M.Sc. (Agri.) Biochemistry
(Batch 2022 Onwards)

Framework of Courses	
Major Courses	20
Minor Courses	08
Supportive Courses	06
Common Courses	05
Seminar	02
Thesis	30
Grand Total	**71**

List of Courses					
Major Courses: Minimum 20 credits	**A: Mandatory Courses (14 credits)**		**Credits**	**L-T-P**	**Remarks**
	BCBE 701	Basic Biochemistry *	4(3-0-1)	3-0-2	**Mandatory Courses (14 credits)**
	BCBE 713	Techniques in Biochemistry *	4(2-0-2)	2-0-4	
	BCBE 730	Enzymology *	3(2-0-1)	2-0-2	
	BCBE 731	Intermediary Metabolism*	3(3-0-0)	3-0-0	
	B: Optional Courses (06 credits)				
	MCE717	Molecular Biology**	3(2-0-1)	2-0-2	**Minimum credits: 06**
	BCBE 733	Animal Biochemistry **	3(2-0-1)	2-0-2	
	BCBE 735	Plant Biochemistry **	3(2-0-1)	2-0-2	
	BCBE 737	Biochemistry of Xenobiotics	2(2-0-0)	2-0-0	
	BCBE 739	Immunochemistry **	3(2-0-1)	2-0-2	
	BCBE 741	Nutritional Biochemistry**	3(2-0-1)	2-0-2	
Minor Courses (08 credits)					
Minor Courses	AHN 706	Principles & Practices of Animal Nutrition**	3(2-0-1)	2-0-2	**Minimum credits: 08**
	BIOL720	Physiological and Molecular Responses of Plants to Abiotic Stresses **	3(2-0-1)	2-0-2	
	GPB 726	Molecular Breeding and Bioinformatics**	3(2-0-1)	2-0-2	
	MCE 708	IPR, Bio-safety and Bioethics **	2(2-0-0)	2-0-0	
	MCE 805	Nanobiotechnology **	3(2-0-1)	2-0-2	
	MCE 821	Plant Tissue Culture **	3(2-0-1)	2-0-2	
Supportive Courses: (06 Credits)					
Supportive Courses	MAS 815	Experimental Designs	3(2-0-1)	2-0-2	**Minimum credits: 06**
	CBBI701	Fundamentals of Bioinformatics and Information Technology	3(2-0-1)	2-0-2	
Common Courses credits: (05 credits)					
Common Courses	MLS 501	Library and Information Services	1(0-0-1)	0-0-2	**Minimum credits: 05**
	LNG 502	Technical Writing and Communications Skills	1(0-0-1)	0-0-2	
	AEC 503	Intellectual Property and its management in Agriculture	1(0-0-1)	0-0-2	
	AEC 505	Agricultural Research, Research Ethics and Rural Development	1(0-0-1)	0-0-2	
	ENVS506	Disaster Management	1(0-0-1)	0-0-2	
Seminar					
Seminar	BCBE 780	Seminar-I	1(0-0-1)	0-0-2	
	BCBE 880	Seminar-II	1(0-0-1)	0-0-2	
Thesis Research					
Thesis	BCBE 899	Thesis	30(0-0-30)	0-0-60	

*** Mandatory Courses**
**** Optional Courses**

Course Structure
(Semester wise)

Semester: I				
S.No.	**Course Code**	**Course Title**	**Credits**	**(L-T-P)**
1.	AHN 706	Principles & Practices of Animal Nutrition**	3(2-0-1)	2-0-2
2.	BCBE 701	Basic Biochemistry*	4(3-0-1)	3-0-2
3.	BCBE 713	Techniques in Biochemistry*	4(2-0-2)	2-0-4
4.	CBBI 701	Fundamentals of Bioinformatics and Information Technology	3(2-0-1)	2-0-2
5.	MCE 708	IPR, Bio-safety and Bioethics **	2(2-0-0)	2-0-0
6.	MCE 717	Molecular Biology**	3(2-0-1)	2-0-2
7.	MLS 501	Library and Information Services	1(0-0-1)	0-0-2
Semester: II				
S.No.	**Course Code**	**Course Title**	**Credits**	**(L-T-P)**
1.	BCBE 730	Enzymology*	3(2-0-1)	2-0-2
2.	BIOL 720	Physiological and Molecular Responses of Plants to Abiotic Stresses**	3(2-0-1)	2-0-2
3.	GPB 726	Molecular Breeding and Bioinformatics**	3(2-0-1)	2-0-2
4.	MAS 815	Experimental Designs	3(2-0-1)	2-0-2
5.	MCE 805	Nanobiotechnology **	3(2-0-1)	2-0-2
6.	MCE 821	Plant Tissue Culture **	3(2-0-1)	2-0-2
7.	AEC 503	Intellectual Property and its management in Agriculture	1(0-0-1)	0-0-2
8.	AEC 505	Agricultural Research, Research Ethics and Rural Development	1(0-0-1)	0-0-2
9.	BCBE 780	Seminar-I	1(0-0-1)	0-0-2
Semester: III				
S.No.	**Course Code**	**Course Title**	**Credits**	**(L-T-P)**
1.	BCBE 731	Intermediary Metabolism*	3(3-0-0)	3-0-0
2.	BCBE 733	Animal Biochemistry**	3(2-0-1)	2-0-2
3.	BCBE 735	Plant Biochemistry **	3(2-0-1)	2-0-2
4.	BCBE 737	Biochemistry of Xenobiotics**	2(2-0-0)	2-0-0
5.	BCBE 739	Immunochemistry **	3(2-0-1)	2-0-2
6.	BCBE 741	Nutritional Biochemistry **	3(2-0-1)	2-0-2
7.	BCBE 880	Seminar-II	1(0-0-1)	0-0-2
8.	ENVS 506	Disaster Management	1(0-0-1)	0-0-2
9.	LNG 502	Technical Writing and Communications Skills	1(0-0-1)	0-0-2
Semester: IV				
S.No.	**Course Code**	**Course Title**	**Credits**	**(L-T-P)**
	BCBE 899	Thesis	30(0-0-30)	0-0-60

*** Mandatory courses**
**** Optional courses**

Course Syllabi

Semester-I

AHN 706	Principles & Practices of Animal Nutrition	3(2-0-1)

- Animal Nutrition- Definition and importance.
- Digestive system of ruminant- Functions of different organs
- Nutrients: Classification and role in animal body.
- Nutritional importance of minerals and vitamins and their sources, deficiency symptoms and requirements.
- Feed stuffs: Classification and their nutritive value, evaluation of feeds and fodder, Non-conventional feed stuffs, Desirable characteristics of good ration,
- Rationing of animals- Balanced maintenance, production and ideal ration, Concept of complete feed and total mixed ration.
- Feeding standards- classification, history and limitations. Nutritional requirements for dairy animals. Preparation of balanced ration for different categories of cattle and buffaloes.
- Feeding practices for dairy animals- Soiling system, Silage making, hay making, pasturing, Supply of green fodder round the year
- Feeding of goats – principles of feeding, feed stuffs, nutritional requirements, feed formulation and feeding practices.
- Feeding of Sheep – principles of feeding, feed stuffs, nutritional requirements, feed formulation and feeding practices.
- Feeding of Swine – Characteristic features of swine nutrition, feed stuffs, nutritional requirements for different classes of pigs, feed formulation and feeding practices, Formulation of Mineral mixture for swine

List of Practical:-

- Identification of feedstuffs- Roughages, concentrates and feed additives
- Computation of balanced ration for milch cows
- Computation of balanced ration for buffaloes
- Computation of balanced ration for working animals
- Computation of balanced ration for breeding bulls
- Formulation of ration for goats and sheep.
- Formulation of ration for swine.
- Preparation of cropping scheme for supply of green fodder round the year
- Preparation of concentrate mixture- mixing of feeds
- Feeding systems.

BCBE 701	Basic Biochemistry	4(3-0-1)

- **Introduction to Biochemistry:** Biochemistry as modern science and its various divisions, Scope and importance of biochemistry in agriculture and allied sciences. Fundamental principles governing life, supramolecular structures, significance of weak non covalent interactions in biology**.** Structure of water, ionization of water, acid base concept, pH and buffers, significance of structure-function relationship. General introduction to physical techniques for determination of structure of biopolymers.
- **Structure and Function of Biomolecules:** Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids. Structure, formation and different forms of immunoglobulin, PR proteins and their classification. Structure, classification and function of plant secondary metabolites.
- **Metabolism:** Structure and biological functions of vitamins and coenzymes, enzymes: classification and mechanism of action; regulation, factors affecting enzyme action. Hormones: animal and plants. Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.
- **Catabolism and its Regulation:** Important and basic degradative metabolic pathways of carbohydrates, lipids and proteins and their regulation. Formation of ATP, substrate level phosphorylation, electron transport chain and oxidative phosphorylation, chemiosmotic theory and proton motive force.
- **Fundamentals of Molecular Biology and Genetic Engineering:** Overview of replication, transcription and translation. Restriction enzymes, DNA cloning, applications of cloning, transgenics.

Practical

- Preparation of standard and buffer solutions
- Detection of carbohydrates, amino acids and proteins
- Extraction and estimation of sugars
- Extraction and estimation of amino acids
- Extraction and estimation of proteins
- Estimation of acid value of fat/oil
- Estimation of peroxide value of fat/oil
- Estimation of saponification value in fats and oils
- Fatty acid composition in fat/oil by GC
- Estimation of DNA and RNA by spectroscopic methods
- Estimation of Ascorbic acid
- Separation of biomolecules by TLC and Paper chromatography
- Estimation of alpha amylase activity
- Qualitative tests for secondary plant metabolites.

BCBE 713	Techniques in Biochemistry	4(2-0-2)

- **Separation Techniques:** Principles and applications of paper, thin layer, gel filtration, ion-exchange, affinity, column & HPTLC, GC, HPLC and FPLC. General principles, paper and gel electrophoresis, native and SDS-PAGE, 2D-PAGE, capillary electrophoresis. Hydrodynamic methods of separation of biomolecules such as viscosity and sedimentation velocity, - their principles. Basic principles of sedimentation, type, care and safety aspects of centrifuge preparative and analytical centrifugation.
- **Spectroscopic Techniques:** Principles and applications of UV-visible, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X-Ray spectroscopy.MS/MS, LC-MS, GC-MS, MALDI-TOF, applications of mass spectrometry in biochemistry. Principle, function and instrumentation of atomic absorption spectrophotometry.
- **Microscopy:** Principles and applications, light, UV, phase contrast, fluorescence and electron microscopy, flow cytometry.
- **Tracer, Imaging, Immunochemical and other Techniques:** Tracer techniques in biology: concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of á, â and ã emitters, scintillation counters, γ-ray spectrometers, autoradiography, applications of radioactive tracers in biology. Principles and applications of phosphor imager, MRI and CT scan. Production of antibodies, immuno-precipitation, immunoblotting, immunoassays, RIA and ELISA. Cryopreservation, polymerase chain reaction (PCR), FACS.

List of Practical:-

- Expression of concentration in terms of dilution, molarity, normality, percent expression
- pH measurement and buffer preparation
- Determination of absorption maxima of biomolecules
- Estimation of biomolecules through spectrophotometry and other methods
- Separation of carbohydrates and amino acids by paper chromatography
- Separation and analysis of fatty acids/lipids by GC
- Separation/estimation of biomolecules through HPLC and FPLC
- Separation of proteins using ion exchange, gel filtration and affinity chromatography
- Electrophoretic separation of proteins and nucleic acids
- Centrifugation- differential and density gradient
- $(NH_4)_2SO_4$ precipitation and dialysis
- Use of radioisotopes in metabolic studies
- PCR
- ELISA
- Western blotting/ Dot blotting

CBBI 701	Fundamental of Bioinformatics & Information Technology	3(2-0-1)

- **Introduction to Bioinformatics**, philosophical, directional and application oriented background of Bioinformatics. Biological databanks: NCBI data model, GenBank sequence database, structural database, biodiversity information, virology information database and Chemoinformatics databases, List of Practical: - on data retrieval involving internet based Bioinformatics tools.
- **Introduction to database:** Data abstraction, data models, E-R Models, E-R Diagrams and their reduction to tables, basic concepts, Network data models, Hierarchical data models, Multimedia data models, Basic concept of Indexing: B, B+ tree indexed files, Static and Dynamic Hashing, Text database, Introduction to distributed Database Processing.
- **Information network** – Internet, Web Browser and address (NCBI, EBI *etc*). Use of INTERNET & WWW; Ethernet and TCP/IP family of protocols
- **Computer Networking –** LAN, WAN, MODEM; Network structure; Network architecture; Hierarchical networks, Optical Vs. Electronic Networking; Security of the network, Fire-walls; Network Goals; Applications Network.

List of 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.
- Setting up NFS server for file sharing.
- Using SSH for secure login.
- Using FTP and SFTP to transfer data across the network.

MCE 708	IPR, Bio-safety and Bioethics	2(2-0-0)

- IPR: historical background in India; trade secret; patent, trademark, design & licensing; procedure for patent application in India; Patent Cooperation Treaty (PCT);Examples of patents in biotechnology-Case studies in India and abroad; copyright and PVP; Implications of IPR on the commercialization of biotechnology products, ecological implications; Trade agreements-The WTO and other international agreements, and Cross bord ermovement of germplasms.
- Biosafety and bio-hazards; General principles for the laboratory and environmental bio-safety; Biosafety and risk assessment issues ;handling and disposal of bio- hazards; Approved regulatory laboratory practice and principles, The Cartagena Protocol on biosafety; Biosafety regulations in India; national Biosafety Policy and Law; Regulations and Guidelines related to Biosafety in other countries
- Potential concerns of transgenic plants–Environmental safety and food and feed safety. Principles of safety assessment of Transgenic plants –sequential steps in risk assessment. Concepts of familiarity and substantial equivalence. Risk- Environmental risk assessment – invasiveness, weediness, gene flow, horizontal gene transfer, impact on on-target organisms; food and feed safety assessment – toxicity and allergenicity. Monitoring strategies and methods for detecting transgenics.
- Field trails –Biosafety research trials –standard operating procedures, labeling of GM food andcrop,Bio-ethics-Mankindandreligion,social,spiritual&environmental ethics; Ethics in Biotechnology, labeling of GM food and crop; Biopiracy

Suggested Reading

- Goel,D.andParashar,S.2013.IPR,biosafety,andbioethics
- Joshi,R.2006.Biosafety and Bioethics
- Nambisan, P. 2017.AnIntroductiontoEthical, Safety and Intellectual Property Rights Issues in Biotechnology.

MCE 717	Molecular Biology	3(2-0-1)

- **Introduction to Nucleic Acids:** Historical development of molecular biology, nucleic acids as genetic material. Nucleic acid structure, chemical and physical properties of nucleic acids, spectroscopic and thermal properties of nucleic acids, DNA supercoiling. Concept of genes and genome, genome complexity**,** genome organization in prokaryotes and eukaryotes, chromatin structure and function, repetitive and non-repetitive DNA, satellite DNA central dogma, genome editing.
- **Synthesis of Nucleic Acid:** Modes of replication, DNA polymerases, topoisomerases, DNA ligase, model of replisome, semi conservative replication in prokaryotes and eukaryotes, inhibitors of replication, DNA damage and repair. Basic principles of transcription, transcription initiation, elongation and termination, RNA processing, RNA interference, siRNAs, miRNAs and other ncRNAs, DNA/ RNA editing. Regulation of transcription, reverse transcription.
- **Protein Synthesis:** Ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacylt RNA synthases. Initiation, chain elongation and termination of translation, energetics, inhibitors of translation. Post translational modifications of nascent polypeptide, protein targeting and turnover, regulation of gene expression in prokaryotes and eukaryotes, nucleases and restriction enzymes.
- **Gene Manipulation:** Importance, Sanger method, High-Throughput Sequencing (HTS) techniques, applications of DNA sequencing. Vectors, isolation of genes, recombinants vector, selection of recombinants, characterization and expression of cloned DNA, transformation, transgenesis, mutation, molecular mechanism of mutation, site directed mutagenesis, *in vitro* mutagenesis. Polymerase chain reaction (PCR), expression cloning, gel electrophoresis, molecular markers, macromolecule blotting and probing, arrays (DNA array and protein array) – principles and application.

List of Practical:-

- Isolation and purification of DNA and RNA
- To check the purity of isolated DNA and RNA
- Restriction fragmentation of genomic DNA
- Separation of oligos by agarose gel electrophoresis
- Southern blotting experiments
- Northern blotting experiments
- Cloning of DNA fragment in vector
- Selection of recombinant
- SSR analysis of DNA
- cDNA synthesis using RT- PCR
- Basic tools in bioinformatics analysis

Semester-II

BCBE 730	Enzymology	3(2-0-1)

- 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, pseudoenzymes, enzyme promiscuity *etc*.
- Enzyme kinetics: steady rate kinetics, Derivation of Michaelis-Menten equation using steady state/equilibrium kinetics, plots of Lineweaver-Burke, Hanes, and Eadie-Hofstee *etc*. Mechanism of bisubstrate and multisubstrate enzyme catalyzed reaction, Enzyme inhibitors, mechanism of enzyme action-lysozyme, chymotrypsin, alcohol DH. metal activated enzymes and metalloenzymes
- Regulation of enzyme activity: Covalent modification, allosteric model concerted and sequential, cooper activity and 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.

List of Practical:-

- Soluble protein estimation
- Enzyme assay by taking any model enzyme
- Isolation and purification of any model enzyme
- Study of the effect of enzyme and substrate concentrations on enzyme activity
- Determination of Km and Vmax
- Determination of pH and temperature optima
- Effect of inhibitors on enzyme activity
- Determination of pH and temperature stability of enzyme
- Electrophoretic analysis of isozymes.

BIOL 720	Physiological and Molecular Responses of Plants to Abiotic Stresses	3(2-0-1)

- Response of plants to abiotic stresses: Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress, Interactions between biotic and abiotic stresses.
- Drought-characteristic features, Water potential in the soil-Plant air continuum. Development of water deficits, energy balance concept.
- Transpiration and its regulation – stomatal functions.
- Physiological processes affected by drought. Drought resistance mechanisms: Escape Dehydration postponement (Drought avoidance), Dehydration tolerance and characteristics of resurrection plants. Osmotic adjustment, Osmoprotectants, Stress proteins. Water use efficiency as a drought resistant trait.
- Molecular responses to water deficit: Stress perception, Expression of regulatory and functional genes and significance of gene products.
- Stress and hormones- ABA as a signaling molecule- Cytokinin as a negative signal. Oxidative stress: Reactive Oxygen Species (ROS). Role of scavenging systems (SOD catalase *etc*.).
- High temperature stress: Tolerance mechanisms- role of membrane lipids in high temperature tolerance. Functions of HSP's.
- Chilling stress: Effects on physiological processes. Crucial role of membrane lipids.
- Salinity: Species variation in salt tolerance. Salinity effects at – Cellular and whole plant level, tolerance mechanisms. Salt tolerance in – Glycophytes and halophytes, Breeding for salt resistance.
- Heavy metal stress: Aluminum and cadmium toxicity in acid soils. Role of Phytochelatins (heavy metal binding proteins).

List of Practical:-

- Measurement of water status of plants, determination of osmotic potential by vapour pressure and freezing point depression,
- Determination of soil water potential and content by psychrometry and other systems.
- Stress imposition and quantification, Stress –stomatal conductance.
- Canopy temperature as a reflection of transpiration and root activity, Water use –efficiency, Determination at whole plant and single leaf level,
- Root- shoot signals-ABA and cytokinin effect on stomatal behavior, Heat tolerance and membrane integrity. Sullivans heat tolerance test, chilling tolerance-
- Galactolipase and free fatty acid levels as biochemical markers for chilling damage, Cold-induced inactivation of O_2 evolution of chloroplasts- as a screening technique for chilling tolerance.

GPB 726	Molecular Breeding and Bioinformatics	3(2-0-1)

- Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, *etc*.), Functional markers; Mapping populations (F2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.
- Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted backcross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.
- Introduction to Comparative Genomics; Large scale genome sequencing strategies; Human genome project; Arabidopsis genome project; Rice genome project; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases; Nanotechnology and its applications in crop improvement.
- Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer; Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, *etc*. and commercial releases; Biotechnology applications in male sterility/ hybrid breeding, molecular farming; Application of Tissue culture in molecular breeding; MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Introduction to bioinformatics: bioinformatics tools, biological data bases (primary and secondary), implications in crop improvement.

List of Practical:-

- Requirements for plant tissue culture laboratory;
- Techniques in plant tissue culture;
- Media components and media preparation;
- Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretations;
- Inoculation of explants, callus induction and plant regeneration; Standardizing the protocols for regeneration;
- Hardening of regenerated plants; Establishing a greenhouse and hardening procedures; Plant Sciences–Genetics and Plant Breeding 19
- Visit to commercial micropropagation unit;
- Transformation using Agrobacterium strains;
- GUS assay in transformed cells/ tissues;
- DNA isolation, DNA purity and quantification tests;
- Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship;
- Construction of genetic linkage maps using computer software;
- NCBI Genomic Resources, GBFF, Swiss Prot, Blast n/ Blast p, Gene Prediction Tool, Expasy Resources, PUBMED and PMC, OMIM and OMIA, ORF finder;
- Comparative Genomic Resources: - Map Viewer (UCSC Browser and Ensembl);
- Primer designing- Primer 3/ Primer BLAST.

MAS 815	Experimental Design	3 (2-0-2)

- 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: 22, 23, 32, &33, factorial-designs. (Yates method of Analysis), 2 x 3 & 2 x 4 factorials. Durcan's Multiple Range Test. Newman's Kuel's Test
- Sampling Techniques: Simple Random Sampling Stratified Random Sampling & Systematic Sampling.

Suggested Reading

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

MCE 805	Nanobiotechnology	3(2-0-1)

- IntroductiontoNanotechnology-Nanomaterials-Self-assemblytoartificialassembly for creation of useful nano structures–Bottoms up and Top down approach (Nanorods, nanocages, nanotubes, quantum dots, nanowires, metal/polymer-based nanostructures)–Preparation and Characterization of nano particles (particle size analyzer, microscopy, *viz.* electron microscopy, atomic force microscopy *etc*).
- Cell structure–Bio macro molecules: Types, Structure, Dynamics and interaction with water–Cellular nano-machines–cellular transducers, membrane channels, membrane transporters, Membrane motors–Creation of bio-nanostructures (Nano liposomes, Nano-micelles, Nanomotors, *etc*).
- Chemical, physical and biological properties of biomaterials and bio response: bio-mineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aero sol properties, application and dynamics; Statistical Mechanics in Biological Systems.
- Nano particular carrier systems; Micro-and Nano-fluidics; Drug and gene delivery system; Micro fabrication, Biosensors, Chip technologies, Nano-imaging, Metabolic engineering and Gene therapy.

List of Practical:-

- Isolation of enzymes and nucleic acids involved in biosynthesis of nanomaterials.
- Synthesis of Gold/ silver Nano particles by biogenic methods, Synthesis of micelles and inverse micelles.
- Synthesis of Carbon Nano-materials by Chemical Vapor Deposition and Sputteringtechnique.
- Preparation of thiolate silver nano particles, Purification and measurement of carbon nanomaterials.
- Zinc selenide quantum dot preparation, Synthesis of Iron Oxide Nanoparticle.
- Thin film preparation by spin coating technique, Synthesis of Nickel metal nanoparticle by urea decomposition method.
- Synthesis of Zinc Oxide nano particle.

Suggested Reading

- Nalwa, H.S.2005. Handbook of Nano structured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publications.
- Niemeyer C.M. and Mirkin C.A. (Eds) 2005. Nanobiotechnology: Concepts Applications and Perspectives, Wiley Inter-science publications.
- Cao,G.,andWang,Y.2004.NanostructuresandNanomaterials:Synthesis,Propertiesand Applications, Imperial College Press.

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

- History of plant tissue culture, principle of Totipotency; Organization of tissue culture laboratory; aseptic techniques; Tissue culture media; Plant hormones and morphogenesis; Direct and indirect organogenesis; Direct and indirect somatic embryogenesis; Applications of plant tissue culture; National certification and Quality management of TC plants; Genetic Fidelity testing and Virus indexing methods – PCR, ELISA
- Micropropagation of field and ornamental crops; Virus elimination by meristem culture, meristem tip culture and micro grafting; Androgenesis and gynogenesis- production of androgenic and gynogenic haploids-diploidization; Protoplast culture – isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybridization -Production of Somatic hybrids and Cybrids, Wide hybridization – embryo culture and embryo rescue techniques; Ovule, ovary culture and endosperm culture.
- Large-scale cell suspension culture -Production of alkaloids and other secondary metabolites-techniques to enhance secondary metabolite production, Somaclonal and gametoclonal variations–causes and applications; Callus culture and *in vitro* screening for stress tolerance; Artificial seeds, *in vitro* germplasm storage and cryo-preservation. Commercial Tissue Culture Case studies and success stories, Market assessment; project planning and preparation, economics, government policies

List of Practical:-

- Preparation of stocks-macronutrients, micronutrients, vitamins and hormones, filter sterilization of hormones and antibiotics.
- Preparation of Murashige and Skoog medium.
- Micro-propagation of plants by nodal and shoot tip culture.
- Anther culture for haploid production.
- Callus induction in tobacco leaf discs, regeneration of shoots, root induction, role of hormones in morphogenesis.
- Plan of a commercial tissue culture unit.
- Synthetic seed preparation.

Suggested Reading

- Razdan, M.K.2003.Introduction to plant tissue culture, 2nd edition, Oxford publications group
- Butenko,R.G.2000.Plant Cell Culture University Press of Pacific
- Herman, E.B.2008. Media and Techniques for Growth, Regeneration and Storage, Aristech Publications, New York, USA.
- Bhojwani, S. Sand Dantu P.2013.Plant Tissue Culture–An Introductory Text. Springer Publications.
- Gamborg, O. Land G.C.Philips (eds.).2013.Plant Cell, Tissue and Organ culture-Lab Manual. Springer Science & Business media.

Semester-III

BCBE 731	Intermediary Metabolism	3(3-0-0)

- **Introduction to Metabolism:** The living cell - a unique chemical system, biochemical reaction types, bioenergetics, bioavailability of nutrients, transport mechanism, signal transduction. Catabolism and anabolism, compartments of metabolic pathways, experimental approaches to study metabolism, metabolic profiles of major organs.
- **Metabolism of Energy Nutrients:** Major catabolic and anabolic pathways of carbohydrate metabolism, the glyoxylate pathway. Fatty acid oxidation, ketone bodies, fatty acid biosynthesis, synthesis of triacylglycerols, cholesterol, eicosanoids. General reactions of amino acid metabolism, degradative and biosynthetic pathways of amino acids, urea cycle, amino acids as metabolic precursors. Mechanisms of energy transduction, electron transport system, oxidative phosphorylation, control of ATP production.
- **Sulphur and Nucleotide Metabolism:** Sulphate reduction and incorporation of sulphur in to amino acids. Synthesis and degradation of purine and pyrimidine nucleotides.
- **Metabolic Regulation and Defects in Metabolism:** Regulation of carbohydrate, lipid, protein, nucleotide metabolism and oxidative phosphorylation. Disorders of carbohydrates, lipids, amino acids and nucleic acid metabolism, and inborn errors of metabolism. Metabolic pathway engineering.

BCBE 733	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, acid-base balance trace elements and vitamins.
- Gastrointestinal physiology-Digestion of food ruminants and non-ruminants absorption of food, bioactive peptides and functional oligosaccharides
- Immune systems, immunoglobulins, monoclonal antibodies, formation of antibody, antibody diversity, complement system – classical and alternate, Major histocompatibility complexes, cell mediated immune response, mechanisms of immunity.
- Animal Hormones-Origin, site of action, biochemical mechanism of hormone action, feed-back mechanism of hormonal secretion.
- Biochemistry of specialized tissues – connective tissue, skin, muscle, nervous tissue and blood and other body fluids.

List of Practical:-

- Separation of serum and plasma from blood
- Preparation of blood film and study of different types of cells
- Total count of red blood corpuscles (R.B.Cs.)
- Total count of white blood corpuscles (W.B.C.)
- Differential count of white blood corpuscles (W.B.C.)
- Determination of the Haematocrit value of the blood samples
- Determination of haemoglobin by Sahli's method
- Determination of hemoglobin by cyanmethemoglobin method
- Determination of blood sugar by Folin-Wu method
- Determination of Urea in serum/plasma
- Determination of Urinary Creatinine

BCBE 735	Plant Biochemistry	3(2-0-1)

- Photosynthesis: significance of photosynthesis, ultra structure of chloroplast, photosynthetic pigments. Light absorption phenomenon, Carbon reduction in C3, C4 and CAM plants, electron transport and photorespiration, Bacterial Photosynthesis,
- Biosynthesis of structural carbohydrates, storage proteins and lipids, sucrose-starch inter-conversion
- Basic concepts of nitrogen and sulphur metabolism: biological nitrogen fixation, nitrate assimilation in plants, sulphur chemistry and function, reductive sulphate assimilation pathway, sulphated compounds
- Phytohormone: Different classes of phytohormones, their biosynthesis and mode of action. Biochemistry of fruit ripening – ripening process, cell wall degrading enzymes, role of ethylene and regulation of ethylene production.
- Secondary Metabolites: Biochemistry and significance of plant secondary metabolites – phenolics, terpenoids, alkaloids, cyanogenic glycosides and glucosinolates, effect of biotic and abiotic factors on plant metabolism and plant defense system.

List of Practical:-

- Fractionation of cell organelles
- Analysis of plants and plant product for various constituents.
- Extraction and identification of sugars from plants, fruits and vegetables.
- Extraction and determination of amino acids and protein.
- Extraction and determination of carotenoids, anthocyanin, chlorophylls, lycopene, curcumin *etc*
- Qualitative tests of secondary metabolites (alkaloids, sterols *etc*.)
- Determination of polyphenols/phenolics
- Estimation of glucosinolates Estimation of cyanogenic compounds
- Assay of PAL/SOD /PPO/LOX

BCBE 737	Biochemistry of Xenobiotics	2(2-0-0)

- **Xenobiotics:** Xenobiotics: classification and their effects on biological systems, Problems related to xenobiotics degradation, potential effects of toxic agents on immune system function, biotic metabolism of xenobiotics - biodegradation/biotransformation
- **Mode of degradation:** Mode of degradation - Enzymatic and Non-enzymatic, Metabolism of toxic compounds with reference to role of detoxifying enzymes, Mechanism of xenobiotics detoxification - in animal using the enzymes of Phase I and Phase II, Role of microbes in xenobiotics degradation and co-metabolism, Biodegradation and its genetics, manipulation of xenobiotic degradative genes
- **Plant metabolism of xenobiotics:** Plant metabolism of xenobiotics - transformation, conjugation and compartmentation, Metabolic responses of pesticides in plants, Impact, metabolism, and toxicity of heavy metals in plants, Regulation of xenobiotics in higher plants: signaling and detoxification.
- **Phytoremediation:** Phytoremediation, Advances in development of transgenic plants for remediation of xenobiotic pollutants, safety assessment of xenobiotics

BCBE 739	Immunochemistry	3(2-0-1)

- **Introduction to immunology:** History and scope of immunology, antigens, adjuvants, immune system, organs, tissues and cells, immunoglobulins, molecular organization of immunoglobulin. Haptens, ag-ab interaction, plant immunity, proteasome mediated process, plantibodies
- **Antibodies:** Classes of antibodies, antibody diversity, theories of generation of antibody diversity, vaccine, monoclonal and polyclonal antibodies, hybridoma, recombinant antibodies, complement system - classical and alternate.
- **The immune responses:** Cellular interactions in immune response, major histocompatibility complex, and cell mediated immune response, cytokines.
- **Immunoregulation and immunological techniques:** Immunoregulation, immunological tolerance, hypersensitivity, mechanisms of immunity, innate resistance and specific immunity, current immunological techniques – ELISA, RIA, Immunoblotting, FACS; basics of PCR and hybridization based methods of detection, microarray based detection, multiplexing.

List of Practical:-

- Handling, inoculation and bleeding of laboratory animals
- Preparation of antigens and antisera, natural antibodies
- Carbon clearance test
- Lymphoid organs of the mouse
- Morphology of the blood leucocytes
- Separation of lymphocytes from blood, viable lymphocyte count
- Antigen-antibody interaction,
- Precipitation and agglutination
- Direct and indirect haemagglutination
- Immunoelectrophoresis
- Complement fixation
- Quantification of immunoglobulins by zinc sulphate turbidity and single radial immunodiffusion
- ELISA
- Western blotting
- Fluorescent Ab test
- Hybridoma technique

BCBE 741	Nutritional Biochemistry	3(2-0-1)

- Basic concepts: Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements. Specific dynamic action of proteins.
- Elements of nutrition: Dietary requirement of carbohydrates, lipids, proteins and dietary fibers. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions. Prebiotics and Probiotics, Anti Nutritional Factors and Food Toxins
- Minerals: Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
- Vitamins: Dietary sources, biochemical functions Biologically active forms of vitamins, deficiency diseases associated with vitamin.
- Detoxification: Definition site phases, of detoxification. Biochemical role of water.
- Biochemical features some diet related disorders like protein-calorie malnutrition diabetes, cardiovascular disease goiter anemia *etc*.

List of Practical:-

- Estimation of amylose and amylopectin
- Estimation of resistant starch
- Estimation fatty acid
- Estimation of phenols in plant tissue/sample
- Estimation of carotenoids
- Estimation of amylase, trypsin and chymotrypsin inhibitor activities
- Estimation of Vitamin C in fruits
- Estimation of reducing & non reducing sugar in fruits
- Estimation of protein contents
- Estimation of dietary fibre
- Determination of limiting amino acids
- Estimation of Phytate/ oxalate
- Estimation of total antioxidant activity by different methods
- Estimation of curcumin