

Course Structure of  
**B. Sc. (Hons.) Biotechnology [from Batch 2014 onwards]**

Course Code	Semester / Course Title	Credits
<b>Semester-I</b>		
CSIT-301	Introduction to Computer Application	3 (2-0-1)
GPT-301	Moral and Value Education	3 (2-1-0)
MCE-301	Cell Biology	3 (2-0-1)
MAS-303	Basic Mathematics-I	3 (3-0-0)
PHY-309	Applied Physics	3 (3-0-0)
CHEM-311	Inorganic Chemistry	3 (2-0-1)
CHEM-313	Organic Chemistry	3 (2-0-1)
BIOL-403	Life Science-I Botany	3 (2-0-1)
BIOL-404	Life Science-II Zoology	3 (2-0-1) <b>27</b>
<b>Semester-II</b>		
BCBE-302	Introductory Biochemistry	3 (2-0-1)
MCE-302	Molecular Biology	3 (3-0-0)
MCE-303	Introductory Biotechnology	3 (3-0-0)
DT-304	Milk and Milk Processing	3 (2-0-1)
MAS-304	Basic Mathematics-II	3 (3-0-0)
PHY-308	Biophysics	3 (3-0-1)
CHEM-312	Physical Chemistry	3 (2-0-1)
MAS-331	Fundamental Statistics	3 (2-0-1)
MBFT-349	Introductory Microbiology	3 (2-0-1) <b>27</b>
<b>Semester-III</b>		
LNG-304	Professional Communication and Technical Writing	3 (3-0-0)
CHEM-330	Analytical Chemistry	3 (2-0-1)
TE-401	Fundamentals of Tissue Culture	3 (2-0-1)
MCE-401	Basics of Molecular Genetics	3 (2-0-1)
BCBE-401	Biochemistry-I	3 (2-0-1)
BCBE-404	Enzymology and Enzyme Technology	3 (2-0-1)
BCBE-406	Basic Techniques in Biochemistry and Instrumentation	3 (2-0-1)
MCE-406	Molecular Biology Techniques and Instrumentation	3 (2-0-1)
ENVS-415	Environmental Studies-I	2 (2-0-0) <b>26</b>
<b>Semester-IV</b>		
DT-305	Fat Rich and Traditional Dairy Products	3 (2-0-1)
MBFT-401	Microbiology-II	3 (2-0-1)
MCE-402	Introduction to Plant Biotechnology	3 (2-0-1)
BCBE-403	Biochemistry-II	3 (2-0-1)
MCE-403	Introduction to Environmental Biotechnology	3 (3-0-0)
MCE-404	Introduction to Animal Biotechnology	3 (2-0-1)
MCE-405	Introduction to Food Biotechnology	3 (2-0-1)
BCBE-408	Chemical Thermodynamics	3 (3-0-0)
GPB-412	Genetics	3 (2-0-1)
ENVS-416	Environmental Studies-II	2 (2-0-0) <b>29</b>
JSBB-400	Training-I (credit will be awarded in V <sup>th</sup> Semester)	-

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Course Code	Semester / Course Title	Credits
<b>Semester-V</b>		
BCBE-402	Basic Proteomics	2 (2-0-0)
BCBE-405	Basic Immunology	3 (2-0-1)
BCBE-501	Biochemical Engineering	3 (2-0-1)
CBBI-501	Applications of Bioinformatics	3 (2-0-1)
DT-501	Quality and Safety Monitoring in Dairy Industry	3 (2-0-1)
MCE-501	Biosafety, Bioethics and IPR in Biotechnology	3 (3-0-0)
BCBE-502	Industrial Biotechnology	3 (2-0-1)
MBFT-502	Industrial Microbiology	3 (2-0-1)
MAS-531	Biostatistics	3 (2-0-1)
JSBB-400	Training-I Evaluation	1 (0-0-1) <b>27</b>
<b>Semester-VI</b>		
TE-501	<i>In vitro</i> Culture Techniques in Plants	3 (2-0-1)
BAM-502	Marketing and Management of Biotechnological Products	3 (3-0-0)
MCE-502	Recombinant DNA Technology	3 (3-0-0)
BCBE-505	Plant Biochemistry	3 (2-0-1)
BCBE-506	Animal Biochemistry	3 (2-0-1)
MBFT-507	Microbial Biotechnology	3 (2-0-1)
PHA-562	Pharmaceutics-VII (Biopharmaceutics and Pharmacokinetics)	3 (3-0-0)
MCE-601	Molecular Breeding	3 (2-0-1)
MCE-602	Genomics	3 (3-0-0)
JSBB-488	Seminar-I	1 (0-0-1) <b>28</b>
JSBB-500	Training-II (credit will be awarded in VII <sup>th</sup> Semester)	-
<b>Semester-VII</b>		
MCE-503	Fundamentals of Nanotechnology	3 (3-0-0)
PHA-574	Pharmaceutical Biotechnology	4 (4-0-0)
MCE-603	Genetically Modified Foods	3 (3-0-0)
MCE-604	Gene Cloning and Gene Therapy	3 (2-0-1)
MBFT-605	Microbial Technology in Food Industry	3 (2-0-1)
BCBE-605	Immunotoxin and Drug Designing	3 (3-0-0)
MBFT-611	Pharmaceutical Microbiology	3 (2-0-1)
JSBB-589	Seminar-II	1 (0-0-1)
JSBB-500	Training-II Evaluation	1 (0-0-1) <b>24</b>
<b>Semester-VIII</b>		
JSBB-699	Project	12 (0-0-12) <b>12</b>
Total Credits		<b>200</b>

## B.Sc. (Hons.) Biotechnology

### SEMESTER - I

#### CSIT-301: Introduction to Computer Applications

3 (2-0-1)

**Introduction to computers:** History, evolution, Memory and Input / Output / Storage Devices.

**Software:** Types of software, System Software, Applications Software, Introduction to Ms-Word and Ms-Excel.

**Operating Systems:** Definition; functions of Operating System. Booting process of computer-warm and cold. Introduction to DOS and Windows Operating System.

**Computer Viruses:** Types of computer viruses, worms, Trojans. Security Aspects.

#### Practical:

DOS - Internal / External Commands

FORMAT

DIR

COPY

PATH

LABEL

VOL

MD, CD

DEL TREE

**Windows** - WINDOWS GUI, Desktop and its elements, Windows Explorer, working with files and folders, setting time and date, Title Bar, Scroll Bars, Menu and Tool Bars.

**MS-Word** - Text, graphics, text boxes, viewing the documents, character and paragraph formatting, page setup, header, footer.

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#### GPT-301 : Moral and Value Education

3 (2-1-0)

#### Objectives

- o To explicitly discuss that is implicitly communicated through Academic disciplines.
- o To Inculcate Life affirming values based on 'Fear of God as the beginning of wisdom'.

#### Section-I. Basics

- o Integrating Heart-Head-Hand - Story of Sam Higginbottom.
- o 'Contextual-Dialogical-Praxological' character of Value education.
- o Different Values: Academic-Economic-Social-Material-Moral-Spiritual.

#### Section-II. Biblical Foundation

- o Proverbs. .. Chapter 2-4.
- o Ten Commandments .. Exodus 20: 1-17.
- o Two Commandments of Jesus .. Mark 12: 29-31.
- o Sermon of Mount .. Matthew Chapter 5-7.
- o Lord's Prayer .. Matthew 6: 9-13; Luke 11: 1-4.
- o Parable of Good Samaritan .. Luke 10: 29-37.
- o Parable of Two Brothers .. Luke 15: 11-32.

#### Section-III. Formation of Character

- o Voice of Conscience.
- o Virtues .. Prudence-Justice-Courage-Discipline-Success-Faith-Hope-Love.
- o Values of Life .. Marriage-No same sex marriage-Divorce-Abortion.
- o Values of Belonging .. Family-Friends-Faith-Community-Nation-World.

#### **Section-IV. God-Human-Plants-Animals**

- o Stewardship of Creation.
- o Biotechnological Advancement.
- o Exploitation of Animals, Plants and Microorganisms.
- o Environmental Hazards.

#### **Section-V. Our Constitution**

- o Fundamental Rights.
- o Directive Principles of State Policy.
- o Fundamental Duties.
- o Enlightened Citizenship: Ten Points of Dr. A.P.J.AbdulKalam.

#### **Section-VI. Interactive Sessions**

- o Sexual Harassment.
  - o Corruption.
  - o Substance Abuse.
  - o Violence.
  - o Communalism.
  - o Cyber crime.
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### **MCE-301 : Cell Biology**

**3 (2-0-1)**

**Unit 1.** An introduction to cell biology: History of cell biology. Development of cell theory. Modern cell biology.

**Unit 2.** Diversity of cell size and shape: Structure of prokaryotic cells (bacteria, fungi, virus, cyanobacteria, mycoplasma etc.). General organization of eukaryotic cells, cell shape, cell size, cell volume and cell number.

**Unit 3.** Organization of cell: Cell wall, plasma membrane, their structural organization and functions. Membrane bound cell organelles - nucleus, endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and vacuoles. Non-membrane bound cell organelle- ribosome. Cytoskelton- microtubules, intermediate filaments and microfilaments.

**Unit 4.** Cell growth and division: Cell cycle, kinds of cell division, amitosis, mitosis, meiosis, comparison between mitosis and meiosis, crossing over, significance of cell division.

#### **Practical:**

Microscopy- simple and compound microscope Preparation of stains.

Grams staining.

Study of cell division - different stages of mitosis Differential staining of blood cells.

Hanging drop method for motility of bacteria.

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### **MAS-303 : Basic Mathematics-I**

**3 (3-0-0)**

Algebra: Theory of quadratic, Binomial-Theorem (for +ve index), Use of natural and common logarithms, exponential series, partial-fractions, Determinants of order 3, Theory of Matrices, addition, subtraction, multiplication, transpose, elementary ideas on ad joint and inverse. Solution of linear equations, inequalities, permutation and combination.

Trigonometry: Trigonometrical- functions, addition and subtraction formula, double and half angle formula laws of sines and cosines, solutions of triangles, height and distance, real and complex numbers, hyperbolic trigonometric functions. De-Movire's Theorem.

Coordinate-Geometry: Distance between two points, Area of triangle, Straight-lines.

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**Unit-1.** Optics: Interference: Coherent sources, conditions of interference, Fresnel's bi-prism experiment, interference in thin films, wedge shaped film, Newton's ring.

Diffraction: Single slit and double slit diffraction, diffraction grating, Raleigh's criterion of limit resolution, resolving power of telescope and microscope.

Polarization: Polarization of light, Brewster's law, Malus law, phenomenon of double refraction, geometry of calcite crystal, optic axis, principal section, ordinary and extraordinary rays, construction and working of Nicol prism. Plane, circularly and elliptically polarized light. Their production and analysis. Retardation Plates, optical activity, specific rotation, polarimeters.

**Unit-2.** X-rays: Origin of X-rays, continuous and characteristic X-ray spectra, Mosley's law, absorption of X-rays, Diffraction of X-rays, Bragg's law, Bragg's spectrometer, practical applications of X-ray, X-ray Machine.

**Unit-3.** Laser: Spontaneous and stimulated emission of radiation, Einstein's Coefficients. Components of laser. Type of laser and their working and application. Classes of laser equipments.

**Unit-4.** Electromagnetic Theory: Gauss's law, Poisson and Laplace equation, Maxwell's equations, Basic concepts of Electromagnetic waves and its solution in free space. Para, dia, ferro, antiferro and ferri magnetic materials. Hysteresis and magnetic circuits.

#### Reference books:

1. Fundamentals of Optics [Jetkins and White]
  2. Perspectives of Modern Physics [Beiser]
  3. Electrodynamics [David Griffith]
  4. Laser - Theory and Applications [Thyagranjan / Ghatak]
  5. Fundamentals of Physics [Resnick and Halliday]
  6. Engineering Physics [Uma Mukherjee]
  7. Text book of Engineering Physics [Navneet Gupta and Kumar]
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### CHEM-311 : Inorganic Chemistry

3 (2-0-1)

**Unit-1.** Nature of Covalent bond and shapes of molecules: Valence bond theory, pauling slater theory, formation of hydrogen, fluorine, HF molecules, molecular orbital theory (MOT), LCAO (Linear combination of atomic orbital). Electronic configuration of Hetero nuclear diatomic molecules, VSEPR theory, Introduction of hybridization.

**Unit-2.** Nuclear and Radiochemistry: Nuclear shell model, Mass defect, packing fraction, Binding energy, Natural radioactive disintegration, concept of Half Life, Group displacement Law, Artificial radioactivity, Nuclear fusion and Nuclear fission reaction.

**Unit-3.** Coordination Chemistry: Legends, coordination number complex ion, IUPAC rules for coordination compounds, Nomenclature chirality, Warner theory of coordination, pauling theory, crystal field theory.

**Unit-4.** Organometallic Compounds: Types, Classification, Nature of carbon metals bond, preparation, Properties

**Unit-5.** Biochemical Significance of Inorganic metals: Introduction, Na, K, Cl, Fe, Zn, Co.

**Unit-6.** Inorganic Polymers: Classification of inorganic polymers, preparation, Phosphate containing polymers. A general idea of Boranes, Carbides, Silicones, Carbonyles, Nitrosyles.

**Practical:** Semi microanalysis of inorganic salts and mixtures.

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**CHEM-313 : Organic Chemistry**

**3 (2-0-1)**

**Unit-1.** Carbohydrates: Introduction, Classification, Monosaccharide stereochemistry, Fischer projection, Structure of D-glucose, Cyclic structure of D-glucose, Haworth projection, properties. Oligosaccharides- Structure of Sucrose. Polysaccharides- Structure of Starch, Cellulose and Glycogen.

**Unit-2.** Aminoacids: Classification, Essential and Non-essential Amino acids, Optical activity, synthesis. Properties, Zwitter ion and Isoelectric Point.

**Unit-3.** Proteins: Classification, Primary, Secondary and Tertiary structure. Properties, Colloidal nature, Denaturation, Test for Proteins.

**Unit-4.** Fats and Oil: Composition of fats, Introduction, Nomenclature of fats, Physical and Chemical properties of fats, Rancidity, Analysis of fats chemical constants, Saponification, Specification Number, Iodine Number, Acid value, Reichert Miessl value, Polenski value.

**Unit-5.** Alkaloids: Introduction, Classification, Determination of molecular structure of Alkaloids, Properties, Nicotine, Coniine.

**Unit-6.** Terpenoids: Introduction, Classification. Structural features of Terpens or Isoprene Rule, Myrcene, Citral.

**Unit-7.** Nucleic Acids: Chemistry of Nucleic acids, Structure and composition of purine and pyrimidines, Nucleosides, Nucleotides, general composition of DNA and RNA.

**Practical:**

Identification of sugars and organic acids.

Test for proteins and aminoacids.

Test for fats, fatty acids, acids and saponification.

Identification of phenol, acids, carbonyl compounds, hydrocarbons.

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**BIOL-403 : Life Science-I (Botany)**

**3 (2-0-1)**

**Unit 1.** Study of plant parts (root, stem, leaf, flower), inflorescence. Seed and seed germination.

**Unit 2.** Classification of angiosperm with reference of Bentham and Hooker, its merit and demerits. Distinguishing characters of the following families; Leguminaceae, Solanaceae, Liliaceae, Poaceae.

**Unit 3.** Study of structure and function of plant tissue.

**Unit 4.** Plant and Environment: Atmosphere, water, light, Temperature, soil and biota. Ecosystem's structure and function, abiotic and biotic components, food chain, green house effect.

**Unit 5.** Economic botany (name and precise part used); cereals, pulses, fiber, medicines, timber.

**Practical:**

Study of primary structure of root, stem and leaves.

Study of stamata.

Description and identification of important families:

(a) Leguminaceae (b) Liliaceae (c) Solanaceae (d) Poaceae.

Study of economically important plants (cereals, pulses, vegetables, medicinal plants).

Demonstration of Osmosis, Transpiration, Photosynthesis, Respiration.

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**Unit 1.** General principles of classification of animal kingdom with special reference to orders of agricultural importance.

**Unit 2.** Life history and control of important animals parasitic on man and animals

**Unit 3.** Economic importance of following animals (a) Indian Snail (b) Slugs (c) Crabs (d) Mammals (e) Birds (f) Earthworm.

**Unit 4.** Life history and brief rearing methods of some useful insects (a) Honeybee (b) Lac Insects (c) Silk worm.

**Unit 5.** Identification of poisonous and non-poisonous snakes of India. Symptoms of snakebite and antidotes.

**Unit 6.** Crustacea and Mollusca.

**Unit 7.** Local fishes of economic importance, planning and implementation of fish farming.

**Practical:**

Study of the life cycle of the honey bee, silkworm and lac insect by preparation slides and charts.

Study of the general anatomy of an economically important insect by the procedure of dissection.

Study of microscopic preparation (Permanent mounts) under the microscope.

Study of morphology (external form and structure) of some of the preserved animals in the laboratory.

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**SEMESTER - II**

**Introduction to Biochemistry:** Definitions, biological molecules, Role of biochemistry in nutrition, Health of humans. Classes of biological molecules and their chemical nature. Cell organelles composition: cell structure, organelles- functions, cell division types.

**Carbohydrates:** Definition, classification, properties. Metabolism of carbohydrates, monosaccharide and polysaccharide metabolism and nutritional importance.

**Lipid metabolism:** Definition, classification, properties. Metabolism of lipids. Nutritional significance.

**Protein Metabolism:** Definition, classification, properties. Metabolism of proteins and nutritional importance. Enzymes.

**Vitamins and Hormones:** Vitamins: definition, classification, disorder-deficiency, sources. Hormones: classification, properties.

**Practical:**

Determination of Lactic acid from milk.

Identification of sucrose, starch and gelatin in milk.

Determination of protein from milk.

Determination of Fat from milk.

Determination of citric acid from fruit juice.

Determination of acid number of oils.

Determination of saponification of oils.

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### MCE-302 : Molecular Biology

3 (3-0-0)

**Unit 1:** Introduction: Development of molecular biology. Historical perspectives. Concepts in molecular biology.

**Unit 2:** Structure and properties of nucleic acids: Structure of nucleotides, DNA double helix, helical conformations and DNA topology. Types of DNA and RNA- A, B, Z forms of DNA, mRNA, tRNA, rRNA, hnRNA, snRNA. Physical and chemical properties of DNA.

**Unit 3:** DNA protein interaction: Molecular aspects of protein-nucleic acid binding. DNA binding motifs in proteins- Helix- turn - helix, Zinc finger motifs, Leucine zipper, HMG box, etc.

**Unit 4:** Gene organization: Gene structure and architecture, gene clusters, split genes, overlapping genes, pseudogenes, operon, open reading frames, transposons, oncogenes. Range of genome size. C value and gene numbers. Reassociation kinetics, Repetitive DNA - satellite DNA.

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### MCE-303 : Introductory Biotechnology

3 (3-0-0)

**Unit 1.** Introduction: Historical development of biotechnology. Basic concepts of biotechnology. Definition and descriptions of some important terminology in biotechnology.

**Unit 2.** Branches of biotechnology: Study of various branches of Biotechnology including Plant, Animal, Medical, Industrial, Environmental, Marine Biotechnology, Bioinformatics, etc.

**Unit 3.** Biotechnology in India: Biotechnology and developing world- concerns and consequences. Role of biotechnology in Indian industry. Impact on agricultural sector.

**Unit 4.** Biotechnology and other disciplines: Biotechnology- an interdisciplinary pursuit, a three component central core, product safety. New trends in biotechnology.

**Unit 5.** Applications and scope of biotechnology: Practice of biotechnology in medicine, industry, agriculture, live stock improvement and environment. Future perspectives.

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### DT-304 : Milk and Milk Processing

3 (2-0-1)

Definition of milk. Physico-chemical properties of milk. Factors affecting the composition of milk. Reception and preliminary testing of milk at plant.

Processing of market Milk:

Practices for reception, chilling, clarification, separation, storage of raw milk. Homogenization of milk: definition, pretreatment of milk for homogenization, homogenization, synchronization, synchronization of homogenization with HTST plant.

Effect of homogenization on physico-chemical properties of milk.

Pasteurization, sterilization, UHT-processing, Pasteurization methods: LTLT/HTST.

Manufacture of sterilized milk.

Manufacture of special milks: reconstituted recombined milks, flavoured milks, homogenized/ vitaminized milks, lactose-hydrolysed milk.

#### **Practical:**

Reception of milk at the plant.

Pre-treatment of raw milk: chilling, clarification, filtration.

Cream separation, standardization of milk.

Operation of LTLT, HTST pasteurizer.

Preparation of special milks, vitaminized, homogenized milks, flavoured milk, toned, double toned, sterilized, recombined milks, lactose hydrolysed milk.

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**Differential calculus:** Functions, Limit, Continuity and Differentiability, Differential coefficients of standard fractions (algebraic, trigonometric, exponential, logarithmic etc.). Rules for differentiation, differentiation of composite, inverse, implicit and parametric functions. Higher order derivatives. Tangent and normal, maxima and minima.

**Integral Calculus:** Definite integration of standard functions, Integration by substitution, parts, partial fraction. Integration of rational, irrational trigonometric functions etc. Definite integrals and properties. Its application in evaluating area and volume.

**Vector - Algebra:** Definition and identification of vector and scalar, linear operations in vectors, linear combinations of vectors, Linear independence and dependence. Dot and vector products. Triple product.

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**PHY-308 : Biophysics****3 (3-0-1)**

**Unit-1 :** Physical Techniques: Diffusion, Sedimentation, Osmosis, Viscosity, their definition, factors Influencing them and their application in biology.

**Unit-2:** Spectroscopic Techniques: Explanation of Absorption Spectroscopy, Fluorescence, Phosphoresce. An introduction to NMR, ESR, IR, Visible/ UV, X-rays and Raman Spectroscopy and their application in Biomedical field.

**Unit-3:** Radiation Biophysics: Ionizing Radiation, Interaction of Radiation with matter, Dosimetry and Application of Radio isotopes. Biological effect and radiation effects on living system.

**Unit-4:** Thermodynamics: Thermodynamic System, Equilibrium, laws and their applications. Different type of processes, Thermodynamic variables and Entropy. Thermodynamic potentials and Relations Maxwell's, Equations, Fundamental equation of heat flow.

**Reference books:**

1. A Text book of Bio Physics (R.N. Roy)
  2. Essential of Bio Physics (P. Narayanan)
  3. Bio Physics (Pattabhi and Gautam)
  4. Bio Physics - An Introduction (Rodney Cotterill)
  5. Heat and Thermodynamics (Brij Lal and Subrahamanyam)
  6. Heat and Thermodynamics (Zemensky)
  7. Heat and Thermodynamics and Statistical Physics ( Satya Prakash)
  8. Basic Thermodynamics ( E. Guha)
  9. Modern Physics (Richtmyer)
  10. Basic Nuclear Physics ( B.N. Srivastava)
  11. Atomic and Nuclear Physics (S.N. Ghoshal)
  12. Fundaments of Molecular Spectroscopy (C.N. Banwell)
  13. Molecular Structure and Spectroscopy (G. Aruldas)
  14. Atomic and Molecular Physics (Gupta Kumar and Sharma)
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### CHEM-312 : Physical Chemistry

3 (2-0-1)

**Unit 1.** Ionic equilibrium: concepts of acids and their related strength, buffer solution and its pH, hydrolysis of salts, acids -base indicators oswalds and quinonoides theory, solubility product.

**Unit 2.** Chemical kinetics: order and molecularity, differential rate laws and integrated rate laws equations for zero, 1st, 2nd and 3rd reactions (derivations included) significance of rate constant and its evaluation, time for definite fractional change of reaction, determination of order.

**Unit 3.** Electro chemistry: reversible and irreversible cells, EMF of a cell and free energy, nernst equation, equilibrium constant, standard electrode potential, types of reversible electrodes, applications of EMF measurements, determination of solubility product, pH, dissociation constant of acids, hydrolics constant solubility, soluble salts.

#### **Practical:**

Determination of rate constant and order of reaction for hydrolysis of ester by an acid.

To study the kindtics of dissociation of Magnesium in dilute HCl.

To determine the order of saponification of ethyl acetate with NaOH.

Determination of density of liquid by density bottle.

To find surface tension of the given liquid.

To find the relation and absolute viscosity of given liquid.

Determination of carbonates, bicarbonates and total alkalinity in water.

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### MAS-331 : Fundamental Statistics

3 (2-0-1)

Definition and applications of Statistics, Testing of Hypothesis: Concept of Hypothesis, Degrees of freedom, Level of significance Measures of central tendency, Measures of dispersion, standard error of mean. Coefficient of variation Probability: Definition and applications, numerical problems.

Simple-correlation between two variables (Definition, properties and numericals).

Regression- Lines: Definition and uses, Method of least square, Concept of regression-coefficient.

**Practical:** Measures of central tendency, dispersion, simple correlation coefficient, regression lines

#### **Books:**

1. Probability and Statistics for Engineers [R.A. Johnson]
  2. Probability and Statistics for Engineers [A.J. Haten]
  3. Fundamental of Mathematical Statistic [Gun Gupta and Das Gupta]
  4. Fundamental of Mathematical Statistics [Gupta and Kopoor]
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### MBFT-349 : Introductory Microbiology

3 (2-0-1)

Definition, Scope and History of Microbiology.

Cellular organization of prokaryotic and eukaryotic cells.

Difference between prokaryotic and eukaryotic cells.

General characteristics and nature of Bacteria, Mycoplasma, Rickettsiae, Chlamydiae,

Actinomycetes, Protozoa, Fungi, Algae and Viruses.

**Practical:**

Familiarity with equipment to be used in Microbiology Laboratory.

Cleaning, washing and sterilization of glass wares.

Observation of permanent slides to study the structural characteristics of common bacteria, fungi, algae and protozoa.

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**SEMESTER - III****LNG-304 : Professional Communication and Technical Writing 3 (3-0-0)****Language**

- [a] Word enrichment (Antonyms, synonyms, homonyms, acronyms, homophones).
- [b] Tenses.
- [c] Concord.
- [d] Modifiers.
- [e] Preposition.
- [f] Inflection.
- [g] Determiners.
- [h] Voice.

**Communication**

- [a] Role of Body language in communication.
- [b] Self introduction.
- [c] Conversation in different situations.
- [d] Use of specific expressions.
- [e] Group Discussions.
- [f] Role Plays.
- [g] Interviews.
- [h] To cater different types of audience.

**Technical writing**

- [a] Resume.
- [b] Curriculum vitae.
- [c] Letters.
- [d] Memos.
- [e] Report.
- [f] Proposals.
- [g] Usage of graphics.
- [h] Different administrative documents (Notices, Circulars, Memos, Agenda, Minutes).

**Speech**

- [a] Accent.
  - [b] Intonation.
  - [c] Different types of speeches.
  - [d] Delivering of different types of speeches.
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**CHEM-330 : Analytical Chemistry****3 (2-0-1)**

**Unit 1.** General principle of analytical chemistry: Volumetric analysis. Solutions, preparation of primary and secondary standard solutions, Neutralization (Acid- Base) Titration, Iodometry, Iodimetry, Permagnometry. Volumetric determination of calcium. Gravimetric analysis: principles and methodology. Estimation of calcium.

**Unit 2.** Colorimetry: Principle Lamberts and Beer's law. Absorption law (Derivation required), methodology and applications.

**Unit 3.** Thermometric analysis: Thermo gravimetric Analysis - types, Instrumentation, methodology and Application.

**Unit 4.** Potentiometer titration: Electrode system, Ion selective electrodes, Ion selective membrane electrode, advantages of potentiometric titrations. Application of potentiometer titrations.

**Unit 5.** Polarimetry and flourimetry: Instrumentation methodology and applications.

**Unit 6.** Spectrophotometry: Principle, Instrumentation, methodology and Application.

**Unit 7.** Spectroscopic techniques: Introduction of UV, IR and Mass Spectroscopy.

**Practical:**

Preparation of primary and secondary standard solution.

Standardization of secondary standard solution.

Preparation of and standardization of an acid solution.

Preparation and standardization of solution of  $\text{KMnO}_4$ .

Volumetric determination of Fe by  $\text{KMnO}_4$ ,  $\text{K}_2\text{CO}_3$  solution.

Determination of Ca volumetrically.

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**TE-401 : Fundamentals of Tissue Culture**

**3 (2-0-1)**

Plant Tissue Culture: A historical view, organization of tissue culture laboratory, aseptic techniques, media formulation, clonal propagation vs tissue culture, totipotency, growth differentiation and morphogenesis in tissue culture, various types of aseptic cultures and culture techniques.

Animal Tissue Culture: Basic techniques, organ culture, media formulation for animal cell, initiation of cell culture, evolution and maintenance of cell lines, Suspension culture and Immobilized culture.

Application of tissue culture techniques: Somoclonal and gametoclinal variation, protoplast fusion and somatic hybridization, cybridization, haploid and monoploid production, secondary transformation, production of metabolites, artificial seeds, preservation of genetic resources, cryopreservation, application of tissue culture for plant improvement.

**Practical:**

Laboratory equipments used in Plant Tissue culture.

Plant Growth Hormones.

Media preparation.

Preparation and Sterilization of explants.

Callus induction.

Meristem culture.

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**MCE-401 : Basics of Molecular Genetics**

**3 (2-0-1)**

**Unit 1.** Introduction: Basic concepts in molecular genetics. Prokaryotic and Eukaryotic genome. Concept of gene and central dogma.

**Unit 2.** Transcription: Mechanism of transcription in prokaryotes and eukaryotes. Transcription of protein coding genes- mRNA. Post transcriptional modifications- 5'capping, poly A tailing and mRNA splicing in eukaryotes.

**Unit 3.** Translation: Introduction to protein synthesis. The nature of genetic code. Mechanism of translation in prokaryotes and eukaryotes. Post translational modification of proteins.

**Unit 4.** Regulation of gene expression: Gene regulation in prokaryotes - lac and trp operons as model systems. Gene regulation in eukaryotes - Transcriptional level control, RNA processing level control, translational level control, post translational level control.

**Unit 5.** Gene mutation: Mutagenesis. Causes of mutation - spontaneous and induced. Types of mutagens- physical and chemical. Classification of mutations. Molecular basis of gene mutation.

**Practical:**

Structural elucidation of nucleotides and nucleic acids. Study of DNA and RNA models.

Extraction of proteins from plant tissues.

Estimation of proteins by Lowry and Bradford methods.

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**BCBE-401 : Biochemistry-I**

**3 (2-0-1)**

**Chemical structure of proteins** and their properties, cellular membrane and transport phenomenon.

**Intermediary metabolism-** concept of anabolism and catabolism, metabolism of carbohydrates, lipids and aminoacids and their interrelationship.

**Biological oxidation**, electron transport system, oxidative phosphorylation, free energy changes in biochemical reactions, energy changes in biochemical reactions, energy rich compounds.

**Metabolism** of nucleic acids and proteins.

**Hormones:** regulation of metabolism by various hormones.

**Practical:**

Specific group tests for carbohydrates.

Specific group tests for amino acids.

Specific tests for lipids.

Determination of mil protein, fat and lactose.

Determination of acidity in sample.

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**BCBE- 404 : Enzymology and Enzyme Technology**

**3 (2-0-1)**

**Introduction of enzymes:** General properties and significance, classification and nomenclature. Terms and definition in enzymology: enzyme activity, specific activity, turnover number, active site, isoenzyme, marker enzyme Multienzyme complex, extracellular enzymes, extremozymes, abzymes, ribozymes, induced enzyme etc. extracellular enzymes, extremozymes abzymes, ribozymes, induced enzyme etc.

**Factor affecting enzyme activity:** pH, Temperature, substrate concentration etc. Isolation, purification and localization of enzyme, techniques involved in enzyme assays.

**Enzyme kinetics:** Steady rate kinetics, Derivation of Michaelis-Menten equation using steady state/equilibrium kinetics, plots of Lineweaver-Bruke etc. mechanism of substrate and multi-substrate enzyme catalyzed reaction.

**Regulation of enzyme activity:** Covalent modification, enzyme inhibition and kinetics. Allosteric enzyme:- feed back inhibition, allosteric model concerted and sequential, cooperativity.

**Mechanism of enzyme action and concept of active site:** vis-à-vis lysozyme, chymotrypsin, alcohol dehydrogenase, glyceraldehyde 3-phosphate dehydrogenase, proteases.

**Enzyme Technology:** Commercial production of enzymes, preference of extracted enzyme over whole organism, immobilization of enzymes, example of enzyme engineering, application of enzyme (therapeutic uses, analytical uses, manipulated uses etc.), uses of enzyme in solutions, enzyme reactors, biphasic system, bi and poly functional enzymes, solvent engineering.

**Practical:**

Determination of protein.

Determination of salivary amylase.

Activity of effect of salt on salivary amylase.

Detection of effect of pH on enzyme activity.

Determination of Acid/Alkaline phosphatase.

Determination of enzyme kinetics.

Separation of protein by PAGE.

Identification of extra cellular enzymes like protease, oxidase, urease, catalase and lipase.

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**BCBE-406 : Basic Techniques in Biochemistry and Instrumentation 3 (2-0-1)**

**Electrophoresis:** Principle and applications, paper and gel electrophoresis (agarose and PAGE), Isoelectric focusing.

**Centrifugal techniques:** Principle and types, Differential centrifugation, Ultracentrifugation.

**Restriction analysis of DNA:** Competent cell preparation and transformation of DNA. DNA foot printing, DNA finger printing, Polymerase chain reaction (PCR).

**Radioisotopic and other techniques:** Detection and measurement of isotopes (GM and scintillation Counters).

**Molecular Biology Techniques:** Isolation and purification of DNA, RNA and Plasmid DNA. Isolation of m-RNA from mammalian cells, Sequencing of protein and nucleic acids, Chemical synthesis of nucleotides.

**Chromatography:** Ion exchange chromatography, affinity chromatography, HPLC, Column chromatography.

**Practical:**

Preparation of gels (agarose, PAGE) for electrophoresis.

Separation of different proteins by electrophoresis.

Protein estimation by Folin-Lowry methods.

Protein estimation by Biuret methods.

Identification of amino acids by paper chromatography.

Separation of amino acids, ions etc. by column chromatography.

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**MCE-406 : Molecular Biology Techniques and Instrumentation 3 (2-0-1)**

**Unit 1.** Molecular biology techniques: Cell fractionation. Isolation and purification of genomic DNA. Polymerase Chain Reaction. Nucleic acid blotting. DNA sequencing techniques.

**Unit 2.** Instrumentation in biotechnology: Working principles, instrumentation and applications of pH meter, centrifuge, colorimeter, spectrophotometer, autoclave, distillation unit, lyophilizer, flame photometer.

**Unit 3.** Methods for separation of macromolecules: Chromatography- column, thin layer, paper, ion exchange, gel filtration, affinity. Electrophoresis- agarose gel electrophoresis and poly acrilamide gel electrophoresis.

**Unit 4.** Microscopy: Principles and applications of microscopy- simple, compound, phase contrast and electron microscopy.

**Practical:**

Measurement of hydrogen ion concentration of a given solution Separation techniques- centrifugation and electrophoresis.

Study of working principles and operation of some important equipments used in biotechnology laboratory viz., spectrophotometer, pH meter, centrifuge, electrophoresis apparatus (AGE and PAGE), PCR machine, Distillation unit, autoclaves etc.

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**ENV-415 : Environmental Studies-I**

**2 (2-0-0)**

The multidisciplinary nature of environmental studies: Definition, scope and importance- need for public awareness- Ecosystems- Concept of an ecosystem- structure and function of an ecosystem- producers, consumers and decomposers- energy flow in the ecosystem- Ecological succession - Food chains, food webs and ecological pyramids - Introduction, types, characteristic features structure and function of following ecosystems- [(a) Forest ecosystem, (b) Grassland ecosystem, (c) Desert ecosystem, (d) Aquatic ecosystem (ponds, streams, lakes, rivers, ocean, estuaries)].

Social issues and the environment- from unsustainable to sustainable development urban problems related to energy- water conservation, rain water harvesting, water sheds management- resettlement and rehabilitation of people; its problems and concerns. Case studies.

Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies, Wasteland reclamation. Consumerism and waste products.

Environmental protection act. Air (prevention and control of pollution) Act - Water (Prevention and control of pollution) Act- Wild life protection Act- Forest Conservation Act- Issues involved in enforcement of environmental legislation- public awareness.

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**SEMESTER - IV**

**DT-305 : Fat Rich and Traditional Dairy Products**

**3 (2-0-1)**

**Cream:** Definition and Legal standards, Methods of separation, Efficiency of cream separation and factors affecting it; control of fat concentration in cream. Neutralization, standardization, pasteurization and cooling of cream.

**Butter:** introduction to the butter-making process; batch and continuous methods. Technology of butter manufacture; over-run in butter; packaging and storage.

Butter-making equipment: construction, operation, and continuous butter making machines.

**Khoa:** Classification of types, standards methods of manufacture and preservation factors affecting yield of khoa. Physicochemical changes during manufacture and storage of khoa. Mechanization in manufacture of khoa. Product identification, process description, factors affecting yield physicochemical changes during manufacture.

**Chhana:** Product description, Standards method of manufacture, packaging and preservation.

**Paneer:** Product description standards method of manufacture packaging and preservation. Physicochemical changes during manufacture and storage.

**Ghee:** Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee.

**Practical :** Standardization, neutralization, pasteurization and cooling of cream. Preparation of cooking butter by the hand-operated churn. Manufacture of table butter using the power-driven chum. Preparation of khoa from cow, buffalo and concentrated milk. Analysis of khoa, chhanna and paneer for total solids, moisture, fat and acidity. Preparation of chhana from cow and buffalo milk and mixed milk. Preparation of paneer from cow and buffalo milk and mixed milk.

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### **MBFT-401 : Microbiology-II**

**3 (2-0-1)**

Diversity and importance of microorganisms in the environment, soil, water, air-borne, metabolic diversification and biogeochemical cycles.

Microbial interaction: microbe-microbe, microbe-plant and microbe-animal interactions.

Common pathogenic microbes in plants and animals.

Environmental microbiology, Bioremediation, aromatic organic pollutants, metal immobilization, Bio-augmentation, Waste and water treatment.

Industrial microbiology and fermentations, Modern developments, Microbes and biotechnology.

Microbes in human welfare, biofertilizers, pesticide, waste treatment.

Introduction to microbial genetics: transformation, Conjugation, Mutation and plasmids.

**Practical:**

Isolation of agriculturally important microorganisms, *Rhizobium*, *Azotobacter* etc.

Microbial analysis of soil water and air.

Microbial analysis of fresh foods, fermented foods and vegetables.

Antibiotic sensitivity tests.

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### **MCE-402 : Introduction to Plant Biotechnology**

**3 (3-0-1)**

**Unit 1.** Introduction to plant biotechnology: Definition. History and development of plant biotechnology. Modern trends in plant biotechnology.

**Unit 2.** Gene transfer in plants using *Agrobacterium*: Ti plasmids, transfer of T-DNA, construction of binary and co-integrate vector systems. *Agrobacterium* mediated leaf disc transformation.

**Unit 3.** Direct gene transfer in plants: Physical (Particle gun delivery, electroporation, microinjection, macroinjection, electroinjection, fiber mediated DNA delivery, Laser induced DNA uptake, Sonication) and Chemical methods of gene transfer (Poly ethylene glycol, Poly vinyl alcohol, Calcium phosphate).

**Unit 4.** Applications of plant biotechnology: Improving agronomic traits - genetic manipulation of plants for salt resistance, herbicide resistance, fungi and virus resistance, insect and other pest resistance. Modification of production traits - delayed fruit ripening, improving seed storage proteins.

**Practical:**

Safety aspects and precautions to be taken in Biotechnology Laboratory.

Preparation of reagents, stock solutions and buffers for plant DNA isolation.

Study of Labware used for isolation of DNA.

Isolation of genomic DNA from plant tissues by CTAB method.

Purification of crude DNA samples.

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**Protein Chemistry:** Structure of proteins, methods for determining the 3D structure of a protein- X-ray diffraction, NMR, Mass spectrometry, protein homology among species, protein denaturation and folding, assisted folding, edman degradation, glycoprotein, lipoproteins, proteoglycans, phosphor proteins, chromoprotein, bacterial and viral protein (HIV, HBV, toxins, etc.).

**Biomembranes:** Molecular constituents of membranes, movement of molecules through membranes, energetics of membrane transport system, biosignalling, voltage gated ion channels, transporters and group translocation with examples.

**Sensory systems:** Olfaction, taste, vision, hearing and touch with their biochemical mechanisms.

**Physiochemical properties of nucleic acids:** Hydrogen bonding, bond length, tautomerism and its significance in nitrogen bases, DNA denomination, and factor responsible for hypochromicity. Renaturation of DNA, annealing, walloce's rule, hybridization, ionization, enzymatic of nucleic acids, effect of acids and alkalis on nucleic acids, DNA super coiling and nucleic acid mutations.

**Practical:**

Fractionation of egg proteins.

Detection of alpha - amylase activity in saliva.

Determination of sugar/glucose/urine (Benedict's Trirometric method).

Identification of blood constitution.

Extraction of total nucleic acid from plant tissues.

Extraction of RNA from yeast.

Assay of protein by Biuret's method.

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**MCE-403 : Introduction to Environmental Biotechnology 3 (3-0-0)**

**Unit 1.** Introduction to environmental biotechnology: Importance of biotechnology in environmental protection. Biodiversity, ecosystem and population diversity. Environmental hazards.

**Unit 2.** Biomass utilization: Bioremediation, bioleaching, biodegradation, biostimulation, bioaccumulation, bioaugmentation, biomagnification.

**Unit 3.** Biotechnological methods of pollution detection: Bioassay, biosensors and biological indicators. Sewage and soil waste management.

**Unit 4.** Global environment issues: Ozone depletion, green house effect, acid rain, sea level rise, global warming.

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**MCE-404 : Introduction to Animal Biotechnology 3 (2-0-1)**

**Unit 1.** Introduction to animal biotechnology: Definition, history, importance and scope of animal biotechnology. Applications of animal biotechnology.

**Unit 2.** Gene manipulation of animals: Animal viral genome, animal cloning vectors. Gene transfer methods in eukaryotic systems - retroviral vector method, DNA microinjection method, engineered embryonic stem cell method. Selection of clones by using different methods.

**Unit 3.** Transgenic animals: Production of transgenic mice, rabbits, fish, sheep, goat, cattle, pig, etc.

**Unit 4.** Application of animal biotechnology: Transgenic animals as bioreactors- recombinant proteins produced by animal bioreactors. Transgenic animals as models of human diseases. Xenotransplantation. Embryo transfer technologies in cattle and its application.

**Practical:**

Handling of laboratory animals - mice, rabbits etc.

Isolation and purification of DNA from blood samples.

Isolation and enumeration of bacterial population from meat samples.

Development of Cell Lines from Egg Embryo.

Screening of UV mutation in *E. coli*.

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**MCE-405 : Introduction to Food Biotechnology 3 (3-0-0)**

**Unit 1.** Role of microbes in food process, operation and production; new protein foods:- single cell protein, mushroom food yeasts, algal proteins, Nutraceuticals. Enzymes and chemicals used in food processing.

**Unit 2.** Fermentation as a method for preparing and preserving foods. Food additives like coloring, flavors and vitamins.

**Unit 3.** Organism and their use for production of fermented foods and beverages, cheese, sauerkraut, idli, vinegar.

**Unit 4.** Quality control, case studies on Biotechnology in the evolution of food quality. Food spoilage and food borne diseases, food borne infections and intoxications.

**Unit 5.** Post harvest technology and process of food preservation.

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**BCBE 408 : Chemical Thermodynamics 3 (3-0-0)**

**Introduction to Thermodynamics Terms** (System, surrounding, boundaries etc.) open and closed loop systems, isolated systems, thermodynamic variables, extensive and intensive properties.

**Thermodynamic process-** lost thermal, adiabatic process, isobaric, isochoric, cyclic and irreversible processes.

**Laws of thermodynamics-** thermal equilibrium, zero law, first law, second law of thermodynamics, energy concept, law of conservation of energy, concept of enthalpy, entropy.

**Reactive systems,** degree of reaction, reaction equilibrium, laws of mass action, Gibbs functional change heat of reaction, fugacity + reactivity, construction, enthalpy of formation, laws for reaction systems.

Air cycle, Otto cycle, work done in cycles, thermal efficiency.

**Refrigeration-** Introduction to principles of vapors compression cycle.

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**GPB-412 : Genetics 3 (2-0-1)**

**Unit 1.** Cell: Plant cell and animal cell, chromosome structure, cell divisions- mitosis, meiosis, variations in chromosomes; polytene chromosome, lampbrush chromosome.

**Unit 2.** Structural changes in chromosomes: Deletions and duplications, translocation and inversion. Numerical changes in chromosomes.

**Unit 3.** History: Pre-mendelian and post-mendelian concepts of heredity, mendelian principles of heredity, dominance relationship, gene interaction.

**Unit 4.** Linkage and crossing over mechanisms, multiple alleles, pleiotropism and pseudoalleles. Sex determination and sex linkage, sex limited and sex influenced traits.

**Unit 5.** Chemical basis of heredity, mode of replication of genetic material transcription and translation mechanisms of genetic material. Gene regulation and operon concept.

**Unit 6.** Mutations: Chemical and physical mutagenes, mode of action of mutagenes. Extranuclear inheritance, Polygene and quantitative inheritance.

**Practical:**

- Simple and compound microscope.
- Numericals on monohybrid and dihybrid crosses.
- Numericals on epistatic interactions.
- Practice on mitotic and meiotic cell divisions.
- Numericals on probability.
- Numericals on chi-square.
- Coefficient of coincidence.
- Coefficient of interference.
- Sex linked inheritance.

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**ENV-416 : Environmental Studies-II**

**2 (2-0-0)**

Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems.

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

Role of an individual in conservation of natural resources.- Equitable use of resources for sustainable lifestyles. Biodiversity and its conservation- Introduction- Definition: genetic, species and ecosystem diversity.

Biogeographical classification of India- Value of biodiversity: consumptive use, productive use, social, ethical aesthetic and option values

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

Environmental Pollution- Definition-Causes, effects and control measures of: Air pollution- Water pollution- Soil pollution-Marine pollution- Noise pollution- Thermal pollution- Nuclear pollution. Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

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## SEMESTER - V

### BCBE-402 : Basic Proteomics

2 (2-0-0)

Introduction, birth of large scale biology, the genome transcriptome and proteome, functional genomics at the DNA and RNA levels, transcriptomics, large-scale mutagenesis, RNA interference, the need for proteomics, the scope of proteomics, sequence and structural proteomics, Expression proteomics, interaction proteomics, functional proteomics, the challenges of proteomics.

Strategies of protein separation, protein separation in proteomics-general principles, principles of two dimensional gel electrophoresis, general principles of protein separation by electrophoresis, separation according to charge but not mass-isoelectric focusing, separation according to mass but not charge-SDS-PAGE, two dimensional gel electrophoresis proteomics, principles of liquid chromatography in proteomics.

Protein expression mapping, protein expression mapping in mammalian systems, microbial system and plat system, quantitative protein expression mapping by metabolic labeling of proteins with radioactive amino acids metabolic labeling of proteins with stable isotopes, *in vitro* labeling of proteins using isotopes-coded affinity tags.

Current status of and future of proteomics in health and care, plant biochemistry and animal biochemistry.

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### BCBE-405 : Basic Immunology

3 (2-0-1)

**Basic terminology:** Infection, pathogen, antigen, antibody, bacterial and viral antigens, haptens, adjuvants, immunogens interferons, epitopes, paratopes, lymphokines.

**Specific and non-specific immune response:** Cellular basis of immunity, humoral and cell mediated immunity, biochemistry of immunoglobulins (structure, types, property and function).

**Cells of immune system:** cells involved in adaptive immune response i.e., B and T cells, cells involved in innate immune response- macrophages, dendritic cells, phagocytes, mast cells granulocytes, etc.

**Organs of immune system:** primary lymphoid and secondary lymphoid organs, their structure and function. Major Histo Compatibility complex (MHC class I and class II), their structure and function. Chemistry of antigen-antibody interactions, precipitation and agglutination.

**Structure of T-cell receptors** and their comparison with analogous antibody molecule. Natural Killer cell, Their structure and function. Superantigens and Antibody dependent cell mediated cytotoxicity (ADCC).

**Immunodeficiency diseases:** Primary B and T cell deficiency diseases, Autoimmunity, Hypersensitivity. Principles of RIA, ELISA and immunoelectrophoresis (Rocket immunoelectrophoresis), use of monoclonal antibodies in immunodiagnosis and immunotherapy.

#### Practical:

To prepare blood smear.

Separation of serum and plasma from blood.

Qualitative tests of important constituents of plasma and serum.

Separation of plasma proteins (i.e., Fibrinogen, globulin, and albumin).

Determination of E.S.R. of any blood sample.

Preparation of antigen from blood.

Determination of the blood group.

Determination of the haematocrit value of the blood sample.  
Use of widal kit for rapid quantitative slide test.  
Determination of density of blood.  
Determination of bleeding and clotting time of blood.  
Preparation of haematin crystals.

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### **BCBE-501 : Biochemical Engineering**

**3 (2-0-1)**

**Biochemical Engineering:** Bioreactors definition, classification of chemical reactors, residence time, bioreactors design and their functions, types of bioreactors. Application of bioreactors in bio-fertilizer production, alcohol production, antibiotic production, plant cell culture, animal cell culture, waste management.

**Control of bioprocess parameters** in bioreactors, temperature, pressure, oxygen supply, agitation, nutritional, on/off control, PID control, control of heating of bioreactors, flow measurement control, chemical and electrical methods of foam control, off-line control parameters (measurement of properties analysis of cell population and composition), use of computer technology in bioprocess control system.

**Engineering principles:** Transport phenomenon in bioprocess, mass transfer principles, mass transfer coefficient in gasses and liquids, heat transfer principles, coefficient of heat transfer, applied enzyme catalysis, biomass production in cell cultures.

**Upstream and downstream processing:** Media formulation, sterilization of equipments, gas compressor types and principles of compression, air filtration, solid and liquid handling. Industrially fermented broth (filtration and ultra-filtration), centrifugation, solvent extraction, chromatographic separation, liquid extraction of biopolymers and antibiotics ion exchange recovery of antibiotics and proteins.

**Practical:**

- To estimate dimensionless mixing time in a batch reactor.
  - To study the pH control system of bioreactor.
  - To understand the functioning of bioreactor and to carry out its blank sterilization.
  - To study the operation of a bioreactor.
  - To study the dissolved oxygen in bioreactor.
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### **CBBI-501 : Applications of Bioinformatics**

**3 (2-0-1)**

**Bioinformatics and Internet:** Introduction to Bioinformatics, Internet Basics, TCP/IP, FTP, www, Browsers, Internet resources.

**The NCBI data model:** Introduction, Databases and tools on NCBI, Entrez, Seq-id, collection of sequences, annotation of sequences.

**Biological Database:** Protein sequence databases, primary, secondary, composite and structural databases, Nucleotide databases- GenBank, EMBL, DDBJ, Literature databases.

**Sequence Alignment And Database Searching:** Methods, types, FASTA, BLAST programs and other tools.

**Multiple Sequence Alignment:** Introduction, methods, applications, ClustalW and COBALT programs.

**Phylogenetic Analysis:** Fundamental of Phylogenetic model, Dendrogram, cladogram, phylogram, phylogenetic analysis methods, Tree interpretation, Tree building and tree evaluation, Phylogenetic analysis software.

**Structure of Proteins and Nucleic acids:** Introduction, PDB, MMDB, Structure file format, visualizing structure information, tools, Advanced structure modeling.

**Comparative Genome Analysis:** Introduction, methods, genome analysis and annotation, application.

**Practical:**

Understanding Linux Operating System and Commands.

Introduction to NCBI.

Using Entrez to search Literature Databases.

Retrieving DNA sequence from GenBank and analyzing various formats of the data stored.

Retrieving Protein sequence from GenPept (NCBI) and Expasy.

Analyzing Protein Sequences.

Analyzing DNA sequence.

Sequence alignment using BLAST (Basic Local Alignment Search Tool).

Sequence alignment using FASTA.

Multiple sequence alignment using ClustalW.

Phylogenetic analysis using COBALT

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**DT-501 : Quality and Safety Monitoring in Dairy Industry 3 (2-0-1)**

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of codex alimentarius commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system and their application during milk production and processing. National and international food regulatory standards; BIS, PFA, ICMSF, IDF etc., their role in the formulation of standards for controlling the quality and safety of dairy foods. Rapid assessment of dairy food for microbial and non-microbial contaminants; Enumeration Principles in detection of predominant spoilage organisms and pathogens like indicator organisms, *E. coli*, *Salmonella*, *Shigella*, *Staphylococcus aureus*, *Bacillus cereus* and non microbial contaminants like antibiotic residues, aflatoxin, pesticides other inhibitors etc. from dairy foods and their control measures. Microbial quality of water and environmental hygiene in dairy plant; chlorination of dairy water supply, quality of air. Personnel hygiene, treatment and disposal of waste water and effluents; setting up of a microbiological/ pathogen lab in a dairy plant and its safety concern.

**Practical:** Evaluation of common sanitizing agents used in dairy plants by (a) suspension (b) capacity test. Microbiological tests for assessing equipment and personnel hygiene by swap and rinse methods. Detection of faecal and non- faecal coliforms and faecal streptococci in dairy plant. Detection and enumeration of different pathogenic bacteria in dairy products: *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella* and *Shigella*. Bacteriological analysis of dairy water for : (a) total viable counts (b) coliform counts (MPN). Detection of antibiotic residues, pesticides, aflatoxins and staphylococcal enterotoxins in milk using rapid techniques. Determination of BOD in dairy waste water. Quality evaluation by HACCP in the preparation of dairy products.

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**MCE-501 : Biosafety, Bioethics and IPR in Biotechnology 3 (3-0-0)**

**Unit 1.** The legal and socioeconomic impact of biotechnology, public education of the process of biotechnology involved in generating new forms of life for informed decision making, biosafety regulation and national and international guidelines, r-DNA guidelines, experimental protocol approvals, levels of containment, regulatory bodies in biotechnology, biosafety committee.

**Unit 2.** Ethical issues, moral values on experimental animals, ethical implications of biotechnological products and techniques.

**Unit 3.** Intellectual property rights, WTO, TRIPS, International conventions, patents and copy rights, patent claims, methods of applications of patents.

**Unit 4.** Legal implications, biodiversity and farmers right. Beneficial application and development of research focus to the need of the poor, identification of directions for yield effect in agriculture, aquaculture etc.

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**BCBE-502 : Industrial Biotechnology**

**3 (2-0-1)**

Application of biotechnology in pharmaceutical, food and beverages, leather, paper, textile, detergent and chemical industries.

Biotechnology industry and medicine: Antibiotics, therapeutic applications, developing recombinant proteins for medical and therapeutic use, drug designing, new drug targets and vaccine development- insulin, anti-haemophilic factor, human serum albumin, engineered enzymes.

Food and beverage industry: Xylanase, emulsifiers, high intensity sweetener, edible mushrooms, foods from microbes, role of biotechnology to improve food quality and food production.

Fermentation, cultures of microorganisms, solid or semisolid cultures, batch culture, continuous culture, fedbatch culture. Metabolic pathways in microorganisms, glycolysis or EMP pathways, entner-doudoroff pathways, the pentose phosphate pathways.

**Practical:**

- Estimation of casein protein in milk.
  - Qualitative determination of different constituents of baking powder.
  - Estimation of glucose by anthron method.
  - Determination of vitamin-C in sample.
  - Estimation of lipid.
  - Determination of colour and pigments.
  - Methylene blue reduction test of milk.
- .....

**MBFT-502 : Industrial Microbiology**

**3 (2-0-1)**

- >> Production of aminoacids.
- >> Production of vinegar.
- >> Manufacture of various chemicals: Lactic acid, Citric acid, Ethanol.
- >> Industrial production of therapeutic compounds- penicillin, vitamins, vaccines.
- >> Microbial transformation of steroids.
- >> Production of microbial enzymes.
- >> Microbial deterioration of materials- textile, paper, paint and painted surfaces etc.
- >> Production of Vaccines.
- >> Use of microorganisms in bioassays.

**Practical:**

- Demonstration of fermentor its parts and maintenance.
  - Screening for antibiotic production.
  - Screening for enzyme production.
  - Assay of antibiotics.
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**MAS-531 : Biostatistics**

**3 (2-0-1)**

1. Elementary idea of probability, Normal distribution, Binomial distribution, Poisson distribution.
2. Correlation and regression analysis: Types of correlation- simple, partial and multiple correlation and regression.
3. Tests of significance: t-test, F-test, Chi-square test (2x2) Contingency table.
4. Hypothesis: Testing of Hypothesis, level of significance, confidence level, degree of freedom, acceptance region, rejection region.
5. Analysis of variance: Definition and assumptions one way two way classification (problem based).

**Practical:** Correlation, Regression, Tests of significance, Analysis of variance

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**SEMESTER - VI**

**TE-501 : *In vitro* Culture Techniques in Plants**

**3 (2-0-1)**

**Unit 1.** Introduction to plant tissue culture: Historic view, organization of tissue culture laboratory, aspectic techniques, media formulation, clonal propagation vs tissue culture, totipotency, growth, differentiation and morphogenesis in tissue culture.

**Unit 2.** Types of in vitro cultures: Axillary bud proliferation, Organogenesis, Embryogenesis, organ culture, anther culture, suspension culture.

**Unit 3.** Application of tissue culture techniques: Somaclonal and gametoclinal variation, protoplast fusion and somatic hybridization, haploid and monoploid production, cybridization, preservation of genetic resources, cryopreservation, application of tissue culture for plant improvements, production of secondary metabolites, artificial seeds.

**Practical:**

- Media preparation.
  - Preperation and Sterilization of explants.
  - Callus induction.
  - Initiation and Maintenance of Suspension Culture.
  - Meristem culture.
  - Somatic embryogenesis.
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**BAM-502 : Marketing and Management of Biotechnological Products 3 (3-0-0)**

1. Concept of marketing
  2. Customer Satisfaction and Buyer Behaviour.
  3. Marketing Mix
  4. Analyzing Consumer Markets of Biotechnological products.
  5. Pricing-strategies and methods of pricing of Biotechnological products.
  6. Identifying Markets Segments and Selecting Target Markets for Biotechnological products.
  7. Positioning the Market Offering Through the Product Life Cycle.
  8. Distribution Channel.
  9. Promotion of Biotechnological Products.
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**MCE-502 : Recombinant DNA Technology** **3 (3-0-0)**

**Unit 1.** Biology of cloning vectors: Plasmids, lambda bacteriophage, cosmids, M13 bacteriophage, phagemid, Agrobacterium tumifaciens- binary and cointegration vector strategy.

**Unit 2.** Enzymes used in genetic engineering: Exonucleases, endonucleases - S1 nuclease, restriction endonucleases; ligases, polymerases, reverse transcriptase, terminal deoxy nucleotidyl transferases, kinases, alkaline phosphatase.

**Unit 3.** Principles of recombinant DNA technology: Construction of recombinant DNA, rDNA expression, genomic and complimentary DNA (cDNA) libraries, detecting expression of foreign genes.

**Unit 4.** Application of r-DNA technology: Medicine, industry, agriculture, live stock improvement, environmental protection, etc.

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**BCBE-505 : Plant Biochemistry** **3 (2-0-1)**

**Metabolism of carbohydrates:** metabolism of carbohydrate in plants, plant acids, plant respiration.

**Chloroplast and pigments:** chloroplast morphology, structure and biochemical anatomy of chloroplast, chlorophyll and photosynthetic pigments.

**Photosynthesis:** photosynthesis in plants including bacterial photosynthesis, C3 and C4 pathways, CAM photomorphylation, photosystems, cheiosmotic coupling, etc. photorespiration, relationship between photosynthesis, photorespiration and crop productivity, photoperiodism, photomorphogenesis. Environmental and agricultural aspects of photosynthesis.

**Nitrogen metabolism:** Metabolism on N-compounds in plants (seedlings and leaves), nitrogen cycle, nitrate and nitrite reduction, denitrification, symbiotic and non-symbiotic nitrogen fixation, nitrogen organization, function and regulation, assimilation of fixed nitrogen by plants, nitrification.

**Plant microbe interaction:** Chemo-autotrophy in rhizobia, nitrifying bacteria, metabolism of lipids in plants, phosphorous solubilizing bacteria, biochemical changes in infected plants.

**Plant nutrients:** Biochemical roles of inorganic ions in plants (both macro and micronutrients), symptoms of nutrient deficiency in plants, assimilation of P, S, Ca, their metabolism, stress physiology, uptake of nutrients in stress condition, transport phenomenon in plants.

**Practical:**

Analysis of plants and plant product for various constituents.

Extraction and identification of sugars from plants fruits and vegetables.

Extraction and determination of amino acid and protein.

Determination of lipids, phospholipids, cholesterol in food, fruits and vegetables.

Determination of various plants nutrients.

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**BCBE-506 : Animal Biochemistry** **3 (2-0-1)**

**Biochemistry of Blood and Body fluids-** Biochemical composition of blood groups, path way of blood clotting, physiological function of blood, buffering action of blood, kinds other body fluids and their chemistry.

**Biochemistry of Body tissue-** Connective tissue, collagen, elastin muscle protein, muscle construction,

Biochemistry of Fat in adipose tissue, steroids- structure and biochemical function; Cholesterol- Structure and biochemical synthesis, plasma lipids, transport of lipids, lipo-protein, chylomicrons, VLDL, HDL, LDL, and Lp(a), free fatty acids, non-esterified fatty acids.

Anti-oxidant- Generation of free radicals, damage produced by reactive-oxygen species (ROS), free-radicals, and scavenging enzyme system.

Animal Hormones- Origin, site of action, biochemical mechanism of hormone action, feed-back mechanism of hormonal secretion.

**Practical:**

Identification of blood constituents.

Action of salivary amylase.

Action of digestive enzymes on proteins.

Determination of constituents of milk protein, fat, lactose.

Determination of sugar in urine and blood.

Determination of cholesterol in blood and biological sample.

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**MBFT-507 : Microbial Biotechnology**

**3 (2-0-1)**

History of Microbial Biotechnology.

General Concept of microbial biotechnology.

Principles of exploitation of microorganism, primary and secondary metabolism.

Microbial Production of:

Antibiotics: penicillin, streptomycin; Enzymes: proteases, amylases, lipases; Organic acids: Citric acid acetic acid; Vitamins: Glutamic acid lysine; Alkaloids, Alcohol, beer, wine, sake Polysaccharides; Food and Dairy Products: Single cell protein, Single cell oil, Flavours, Cheese, bread and yogurt.

Mushroom cultivation: Production of mushrooms-production steps, harvesting and preservation and nutritive value.

Microbial production of nucleosides, nucleotides and pigments.

Microbial transformations of antibiotics and steroids.

Bio-fertilizers and bio-pesticides.

Biopolymers and bio-plastics.

**Practical:**

Isolation of industrially and biotechnologically important microorganisms.

Production of SCP.

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**PHA-562 : Pharmaceutics-VII (Biopharmaceutics and Pharmacokinetics) 3 (3-0-0)**

**1. Introduction to biopharmaceutics and Pharmacokinetics** and their role in formulation development and clinical setting.

**2. Biopharmaceutics** [a] Factors influencing absorption- physiochemical, physiological and pharmaceutical. [b] Plasma protein binding.

**3. Pharmacokinetics** [a] Significance of plasma drug concentration measurements. [b] Compartment kinetics- Definition and scope. One compartment and two compartment models. Determination of pharmacokinetic parameters from plasma and urine data after drug administration by intravascular and oral route. [c] Pharmacokinetics of drug absorption- Zero

order and first order absorption rate constant using wagner- Nelson and Loo Reigelman method. [d] Volume of distribution and distribution coefficient. [e] Clearance concept, mechanism of renal clearance, clearance ratio, determination of clearance. [f] Extraction ratio, hepatic clearance, biliary excretion, Entero-hepatic circulation. [g] Non-linear pharmacokinetics with reference to one compartment model after I.V. drug administration, Michaelis Menton Equation, detection of non-linearity (saturation mechanism).

**4. Clinical Pharmacokinetics** [a] Dosage adjustment in patients with and without renal hepatic failure.

**5. Bio-availability and bio-equivalence:** [a] Measures of bioavailability,  $C_{max}$ ,  $T_{max}$  and Area Under the Curve (AUC) [b] Design of single dose bio-equivalence study and relevant statistics.

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### **MCE-601 : Molecular Breeding**

**3 (2-0-1)**

**Unit 1.** Introduction to markers: Different kinds of markers- morphological, biochemical and molecular markers.

**Unit 2.** Molecular marker systems: PCR based approaches- RAPD, SSR, AFLP, AP-PCR; targeted PCR, STS, SCAR; and non-PCR based approach (RFLP).

**Unit 3.** Marker assisted selection (MAS): Development of markers, generation of mapping population, bulk segregate analysis, use of NILS for tagging genes, selection of QTLs for MAS.

**Unit 4.** Molecular markers in plant breeding: Uses of molecular markers- resistance breeding, gene interogression, gene pyramiding, antibiotic resistance, improvement of qualitative characters, fertility restorer genes and hybrid vigour.

#### **Practical:**

Extraction of proteins from plant tissues.

Protein profiling of crop plants by Polyacrylamide gel electrophoresis Study of Labwares used in PCR analysis.

PCR amplification of DNA samples.

Electrophoretic separation of PCR products.

Staining, visualization and scoring of PCR products.

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### **MCE-602 : Genomics**

**3 (3-0-0)**

**Unit 1.** Introduction: Basic concepts of genomics. Structural and functional genomics. Proteomics, transcriptomics, metabolomics and phenomics.

**Unit 2.** Genome: Physico-chemical properties of genome, genome size and sequence components, gene structure and higher order genome organization.

**Unit 3.** Genome analysis: DNA sequencing, DNA Micro array, gene finding, genome databases and data mining. Structural, functional and comparative genomics.

**Unit 4.** Genome mapping: Basic concepts, model organisms, genome projects, genetic and linkage map, cytogenetic maps, physical maps, comparative genome mapping.

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## SEMESTER - VII

### MCE-503 : Fundamentals of Nanotechnology

3 (3-0-0)

**Unit 1.** Introduction: Overview, history and background, importance of nanotechnology in modern science.

**Unit 2.** Analyzing tools: Overview of modern microscopic tools like SEM, TEM, STM, AFM, Confocal Microscopy. Overview of types of Spectroscopies like UV-Vis, IR, Raman spectroscopy. X-Ray Crystallography.

**Unit 3.** Nanomaterial Synthesis: Basic physics and chemistry of nanomaterials. Types of synthetic routes, Top-down and Bottom-up techniques.

**Unit 4.** Nanomaterial Applications: Application of nanomaterials in the field of electronics, composites, catalysis, ceramics. Uses in biosensors, drug delivery, gene therapy.

**Unit 5.** Safety aspects: Nanoparticle related Health and safety issues, ethical, legal and social implications, environmental issues.

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### PHA-574 : Pharmaceutical Biotechnology

4 (4-0-0)

**1. Immunology and Immunological preparations:** Principles, antigens and haptens, immune system, cellular humoral immunity, immunological tolerance, antigen-antibody reactions and their application. Hypersensitivity, Active and Passive immunization; Vaccines- their preparation, standardization and storage.

**2. Genetic Recombination:** Transformation, conjugation, transduction, protoplast fusion and gene cloning and their applications. Development of hybridoma for monoclonal antibodies. Study of drugs produced by biotechnology such as activase, humulin, and humatrope, HB etc.

**3. Antibiotics:** Historical development of antibiotics. Antimicrobial spectrum and methods for their standardization. Screening of soil for organisms producing antibiotics, fermenter, its design, and control of different parameters. Isolation of mutants, factors influencing rate of mutation. Design of fermentation process. Isolation of fermentation products with special reference to penicillins, streptomycins, tetracyclines and vitamin B12.

**4. Microbial transformation:** Introduction, types of reactions mediated by microorganisms, design of biotransformation process and its improvements with special reference to steroids.

**5. Enzyme Immobilization:** Techniques of immobilization, factors affecting enzyme kinetics. Study of enzymes such as: hyaluronidase, penicillinase, streptokinase and streptodornase, amylases and proteases etc. Immobilization of bacteria and plant cells.

**6. Blood products and plasma substitutes:** Collection, processing and storage of whole human blood, concentrated human RBCs, dried human plasma, human fibrinogen, human thrombin, human normal immunoglobulin, human fibrin, foam plasma substitutes- ideal requirements, PVP, Dextran etc. for control of blood pressure as per I.P.

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### MCE-603 : Genetically Modified Foods

3 (3-0-0)

**Unit 1.** Introduction to GM foods: History and development of GM food/ crops. Currently existing GM foods/ crops.

**Unit 2.** Cultivation of GM crops: Growing of GM food crops. Countries cultivating GM food crops.

**Unit 3.** Debate on GM foods around the world. Criticisms against GM foods. Biosafety concerns and regulators of GM foods. GM food criteria in India. GM food labelling and GM labelling. Consumer acceptance and market forces.

**Unit 4.** Economical and political effects of GM foods. Future developments.

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**MCE-604 : Gene Cloning and Gene Therapy      3 (2-0-1)**

**Unit 1.** Gene cloning: Introduction to gene cloning, basic events of gene cloning, selection strategies for a clone of a specific gene.

**Unit 2.** Expression of cloned gene: Expression of cloned genes in cultured cells, production of proteins from cloned genes, production of recombinant pharmaceuticals - insulin, human growth hormone, hepatitis B virus vaccine, tissue plasminogen activator (tPA).

**Unit 3.** Gene therapy: Introduction and approaches to gene therapy. Types of gene therapy - germline gene therapy, somatic cell gene therapy, augmentation therapy, *ex vivo* gene therapy, *in vivo* gene therapy. Viral gene delivery systems - retrovirus and adenovirus vector systems.

**Unit 4.** Applications of gene therapy: Correction of gene defects and disorders, Cystic fibrosis, Human adenosine deaminase deficiency, Duchenne muscular dystrophy. Ethical issues raised by gene therapy.

**Practical:**

Preparation of Buffers for Genomic and Plasmid DNA Isolation of Bacterial Genomic DNA.

Estimation of DNA by Diphenylamine Method.

Restriction Digestion of  $\lambda$  DNA with Eco R1 Restriction Enzyme Ligation of  $\lambda$  Eco R1 Digest using T4 DNA Ligase.

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**MBFT-605 : Microbial Technology in Food Industry      3 (2-0-1)**

>> Food as a substrate for microorganisms.

>> Primary Sources of Microorganisms in Foods.

>> General principles underlying spoilage of foods and different methods of preservation of foods.

>> Starter Cultures.

>> Fermented milk product and other food: types, production and defects.

>> Fermented beverages: Brewing, malting, mashing, hops and primary and secondary fermentation.

>> New protein foods - SCP, mushroom, food yeasts, algal proteins.

>> Quality and safety assurance in food and dairy industry.

**Practical:**

Familiarity with bacteria and fungi important in food industry.

Evaluation of milk sample by Direct Microscopic Count.

Starter Activity test.

Microbiological analysis of Dahi.

Isolation and identification of microorganisms involved in food spoilage (vegetable, fruit).

Enumeration of microorganisms in different food products (fruit juice, sugar etc).

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**History of drug discovery and Molecular biology for drug:** Early and recent history of drug discovery, enzymes/receptor as drug target. molecular biology for drug discovery (recombinant proteins and monoclonal antibodies as drug). Molecular basis of disease processes. Target identification and validation.

**Organic synthesis for drug discovery:** Target oriented organic synthesis and retro synthetic analysis. diversity oriented organic synthesis and evolving synthetic analysis, solid phase synthesis for drug discovery (parallel is split pool strategy) combinatorial chemistry and high through put screening (HTS).

**Combinatorial chemistry for drug discovery:** Combinatorial biocatalysis for drug discovery, synthesis of Bergen in derivatives. Drug discovery in cancer research/new target based drugs in clinical trials.

**Introduction of pharmacogenomics:** Microbial genomics for new antibiotics, immunotoxin drug (e.g., Ricin, a plant toxin). Drug designing for blocking enzyme activity through blocking hormones receptor through inhibition of nucleic acid synthesis against heterogenous target.

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The nature of microorganisms and their role in causing diseases.

Antibiotics and Synthetic antimicrobial agents: Types of antibiotics and antimicrobial agents, Mechanism of action, microbial resistance, therapeutic, prophylactic usage and adverse reactions, Antibiotic and Synthetic antimicrobial agents:  $\beta$ -lactam, aminoglycosides, tetracyclines, ansamycins, macrolides, Antifungal antibiotics: Griseofulvin, Antiviral drugs: Amantidines, Nucleoside analogues, Interferons, Peptide antibiotics, Synthetic antibiotics: Sulphonamides, Chloramphenicol, Quinolone.

Microbial aspects of pharmaceutical products: Microbial contamination (atmosphere, water, operator, raw material, packaging, buildings, equipments), Microbial spoilage (Types and factors affecting) and preservation, Sterilization of pharmaceuticals (survivor curve, D, Z, F value), Methods: Heat, Gaseous, Radiation, Filtration, Disinfectants and validation: Quality control in pharmaceuticals: In-process and final product control, Sterilization control: physical, chemical and biological indicators, Sterility testing (sampling and methods), Good Manufacturing Practices, Regulatory aspects for Quality Control.

**Practical:**

Sterilizing techniques and their validation.

Evaluation of antiseptics and disinfectants.

Testing the sterility of pharmaceutical products as per IP requirements.

Microbial assay of antibiotics.

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