

**Course Structure and Syllabus for
M. Sc. (Ag) Biochemistry
(For Agriculture Background students)**

Semester: I				
S.No	Course Code	Course Title	Credits	(L-T-P)
1.	BCBE 706	Techniques in Biochemistry and Instrumentation	3 (2-0-1)	(2-0-2)
2.	BCBE 708	General Biochemistry	3 (2-0-1)	(2-0-2)
3.	BCBE 709	Animal Biochemistry	3 (2-0-1)	(2-0-2)
4.	MAS 511	Statistical Methods	3 (2-0-1)	(2-0-2)
5.	MCE-717	Molecular Biology	3 (2-0-1)	(2-0-2)
6.	* LNG 502	Technical Writing and Communication Skills	1(0-0-1)	(0-0-2)
7.	* BCBE 511	Basic Concepts in Laboratory Techniques	1(0-0-1)	(0-0-2)
8.	* MLS 501	Library and Information Services	1(0-0-1)	(0-0-2)
Total Credits				18

Semester: II				
S.No	Course Code	Course Title	Credits	(L-T-P)
1.	BCBE 702	Intermediary Metabolism I	3 (2-0-1)	(2-0-2)
2.	BCBE 813	Enzymology	3 (2-0-1)	(2-0-2)
3.	BCBE 811	Biochemistry of Food grains, fruits and vegetables	3 (2-0-1)	(2-0-2)
4.	MAS 815	Experimental Design	3 (2-0-1)	(2-0-2)
5.	MCE 821	Plant Tissue Culture Technology	3 (2-0-1)	(2-0-2)
6.	* AEAB 503	Intellectual Property and its Management in Agriculture	1(0-0-1)	(1-0-0)
7.	* AEAB 505	Agricultural Research, Ethics and Rural Development Program	1 (0-0-1)	(1-0-0)
8.	BCBE 780	Seminar 1	1 (0-0-1)	(0-0-2)
9.	BCBE 899	Dissertation	2	(0-0-4)
Total Credits				20

Semester: III				
S.No	Course Code	Course Title	Credits	(L-T-P)
1.	BCBE 705	Intermediary metabolism II	3 (3-0-0)	(3-0-0)
2.	BCBE 710	Environmental Biochemistry	2 (2-0-0)	(2-0-0)
3.	BCBE 803	Plant Biochemistry	3 (2-0-1)	(2-0-2)
4.	BCBE 808	Inorganic Nitrogen Metabolism	2 (2-0-0)	(2-0-0)
5.	BCBE 810	Biochemistry of Biotic & Abiotic Stress	2 (2-0-0)	(2-0-0)
6.	BCBE 880	Seminar II	1(0-0-1)	(0-0-2)
7.	CBBI 815	Agroinformatics	3 (2-0-0)	(2-0-2)
8.	MCE 802	Plant Biotechnology	3 (2-0-0)	(2-0-2)
9.	* ENV 506	Disaster Management (e-course)	1 (0-0-1)	(0-0-2)
10.	BCBE 899	Dissertation	6	(0-0-12)
Total Credits				26

Semester: IV				
S.No	Course Code	Course Title	Credits	(L-T-P)
1	BCBE 899	Dissertation	22	(0-0-44)
Total Credits			86	

Semester: I

BCBE 706 Techniques in Biochemistry and Instrumentation 3 (2-0-1)

Centrifugation Techniques: Differential, zonal and density gradient, ultra, types of centrifuges and applications.

Chromatography: Adsorption, partition, exclusion, ion exchange, affinity, H.P.L.C., G.L.C., column.

Electrophoresis: Principles and applications, paper, gel, S.D.S., P.A.G.E., P.F.G.E., Isoelectric focusing.

Molecular Biology Techniques: Isolation and purification of DNA, RNA, plasmid DNA, sequencing of proteins and nucleic acids, chemical synthesis of nucleotides, competent cell preparation and transformation, DNA foot printing, DNA fingerprinting, PCR.

Immunological Techniques: RIA, ELISA, flow cytometry.

Radio isotopic and tracer techniques: Detection and measurement of isotopes (GM and scintillation counters), autoradiography.

Biosensors: Types and uses.

Practical:

Determination of pH using indicators.

The separation of amino acids by paper electrophoresis.

The validity of Beer's law for the colorimetric estimation of creatinin.

Total chlorophyll estimation from the plant sample.

Protein estimation- A. Biuret method, B. Lowry's method.

Estimation of nucleic acid by electrophoresis.

BCBE 708 General Biochemistry 3 (2-0-1)

Scope and importance of biochemistry in agriculture; fundamental principles governing life. structural and functional origination of prokaryotic and Eukaryotic cells; Cell organelles their functions and fractionations

Proteins: amino acid and peptides, Primary, secondary, tertiary and quaternary structures, structure function and evolutionary relationships, protein folding; allosteric proteins.

Carbohydrates: monosaccharide, oligosaccharide, polysaccharide, proteoglycans, and glycoproteins;

Lipids: fatty acids, acylglycerol, phospholipids, sphingolipids, cholesterol, and membranes; isoprenoids, eicosanoids, and their biological importance.

Nucleic acids: bases, nucleotides, RNA and DNA; Different structural forms of DNA; denaturation, renaturation, and hybridization of DNA; different types of RNA;

Definition, Classification, structures and functions of Vitamin, deficiency disorder

Membranes- Transport phenomenon: bio-membranes, diffusion- passive and facilitated and active transport processes. Mechanism of ATP synthase and its regulation, malate aspartate shuttle.

Practical:

Preparation of buffers,

Nitrogen estimation by different methods,

Separation of amino acids by TLC,

Estimation of reducing and non-reducing sugars,

Estimation of oil, iodine value,

Saponification value and acid value, estimation of ascorbic acid,

Estimation of riboflavin and thiamine.

BCBE 709 Animal Biochemistry 3 (2-0-1)

Concepts of Blood and Body fluids-Biochemical composition of blood groups, blood clotting, physiological function of blood, buffering action of blood, kinds other body fluids.

Concepts of respiratory and excretory systems physiology.

Metabolism of foreign compounds, Water and electrolytes.

Gastrointestinal physiology-Digestion of food ruminants and non-ruminants absorption of food, biochemical role of liver, bile acids and bile salt.

Introduction to Immunology: Basics terminology- Antigen, Antibody, Lymphokines, Cytokines, Hapten, Adjuvants, Immunogen, Pathogen, Epitope and paratopes; Humoral and cell mediated immunity, cells of adaptive immune response, Types of immunoglobulin, general information of vaccines .

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

Chemical Composition and Nutritional Value of Feed and Fodder, Microbial changes during preparation Hays, Silage *ect*.

Practical:

Separation of plasma and serum.

Determination of haematocrit value of blood.

Calculation of density of blood.

Determination of bleeding and clotting time of human blood.

Determination of blood typing.

Determination of hemoglobin.

Preparation of human blood film and study of different type of cells.

Determination of glucose in sample.

Determination of cholesterol in sample.

MAS 511

Statistical Method

3(2-0-2)

Statistic, population parameter, frequency distribution frequency polygon, histogram, bar chart Arithmetic Weighted geometric and harmonic mean mode, median for grouped and ungrouped data, standard deviation, mean deviation and coefficient of variation, simple and multiple correlation coefficient, regression line, fitting equations to data by least square method, curve linear regression line, fitting equation to data by least square method. Test of significance, t, F, χ^2 test Distribution: Normal, Binomial and Poisson distribution, confidence interval Analysis of Variance; Definition, assumption, one way and two way classification with one per cell, probability theory.

Reference Books:

1. Introductory Statistics - P.S. Mann
2. Fundamental of Mathematical Statistics- Gupta to Kapoor
3. Fundamental of Mathematical Statistics – Gun Gupta & Das Gupta.

MCE 717

Molecular Biology

3(3-0-0)

Structure of DNA and RNA: Replication, transcription and translation. Post-transcriptional and translational modifications. Transcriptional and translation control of prokaryotes and eukaryotes.

Features of genetic code in prokaryotes and eukaryotes.

Gene expression: operon model, induction and repression, control of gene expression in prokaryotes and eukaryotes.Chloroplast and mitochondrial genomes.

Replication of viruses: Mutagens, oncogenes and carcinogenesis.

General principles of recombinant DNA technology, restriction enzymes. Methods of gene transfer- plasmid and viruses as vectors. Methods for the development of transgenic organisms.

DNA and protein sequence analysis, oligonucleotide synthesis, genomic and cDNA library construction, site-directed mutagenesis, transposon tagging, chromosome walking. Basis of genome organization and mapping, functional genomics. Gene silencing.

Semester: II

BCBE 702

Intermediary Metabolism I

3 (2-0-1)

Bioenergetics: Energy & its- transformation in living systems ; Thermodynamic principles; concept of free energy changes in biochemical reactions, Electro-chemical gradient, energy rich compounds. Introduction to metabolism: methods to study metabolism.

Carbohydrate metabolism: Introduction to digestion and absorption of carbohydrates. Catabolism of carbohydrates: Glycogenolysis, glycolysis, fermentation. TCA, ETS, Energy aspects, HMPS. Anabolism: Biosynthesis of structural polysaccharide. Eg.- peptidoglycon, chitin. Anabolic role of TCA cycle (anapleurotic reactions), gluconeogenesis, glycogenesis, glyoxalate cycle, regulation of carbohydrate metabolism.

Lipid metabolism: Introduction to digestion and absorption, oxidation and biosynthesis of fatty acids. Phospholipids: energy aspects, importance and regulation Biosynthesis of biologically important lipids: biosynthesis of sterols, glycolipids, prostaglandins, prostacyclins, and thromboxins. Energy aspects, regulation and importance.

Oxidative phosphorylation, introduction to electron transport, chain structure localization. Components, oxidative phosphorylation, ATP formation.

Practical:

Determination of lactic acid from milk.

Estimation of total carbohydrates from potato by anthrone method.

Extraction of glycogen from liver.

Extraction of starch from potato.

Determination of citric acid from citrus fruits.

Determination of lactose from milk.

Determination of fat in milk.

Determination of acid value/peroxidation/ saponification no. of fats.

Separation of carbohydrate lipid by TLC.

BCBE 811 Biochemistry of Food grains, fruits and vegetables 3 (2-0-1)

Fundamentals of Nutrition: Importance of fruits & vegetables in human diet, Nutritional Quality of Protein & its Evaluation.

Dietary Fiber. Vitamins-Biochemical Functions & Deficiency Diseases, Fats and Lipids-Types of Fatty Acids and their Significance in Health. Biochemical Composition and Food Value of Fruits & Vegetables, Effects of enzyme action on packing, additive and preservatives. Biochemistry of fruit ripening, Biochemical Aspects of Post Harvest Technology, Storage & Preservation. Biochemical basis of quality improvements of food Grains-Fruits & Vegetables; Nutraceuticals. Food toxins and Anti-metabolites, Food Additives, Storage Proteins.

Biochemistry of Food-grains, Fruits and Vegetables Fundamentals of nutrition, concept of balanced diet. Nutritional quality of protein and its evaluation. Dietary fiber.

Vitamins-biochemical functions and deficiency diseases. Fats and lipids-types of fatty acids and their significance in health.

Biochemical composition and food value of various food grains (including cereals, pulses, oil seeds), fruits and vegetables. Biochemistry of fruit ripening, Sucrose- Starch Interaction

Biochemical aspects of post-harvest technology, storage and preservation. Biochemical basis of quality improvement of food grains, vegetables and fruits, Biochemical Changes in seeds during germination and Storage

Antioxidants, nutraceuticals. Food toxins and anti-metabolites, food additives, storage proteins

Practical:

- Estimation of protein content.
- Estimation of limiting amino acids
- Estimation of starch
- Estimation of lipids/oil content
- Estimation of phenolics
- Phytates and oxalates in leafy vegetables
- Estimation of carotenoids
- Estimation of dietary fiber
- Trypsin and chymotrypsin inhibitor activities
- Estimation of vitamin C in fruits.

BCBE 813

Enzymology

3 (2-0-1)

Reducing and non-reducing sugars in fruits.

Introduction of enzymes: General properties and significance, classification and nomenclature. Terms and definition in enzymology, co-factors, coenzymes, active site concept, isoenzymes, allosteric enzymes, marker enzymes, multienzyme complex, ribozyme, abzyme, synzyme, extremozyme, therapeutic enzymes and immobilized enzymes etc.

Enzyme kinetics: steady rate kinetics, Derivation of Michaelis-menten equation using steady state/equilibrium kinetics, plots of lineweaver- Bruke, Hanes, Eadie- Hofster etc. Mechanism of bisubstrate and multisubstrate enzyme catalyzed reaction, Enzyme inhibitors, mechanism of enzyme action-lysozyme, chymotrypsin, alcohol DH.

Regulation of enzyme activity: Covalent modification, allosteric model concerted and sequential, cooperativity. Feedback inhibition.

Enzyme Technology: Commercial production of enzymes, immobilization of enzymes, example of enzyme engineering, application of enzyme(therapeutic uses, analytical uses, manipulated uses *etc.*), uses of enzyme reactors.

Isolation, purification and localization of enzymes. Various methods to estimate the enzyme activity.

Practical:

Effect of temperature, pH, substrate concentration and enzyme concentration and enzyme concentration on enzyme activity.

Action of salivary amylase on starch.

Determination of acid posphatase activity in sample.

Determination of alkaline phosphatase activity in sample.

Determination of SGOT in serum.

Determination of SGPT in serum.

Determination of urease in plant sample.

Assay of protein by Lowry method.

Assay of catalase in vegetables.

Hydrolysis of egg protein by pepsin.

Analysis of variance technique: Definition & assumptions, One way classification, Two way classification with more than one observation per cell.

Designs of Experiment: Principles of Experimental Design, Randomized Block Design (R.B.D), Latin Square Designs (L.S.D), CRD, Missing Plot Technique in R.B.D & L.S.D. Critical-difference (C.D), Split plot design.

Factorial Experiments: 2^2 , 2^3 , 3^2 , & 3^3 , factorial-designs. (Yates method of Analysis), 2×3 & 2×4 factorials. Durcan's Multiple Range Test. Newman's Kuel's Test

Sampling Techniques : Simple Random Sampling, Stratified Random Sampling & Systematic Sampling.

Reference Book:

1. Fundamentals of Applied Statistics (Volume II):-Gupta & Kapoor
2. Agricultural Statistics: S.R.S Chandel

MCE 821 Plant Tissue Culture Technology 3(2-0-1)

Unit 1: Introduction to plant tissue culture: Historical developments and landmarks in Plant Tissue Culture. Organization of tissue culture laboratory, aseptic techniques, media formulation, clonal propagation vs tissue culture, Totipotency: growth, differentiation and morphogenesis in tissue culture.

Unit 2: Micropropagation: Concept, various stages, organogenesis and somatic embryogenesis. Meristem culture: Meristem culture for mass and clonal propagation, production of pathogen free plants, application in forestry.

Unit 3: Somatic hybridization: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, identification and characterization of somatic hybrids /cybrids, its applications.

Unit 4: Secondary metabolites: Production of secondary metabolites by plant cell culture, hairy root culture, and biotransformation.

Unit 5: Cell Lines: Cell line selection for resistance to herbicide, stress, insect and diseases

Unit 6: Haploid culture: Tissue culture methods for haploid production and its applications

Practicals:

Media preparation

Explant selection, sterilization and inoculation

Callus and cell suspension culture: Induction and growth parameters

Androgenesis: Anther and Pollen culture

Plant regeneration from embryo, meristem and callus culture

Synthetic seed preparation

Semester: III

BCBE 705 Intermediary metabolism II 3 (3-0-0)

Amino acid catabolism: introduction to digestion and absorption, amino acid degradation pathways and their mode of degradation- Transamination, oxidative deamination, deamination and importance. Urea cycle, formation of excretory products, linking to TCA cycle and regulation.

Amino acid biosynthesis: overview, biosynthesis of essential amino acids- tryptophan, tyrosine, valine, lysine.

Biosynthesis of non-essential amino acids: glycine, serine, cystine, threonine, phenylalanine, histidine, praline, arginine.

Purine & Pyrimidine nucleotide metabolism: introduction, *denovo* and salvage pathways of purine and pyrimidine nucleotide biosynthesis. Catabolism of purine and pyrimidine nucleotides. Biosynthesis of nucleotide coenzymes.

Practical:

Parametric analysis of section of protein-dye.
Determination of protein from milk.
Fractionation of egg proteins.
Quantification of serum proteins by honey method.
Estimation of protein from leaf tissue.
Isolation of DNA from plant /bacterial sample.
Quantification of DNA.
Isolation of RNA from bacterial/ plant tissue.

BCBE 710**Environmental Biochemistry****2 (2-0-0)**

Introduction to environmental biochemistry; Environment-Waste:- Agro waste; industrial effluents, Sugar industry, Distillers, Paper industry,
Environmental carcinogen; Global Environmental problems: Ozone Depletion, UV-B, Green House Gases and Biochemical Issues-Toxicant Effects on Cellular Organismic –PCDs.
Pesticide interactions-Host plant Resistance and Biological Control. Principles of pesticide metabolism, mode of action and uses of the main pesticides: insecticides, fungicides, herbicides.
Microbial degradation of pesticide in soil. Species differences and other phenomena associated with the metabolism of pesticides; Environmental risk assessment; Insecticide resistance.
Xenobiotics in environment: Decay Behavior, Degradation of Plasmids, Hydrocarbons, Substituted Hydrocarbons, Oil Pollution- Surfactants; Bioremediation of Xenobiotics: Environmental cleanup, Biomass Utilization, Microbial Degradation of Xenobiotics.

BCBE 803**Plant Biochemistry****3 (2-0-1)**

Photosynthesis: significance of photosynthesis, ultra structure of chloroplast, photosynthetic pigments. Light absorption phenomenon, Photosynthesis in C₃ and electron transport, photophosphorylation: photo respiration, CAM.
Bacterial Photosynthesis, photochemistry and electron transport and CO₂ fixation.
Nitrogen metabolism: Metabolism of N-compounds in plants, biological nitrogen cycle, nitrogenase structure and function, nitrate reduction, nitrification, denitrification, symbiotic and non-symbiotic nitrogen fixation, function and regulation, Assimilation of fixed nitrogen by plants.
Plant Hormones: Definition of phyto hormones, Auxins, biochemistry and mode of action of Auxins, Gibberellin, Cytokinins and other natural growth hormones in plants (ethylene, abscissic acid) Signaling Pathways, Phytochrome .
Plant disease and defense mechanism: Biochemistry of bacterial and viral and fungal diseases, Micro and Macro nutrients deficiency in plants. (Biochemical role of inorganic ions in plants).
Secondary metabolism in plants: Phenolic metabolism shikimate, and phenyl propanoid pathways, flavonoids, lignins, and anthocyanins. Isoprenoid metabolism, terpenoids and carotenoids, alkaloids, cyanogenic glycosides and non protein amino acids.

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.

BCBE 808 **Inorganic Nitrogen Metabolism** **2 (2-0-0)**
Biochemistry of nitrogen cycle. Biological nitrogen fixation; Structure, function and regulation of nitrogenase; Structure, function and regulation of *nif* genes in *Klebsiella pneumoniae* and *Clostridium*.
Biochemical basis of legume-Rhizobium symbiosis; Genes involved in symbiosis. Different types of hydrogenases and role of uptake hydrogenase in N - fixation; Chemoautotrophy in rhizobia. Biochemistry of ferredoxin and other non-haem iron proteins.
Biochemistry of nitrate assimilation and mechanism of its regulation; GS/GOGAT and GDH pathways; Ureides and amides as nitrogen transport compounds.
Biochemistry of denitrification process and phosphorylation in denitrifying bacteria. Path of carbon assimilation in nitrifying bacteria.

BCBE 810 **Biochemistry of Biotic & Abiotic stress** **2 (2-0-0)**
Plant- pathogen interaction and disease development, changes in metabolism of cell wall composition and vascular transport in diseased plants, Expression, structure and activity of gene products caused by genetic mutation, epigenetic phenomena and environmental agents leading to diseases.
Plant defense response, antimicrobial molecules, hypersensitive response and cell death, systemic and acquired resistance, pathogen derived resistance, antipathogenic principles.
Plant viruses, host virus interactions, disease induction, virus movement and host range determination; viroids.
Biochemical basis of abiotic stresses namely: drought, salinity, temperature, heavy metals, and water pollutants, synthesis and function of proline and glycine betaine, stress tolerance, stress adaptation, interaction between biotic and abiotic stresses.
Reactive oxygen species, antioxidants, enzymes of defense system. Molecular strategies for imparting tolerance against biotic and abiotic stresses.

MCE 802 **Plant Biotechnology** **3(2-0-1)**
Unit 1: Plant genome, nuclear genome, chloroplast genome and mitochondrial genome.
Unit 2: Genetic engineering in plants: Biology of agrobacterium tumefaciens, techniques of transferring agronomically important genes using Ti plasmid, protoplast fusion method; methods of direct gene transfer; transfer and expression of cloned DNA in plant cells.
Unit 3: Improving nutritional value of seed storage protein, application of biotechnology in crop improvement, genetic engineering of plants for delay of fruit ripening, herbicides tolerance, and salt resistance; virus and pest resistance, role of monoclonal antibodies in agriculture.
Unit 4: Biofertilizers, classification of biofertilizers and importance of Biofertilizers, *nif* genes; algal bio fertilizer, Azolla bio-fertilizer, vesicular and arbuscular mycorrhizae.
Unit 5: Biological control, types of biological control, biocontrol agents, microorganisms, viruses, protozoans, production of microbial insecticides.
Practicals:
Study of Pipetman use and pipetting techniques
Study of labware used for DNA isolation and PCR
Sterilization of glassware, labware and double distilled water for PCR analysis.
Preparation of buffers, reagents and media required for PCR and analysis and its sterilization.
Isolation of plant Genomic DNA using CTAB method and purification of DNA samples.

Quantitative analysis of purified DNA samples through spectrophotometer.
Amplification of DNA samples using Polymerase Chain Reaction, analysis of amplicons, scoring and data analysis.

CBBI-815

Agroinformatics

3(2-0-2)

Introduction to Bioinformatics, background of bioinformatics. Information network - Internet, web Browser and address (NCBI, EBI etc). Introduction to Agroinformatics, Indian and International Scenario, Intelligent Technology in Agroinformatics, Organic Farming and Information Technology, Geographical Information System (GIS).

Agriculture Information Sources, Scientific Communications, Agriculture Literature, Journals, Technical Reports, Electronic Publishing, Flow of agriculture and Scientific information, Agriculture Information System-AGRIS/CARIS/AGROVOC/ARIS, Decision Support

System(DSS) and its types .

Database concepts and their types, database architecture, data normalization, File Transfer Protocol, DBMS, RDBMS, Agricultural Databases and their importance, Functioning of Agricultural Databases, Plant Genome Databases, AGRICOLA, Plants National Databases (PPMdb, TAIR, GrainGene, BrassicaDB, MaizeDB, Soybase, TIGR etc).

Bioinformatics Applications-EMBL, Genbank, OMIM, DDBJ, Gene Cards, Sequence search and Retrieval, Sequence Identification (BLAST), Alignment, Sequence analysis/ submission/translation, Proteomic and Genomic Web resources

AgriInformatics tools-Crop Nutrient Tool, Vegspec, NAT, Ecological Site Descriptor, other farm and risk management softwares.

Practicals:

1. Familiarity with web resources and information network
2. Familiarity with different databases related to agriculture
3. To study decision support system
4. Data retrieval and analysis from databases
5. To use various agri-informatics tools

Semester: IV

BCBE 899

Dissertation