related Intellectual Property provisions.

Course Content

UNIT-I: Entrepreneurship Development

1. Basic concept and historical background of entrepreneurship.
2. Guidelines for entrepreneurship.
3. Entrepreneurship: Selection of a product, line, design and development processes.
4. Economics on material and energy requirement, stock the product and release the same for making etc.
5. 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.
6. Importance of market concept in entrepreneurship.

UNIT-II: Introduction to IPR

1. Importance of IPR, advantages of IP protection, relationship with trade, Product / design patent and Terminologies.
2. Types of IPRs: Copyrights, trademarks, Trade Secrets, Patents, and Geographical indicators, IC layout design, plant variety protection.
3. Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions.
4. Intellectual/Industrial property and its legal protection in research, design and development.
5. Patenting in Biotechnology, economic, ethical and depository considerations.

Suggested Readings:

1. David H. Holt (2005) *Entrepreneurship,* New Venture Creation.
2. Jack M. Kaplan, *Patterns of Entrepreneurship.*
3. C.B. Gupta and S.S. Khanka (2010) *Entrepreneurship and Small Business Management,* Sultan Chand & Sons Publication.

BBT 406: Practical on Mol. Biology, Immunology, Chemistry-2 and Enzymology Practical Credit: 4

This practical course is based on the laboratory methods for the study of cellular components at molecular level as well as the basic immunodiagnostic techniques. After successful completion, this course enables students

CO1. To learn the molecular methods of isolation of DNA/RNA from plant animal and microbial sources and their quantification using UV-VIS spectrophotometric analysis.

It also helps in learning the method of separating of DNA bands by agarose gel electrophoresis on the basis of their molecular weight.

CO2. To understand the principle and process of blood group determination following slide agglutination test, blood cell count following blood film preparation and immune-diagnostic methods like Radial immunoassay and ELISA.

CO3. To understand the process of preparations of standard solutions using the concept of primary and secondary standards as well as different units of concentration like molarity, molality, and normality.

CO4. To familiarize with the process of titrimetric analysis involving Acids-Bases, Redox reactions and Complexometric Titrations.

CO5. To learn the laboratory method of Isolation and purification of an extracellular enzyme and etermination of Km and Vmax value for that enzyme.

Course Content

Chemistry-2

Titrimetric Analysis:

Preparations of standard solutions (concept of primary and secondary standards), Different units of concentration (molarity, molality, normality and formality)

(A) Titrations involving Acids-Bases:

Principles of acid-base titrations, Principle behind selection of an appropriate indicator.

1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared)
2. Determination of concentration of carbonate and hydroxide present in a mixture.
3. Determination of concentration of carbonate and bicarbonate present in a mixture.
4. Determination of concentration of free alkali present in soaps/detergents/shampoos.

(B) Titrations involving redox reactions:

Concept of electrode potential, principle behind selection of an appropriate indicator.

5. Standardization of KMnO4 solution (standard solution of Mohr's salt to be prepared).
6. Determination of concentration of Fe(II) in Mohr's salt and/or $K2Cr_2O_7$ using diphenylamine/ N-phenylanthranilic acid as internal indicator (standard solution of $K2Cr_2O_7$ and /or Mohr's salt to be prepared).
7. Determination of iron content in ores / alloys using appropriate redox titration.

(C) Complexometric Titrations

Principles of complexometric titrations

8. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.
9. Determination of concentration of Ca/Mg in drugs or in food samples.
10. Determination of concentration of total hardness of a given sample of water by complexometric titration.

(At least 2 experiments from each set.)

Suggested Readings:

1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS.
2. Harris, D.C. & Freeman, W.H. & Co. *Quantitative Chemical Analysis 7th Ed.*, New York.

SEMESTER-V

BBT 501: Industrial Fermentations Theory Credit: 4

After successful completion, this course enables students

CO1. To have a comparative account on old and recent techniques for screening industrially important microorganisms. **(0.15)**

CO2. To understand the principle and types of bioreactor and their industrial application. **(0.15)**

CO3. To explore the different production approaches for industrial products like organic acid, alcohol, enzymes, single cell protein etc. **(0.20)**

CO4. To understand the principles of food preservation using fermentation processes. Students get acquainted to different kinds of Bioreactors and fermenters used for the purpose. **(0.25)**

CO5. To develop the concept for genetic improvement of industrially useful microbes as well as the process and role of enzyme immobilization in food industries. **(0.25)**

Course Content

UNIT I

1. Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid,
2. Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti-cancer agents, amino acids.

UNIT II

1. Microbial products of pharmacological interest, steriod fermentations and transformations.
2. Over production of microbial metabolite, Secondary metabolism – its significance and products.
3. Metabolic engineering of secondary metabolism for highest productivity.
4. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III

1. Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products.
2. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT IV

1. Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions.
2. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up.
3. Metabolic engineering of antibiotic biosynthetic pathways.

BBT 502: Recombinant DNA Technology Theory Credit: 4

After successful completion, this course enables students

CO1. To have the basic concept of rDNA technology as the basis of genetic modification of cellular organisms.

CO2. To understand the types, nature and functions of restriction enzymes that act as the mediators of DNA modification during genetic manipulation process.
It also gives an insight into the concept of different vectors (plasmids, cosmids, phagemids, and artificial chromosome vectors) that act as carrier of DNA fragment between cellular organisms during genetic modification.

CO3. To understand the methods in molecular cloning process for transformation and delivery of gene with special emphasis on different blotting techniques (Southern, Northern and Western) in hybridization process.

CO4. To get an insight in to one of the most versatile molecular technique of Polymerized Chain Reaction (PCR); principle, types, applications and different PCR based and PCR independent marker (RAPD, RFLP, AFLP) methods in Molecular Biology.
It also describes the construction and screening genomic and cDNA libraries.

CO5. To understand the application of rDNA technology for the production of human therapeutic agents (insulin, HGH, recombinant vaccines) and transgenic crops.

Course Content

UNIT I

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

UNIT II

1. Restriction and modification system, restriction mapping. Southern and Northern hybridization.
2. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription. Genome mapping, DNA fingerprinting,
3. 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)

UNIT III

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

UNIT IV

1. Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and Arhizogenes, Ti plasmids,
2. Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants,
3. Use of plant viruses as episomal expression vectors.

BBT 503: Plant Biotechnology Theory Credit: 4

After successful completion, this course enables students

CO1. To familiarize with the techniques of plant tissue culture, mechanisms of gene transfer and various molecular markers.

CO2. To deals with different media preparation methods and study the role of micro- and macronutrients, hormones, vitamins, etc. in plant tissue culture.

CO3. To have the basic understanding of plant tissue culture and its maintenance, callus culture and suspension culture.

CO4. To understand the various vectorless and vector mediated gene transfer methods in plants improvement.

CO5. To learn the principle and use of molecular markers, and their applications in Plant Biotechnology as well as to get the insight in to the concept of somaclonal variation, callus cultur, totpotency, hybrid and cybrids.

Course Content

UNIT-I

1. Orientation of a functional laboratory and basic infrastructural requirements.
2. Tissue culture media, Preparation and sterilization of media, functions of the elements on growth and development of the explant.
3. Material collection, explant preparation, sterilization and inoculation.
4. Basic culture room conditions required for explants' response.

UNIT-II

1. Introduction to plant tissue culture. Historical records, objectives and scope of plant tissue culture technology.
2. Types of tissue culture techniques developed so far, their scopes and applications.
3. Introduction, Cryo and organogenic differentiation,
4. Types of culture: Seed, Embryo, Callus and suspension culture, Organs, Cell and Protoplast culture: somatic hybridization.
5. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- III

1. In vitro haploid production. Significance and use of haploids.
2. Androgenic methods: Anther culture, Microspore culture, Andogenesis.
3. Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, Chromosome elimination techniques for production of haploids in cereals.

UNIT-IV

1. Transgenic plants- genetic transformation, scope and applications.
2. Bioreactor.

Suggested Readings:

1. Ravishankar G.A and Venkataraman L.V (1997) Biotechnology: Applications of Plant Tissue and Cell Culture. Oxford and IBH Publishing Co., Pvt Ltd.
2. Bhan (1998) Tissue Culture, Mittal Publications, New Delhi.
3. Islan A.C (1996) Plant Tissue Culture, Oxford and IBH Publishing Co., Pvt. Ltd.
4. Lydiane Kyte & John Kelvins (1996) Plants from test tubes. An introduction to Micropropogation (3rd Edition) Timber Press, Partland.
5. Kumar H.D (1991) A Text Book on Biotechnology (2nd Edition). Affiliated East West Press Private Ltd. New Delhi.
6. Chrispeel M.J. and Sdava D.E. (1994) Plants, Genes and Agriculture, Jones and Barlett Publishers, Boston.
7. Reinert J. and Bajaj Y.P.S (1997) Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Narosa Publishing House.

BBT 504: Bioinformatics and Biostatistics Theory Credit: 4

After successful completion, this course enables students

CO1. To understand the contents and properties of bioinformatics databases; perform text- and sequence-based searches, and analyze and discuss the results in light of molecular biological knowledge.

CO2. To learn about the major steps in pair wise and multiple sequence alignment, and execute pair wise sequence alignment by dynamic programming.

CO3. To learn the techniques of predicting the secondary and tertiary structures of protein sequences.

CO4. To become familiar with the use of a wide variety of internet applications, biological database that can be applied in solving research problems.

CO5. To understand the theoretical and practical development of useful tools for automation of complex computer jobs, and making these tools accessible on the network from a Web browser.

Course Content

Bioinformatics

UNIT I

1. 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.

UNIT II

1. Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web.
2. Introduction of Data Generating Techniques and Bioinformatics problem posed by them-Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III

1. 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.

UNIT IV

1. Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.
2. Genome Annotation: Pattern and repeat finding, Gene identification tools.

Biostatistics

UNIT V

1. Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data.
2. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT VI

1. Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT VII

1. Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test.
2. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT VIII

1. Correlation and Regression. Emphasis on examples from Biological Sciences.

BBT 505: Practical on Industrial Fermentations, Recombinant DNA Technology, Chemistry-3 and Bioinformatics and Biostatistics **Practical** **Credit: 4**

This practical course gives the idea of industrial production of important material using fermenter, improvement of crop using the concept of rDNA technology and methods like microprpagation. It also gives the analysis of data using statistical methods and bioinformatics tools. After successful completion, this course enables students

CO1. To understand the design and working principle of a fermenter and its use in the industrial production of solvent, enzymes etc.)

CO2. To acquaint with methods for the isolation of chromosomal DNA from plant and microbial cells, their qualitative and quantitative analysis as well as to become familiar with the technical process of PCR.

CO3. To learn the preparation of medium used in plant tissue culture and carry out the process like micropropagation and artificial seed preparation.

CO4. To learn the methods of statistical analysis (like t, f, z and Chi-square test) of different paired and unpaired data

CO5. To understand the practical aspects of Bioinformatics including
a. operating systems like UNIX, LINUX and Windows;
b. bioinformatics databases systems like NCBI/ PDB/ DDBJ, Uniprot, PDB;
c. sequence retrieval using BLAST and sequence alignment & phylogenetic analysis using clustalW & phylip;
d. protein structure prediction using psipred, homology modeling using Swissmodel, and molecular visualization using jmol.

Course Content

Industrial Fermentations

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

Recombinant DNA Technology

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

Plant Biotechnology

1. Preparation of Hanks Balanced salt solution
2. Preparation of Minimal Essential Growth medium
3. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
4. Preparation of complex nutrient medium (Murashige & Skoog's medium)
5. To selection, Prune, sterilize and prepare an explant for culture.
6. To demonstrate various steps of Micropropagation.
7. Preparation of artificial seed.

Bioinformatics and Biostatistics

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square
5. Sequence information resource
6. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
7. Understanding and using: PDB, Swissprot, TREMBL
8. Using various BLAST and interpretation of results.
9. Retrieval of information from nucleotide databases.
10. Sequence alignment using BLAST.
11. Multiple sequence alignment using Clustal W.

SEMESTER-VI

BBT 601: Bio-Analytical Tools Theory Credit: 4

After successful completion, this course enables students

CO1. To familiarize with the important techniques necessary for the study and prediction of different processes occurring in microbes and other cellular organisms.

CO2. To understand the importance, principle and types of chromatography techniques and their role in the study of biological system.

CO3. To develop the concept on principle and types of electrophoretic techniques and their role in the study of biological system.

CO4. To get an insight in to the principle and types of centrifugation techniques and their role in the study of biological system.
It also gives the concept of radioactivity and its application in biochemical and immunological processes.

CO5. To familiarize with a***dvanced techniques*** **-**Protein Crystallization, MALDI-TOF, Mass Spectrometry, Enzyme and Cell Immobilization which are extensively used in Industrial and R & D sectors.

Course Content

UNIT I

1. Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II

1. Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

1. 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.

UNIT IV

1. Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting.
2. Introduction to Biosensors and Nanotechnology and their applications.

BBT 602: Genomics and Proteomics Theory Credit: 4

After successful completion, this course enables students

CO1. To have the basic concept of Genomics and proteomics.

CO2. To learn different DNA sequencing methods used in sequencing of genome like manual & automated: Maxam & Gilbert and Sangers method.

CO3. To understand the process of Managing and Distributing Genome Data such as Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome.

CO4. To develop the knowledge of protein structure, function and different methods of analizing proteins using molecular tools and techniques.

CO5. To get the basics of analytical Proteomics and its application.

Course Content

UNIT I

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

UNIT II

1. 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.

UNIT III

1. 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.
2. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV

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

BBT 603: Environmental Biotechnology Theory Credit: 4

After successful completion, this course enables students

CO1. To understand the environment around us and the organisms living in normal and extreme conditions of the environment.

CO2. To learn the utilization of the unique properties microorganisms living in the extreme habitats to remediate degraded environment: such as solid and liquid waste management.

CO3. To have the concept of bioremediation with special reference to the remediation of heavy metals and oil spills.

CO4. To get the information on the ethical and safety issues concerned with Biotechnological experiments.
CO5. To know about intellectual property right (IPR), in protecting one's innovations and unique works.

Course Content

Unit- I: Fundamentals of Environmental Biotechnology

1. Environmental Biotechnology: definition, achievements, opportunities and challenges. Bio-plastic and biosensors for environmental monitoring.
2. Microbes in extreme (thermophiles, acidophiles, alkaliphiles, psycrophiles, halophiles and xerophiles) environment. Survival strategy in acidophiles, alkaliphiles and halophiles.

Unit- II: Microbes in Environmental Management

1. Involvement of microbes in domestic and industrial waste-water treatment:
   Solid Waste Management: Sources and types of solid waste, methods of disposal of solid waste (incineration, composting and sanitary landfill)
   Liquid Waste Management: Composition of sewage; Primary, secondary (aerobic and anaerobic) and tertiary sewage treatment.
2. Bioleaching: Concept and application. Microbial enhanced oil recovery (MEOR) technique.

Unit III: Concept of Bioremediation

1. Bioremediation: Concept (*in situ* and *ex situ* bioremediation) and role of bioremediation in controlling industrial and medical effluents.
2. Basic concept of phyto-remediation and myco-remediation.
3. Bioremediation of heavy metals and oil spills.

Unit IV: Technical Aspects of Environmental Biotechnology

1. Basic concept of environmental genomics and metagenomics.

Culture independent techniques in environmental biotechnology: principle and application of DGGE, ARDRA, FAME profile analysis and G+C analysis.

Textbooks:

1. Evans, G.M. and Furlong, J.C. (2003). *Environmental Biotechnology: Theory and Application*. John Wiley and Sons.
2. Jogdand, S.N. (2006). *Environmental Biotechnology*. Himalaya Publishing House.
3. Lohar, P.S. (2005). *Biotechnology*. MJP Publishers, Chennai.
4. Singh, B. D. (1998). *Biotechnology*. Kalyani publishers.
5. Joshi, R.M. Biosafety and Bioethics, Eastern Book House.

References:

1. Das, M.K. (2008). *Environmental Biotechnology and Biodiversity Conservation*. Daya Publishing House, New Delhi.
2. Liu, D.H.F. and Liptak, B. G. (2000). *Wastewater Treatment*. CRC Press.
3. Manahan, S.E. (1997). *Environmental Science and Technology*. Lewis, New York.
4. Metcalf and Eddy (Eds). (2003). Wastewater Engineering. Treatment and Reuse, Tata McGraw-Hill, New Delhi.
5. Pathade, G.R., Biotechnology in Environmental Management. Eastern Book House.
6. Thomas, J.A. and Fuchs, R. (2002). *Biotechnology and safety Assessment*. Academic Press.
7. Wang, L.K., Hung, Y.T. and Shammas, N.K. Eds). (2006). *Advanced Physiochemical Treatment Processes*. Springer-Verlag New York. LLC.
8. Wise, D. L. (Eds). (1997). *Global Environmental Biotechnology*. Proceedings of the third international symposium on the international society for environmental biotechnology. Kluwer Academic Publishers, London.

BBT 603: Animal Biotechnology Theory Credit: 4

After successful completion, this course enables students

CO1. To familiarize with the techniques of animal cell culture, mechanisms of gene transfer and various molecular marker assisted methods in improvement of live-stocks.

CO2. To have knowledge on different cell culture media and their preparation methods.

CO3. To explore the biomedical research involving tissue engineering that aims to grow and replace tissue *in-vitro* using stem cell technology.

CO4. To understand the various vectorless and vector mediated gene transfer methods used in animal cell cloning.

CO5. To get the basics of artificial insemination and embryo transfer techniques for the improvement of live-stocks.

Course Content

UNIT-I

1. Animal Biotechnology: historical background, scope and possible applications.
2. Requirements in an animal cell culture laboratory.

UNIT-II

1. Animal cell culture: concept, principle, culture media, types, merits and demerits.
2. Culture procedure: primary cultures and cell lines, their utilization, present status of progress.
3. Applications of animal cell culture: cell products in antibodies and immune-regulators, prospects of recombinant products, viral vaccines, cell and tissue therapy for benefit of the society.

UNIT-III

1. Animal propagation – Artificial insemination, Animal Clones.
2. Conservation Biology – Embryo transfer techniques.
3. Introduction to Stem Cell Technology and its applications.

UNIT-IV

1. Gene transfer methods in Animals.
2. Introduction to *in vitro* fertilization and embryo transfer in human and livetock.

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.

SUGGESTED READINGS:

1. Elements of Biotechnology- P.K. Gupta., Rastogi publishers, Meerut.
2. B.D.Singh, Biotechnology- Kalyani Publishers, Ludhiana
3. R.C. Dubey, A Text Book of Biotechnology- S. Chand & Company Ltd.

BBT 605: Practical on Bio-Analytical Tools, Genomics and Proteomics and Plant and Animal Biotechnology

Practical Credit: 4

This practical course gives the idea of analytical methods used in biological laboratories, application such methods in solving issues related to the environment as well as the approaches for improving live-stock using technology. After successful completion, this course enables students

CO1. To learn the method of protein analysis under reducing conditions using SDS-polyacrylamide slab gel electrophoresis.
It also helps in understanding the principle and application of chromatography methods for the identification of amino acids and lipids.

CO2. To acquaint with the use of SNP databases at NCBI and other sites and OMIM database for the genomics level study.

CO3. To understand the quality/potability of water through bacteriological analysis of water samples.
It also deals with the laboratory methods for the estimation of Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) through which the condition of a water body can be determined.

CO4. To learn the laboratory conditions and the concept of minimal essential growth medium required during animal cell culture.

CO5. To learn the molecular method for the isolation and quantification of DNA from animal tissue using Agarose Gel Electrophoresis.

Course Content

Bio-Analytical Tools

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of protoplasts from leaves.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.

Genomics and Proteomics

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

Environmental Biotechnology and Enzymology

1. Qualitative analysis of water by MPN counts (for fecal coliforms) method.
2. Bacteriological analysis of water (presumptive, confirmed and completed test)
3. Determination of Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) of water body.

Animal Biotechnology

8. Preparation of Minimal Essential Growth medium
9. Isolation of lymphocytes for culturing
10. DNA isolation from animal tissue
11. Quantification of isolated DNA.
12. Resolving DNA on Agarose Gel.