Post-Graduate Syllabus
of
Dept. of Biochemistry

Uttar Banga Krishi Viswavidyalaya
Pundibari-736165, Cooch Behar, W. B.

Biochemistry Courses

Course No.	Course Title	Credits
	M. Sc. (Ag.)	
BCH 501	Basic Biochemistry	2+1
BCH 502	Chemistry of Biomolecules	2+1
BCH 503	Fundamentals of Enzymology	2+1
BCH 504	Analytical Techniques in Biochemistry	1+2
BCH 505	Plant Biochemistry I	2+1
BCH 506	Metabolic Pathways I	2+0
BCH 507	Molecular Biology	2+1
BCH 508	Pesticide Biochemistry	2+0
BCH 509	Basics of Immunology	2+1
BCH 510	Food and Nutritional Biochemistry	2+0
BCH 591	Master's Seminar	1+0
BCH 599	Master's Research	20
	Ph. D.	
BCH 601	Advanced Enzymology	2+0
BCH 602	Metabolic Pathways II	2+0
BCH 603	Transport Biochemistry	2+0
BCH 604	Advanced Molecular Biology	2+0
BCH 605	Advanced Techniques in Biochemistry	0+2
BCH 606	Plant Biochemistry II	2+0
BCH 607	Current Topics in Biochemistry	1+0
BCH 608	Functional Genomics and Metabolomics	2+0
BCH 609	Environmental Biochemistry	2+0
BCH 691	Doctoral Seminar I	1+0
BCH 692	Doctoral Seminar II	1+0
BCH 699	Doctoral Research	45

Agricultural Chemicals Courses

Course No.	Course Title	Credits
	M. Sc. (Ag.)	
BCH 521	Basic Chemistry-I	2+1
BCH 522	Chemistry of Insecticides and Acaricides	2+1
BCH 523	Basic Laboratory Techniques	1+2
BCH 524	Pesticide Residue Analysis	1+1
BCH 525	Chemistry of Fungicides and Nematicides	2+0
BCH 526	Chemistry of Herbicides and PGRs	2+1
BCH 527	Chemistry of Botanicals and Biopesticides	2+0
BCH 528	Analytical Techniques in Pesticide Chemistry	2+1
BCH 529	Basic Chemistry-II	2+0
BCH 530	Pesticide Formulations	2+1
BCH 531	Movement, Degradation and Metabolism of Pesticides	2+0
BCH 591	Master's Seminar	1+0
BCH 599	Master's Research	20
	Ph. D.	
BCH 621	Regulations and Quality Control of Pesticides	2+0
BCH 622	Advances in Insecticide Chemistry	2+0
BCH 623	Advances in Fungicide and Herbicide Chemistry	2+0
BCH 624	Practicals in Pesticide Chemistry (Based on BCH 622 and BCH 623)	0+1
BCH 625	Special Topics in Agrochemicals	1+0
BCH 626	Principles of Pesticide Chemistry	2+0
BCH 627	Pesticides and Environmental Risk Assessment	2+0
BCH 691	Doctoral Seminar I	1+0
BCH 692	Doctoral Seminar II	1+0
BCH 699	Doctoral Research	45

PG Biochemistry Syllabus

BCH 501 Basic Biochemistry (2+1)

Theory

Importance of biochemistry in agriculture; Fundamental principles governing life; Structure and significance of water in biochemistry; acid-base concept, buffers, pH and pK; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; Physical techniques for determination of structure of biopolymers.

Cell structure and function; chemistry of cell membranes and active transport across cell membrane. Bioenergetics – energy rich compounds, source, conservation and utilization of energy in cell. Fundamentals of thermodynamic principles applicable to biological processes.

Classification and brief ideas on structure of biomolecules like carbohydrates, amino acids and proteins, fats and lipids.

Practical

Preparation of standard and buffer solutions; Qualitative detection of carbohydrates and amino acids; Extraction and estimation of sugars and amino acids; Separation of biomolecules by TLC and paper chromatography.

BCH 502 Chemistry of Biomolecules (2+1)

Theory

Chemistry and function of carbohydrate; monosaccharides – their properties, mutarotation, sugar derivatives; oligosaccharides and polysaccharides – their structures and functions.

Chemistry and function of lipids; fatty acids, fats and oils.

Chemistry of amino acids and proteins. Levels of protein structure. Protein and peptide sequencing.

Chemistry of nucleic acids: structures and biochemical roles of nucleotides and nucleic acids like DNA and RNA.

Introduction to enzymes, nomenclature and classification, cofactors and coenzymes – their role in enzyme catalysis, ribozymes, isozymes, abzymes. Vitamins, their coenzyme forms and functions.

Practical: Quantitative estimation of carbohydrates. Determination of acid value, peroxide value, saponification number, iodine number of fats and oils. Quantitative estimation of amino acids and proteins by different methods. Estimation of Proteins by Lowry's method. Estimation of vitamins and coenzymes, Estimation of Ascorbic acid. Estimation of DNA and RNA by diphenylamine and orcinol methods.

BCH 503 Fundamentals of Enzymology (2+1)

Theory

Introduction and historical perspective, enzyme compartmentalization in cell organelles, isolation and purification of enzymes, measurement of enzyme activity.

Enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis.

Enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity.

Isolation and purification of enzymes, Applications of enzymes in chemical and food industry, enzyme immobilization, biosensors and clinical applications of enzymes.

Practical

Enzyme assay by taking any model enzyme like alpha-amylase or acid phosphatase, isolation and purification of any model enzyme like alpha amylase or acid phosphatase, study of the effect of enzyme and substrate concentrations and determination of Km and Vmax, determination of pH and temperature optima and effect of various inhibitors, determination of the pH and temperature stability of enzyme.

BCH 504 Analytical Techniques in Biochemistry (1+2)

Theory

Chromatographic and electrophoretic methods of separation, Principles and applications of Paper, Thin layer & HPTLC, Gas, Gas-liquid, Liquid chromatography, HPLC and FPLC; Paper and gel electrophoresis, Different variants of polyacrylamide gel electrophoresis (PAGE) like native and SDS-PAGE, 2D-PAGE, capillary electrophoresis.

Spectrophotometry: Principles and applications, UV-VIS, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X-Ray spectroscopy.

Hydrodyanmic methods of separation of biomolecules such as viscosity and sedimentation- their principles, variants and applications.

Tracer techniques in biology: Concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of α, β and γ emitters, scintillation counters, γ-ray spectrometers, autoradiography, applications of radioactive tracers in biology, principles and applications of phosphor imager.

Practical

Determination of absorption maxima of some important chemicals from their absorption spectra, estimation of biomolecule using spectrophotometer, Separation of carbohydrates and amino acids by paper chromatography, Separation of lipids by thin layer and column chromatography, Separation of proteins by ion exchange and gel filtration chromatography, Electrophoretic techniques to separate proteins and nucleic acids, Centrifugation - Cell fractionation, Application of GLC, HPLC, FPLC in separation of biomolecules. Use of radioisotopes in metabolic studies.

BCH 505 Plant Biochemistry I (2+1)

Theory

Structure and function of cell organelle. Photosynthetic pigments and their functions. Photosynthesis, C3, C4 and CAM pathways, photorespiration.

Sucrose-starch interconversion, biosynthesis of structural and storage carbohydrates, storage proteins and lipids. Biochemistry of nitrogen fixation and nitrate assimilation, sulphate reduction and incorporation of sulphur into amino acids.

Biochemistry of symbiotic and nonsymbiotic nitrogen fixation; ammonium assimilation, metabolism and translocation of sucrose in plants. Role of minerals in plant metabolism.

Practical: Determination of photosynthetic rate, estimation of chlorophylls; determination of plant storage and structural saccharides, plant lipids, determination of proteins and nucleic acids during seed germination.

BCH 506 Metabolic Pathways I (2+0)

Theory

The living cell: a unique chemical system, introduction to metabolism, methods of studying metabolism, transport mechanism, bioenergetics, biological oxidation, signal transduction.

Integration of metabolism. Catabolic pathways of carbohydrates – glycolysis, TCA cycle, oxidative phosphorylation. Lipid catabolism – fatty acid oxidation, cholesterol, phospholipids and glycolipid metabolism, regulation and their metabolic disorders. Energy transduction.

General reactions of amino acid metabolism, Degradative pathways of amino acids, regulation and their metabolic disorders.

Nucleotide degradation and their regulation.

Compartmentation of metabolic pathways, metabolic profiles of major organs.

BCH 507 Molecular Biology (2+1)

Theory

Historical development of molecular biology, nucleic acids as genetic material, Genome organization in prokaryotes and eukaryotes, chromatin structure and function.

DNA replication, DNA polymerases, topoisomerases, DNA ligase, reverse transcriptase, repetitive and non-repetitive DNA, satellite DNA; transcription process, RNA editing, RNA processing.

Ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl tRNA synthases, inhibitors of replication, transcription and translation; translation and post-translational modification; nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes, molecular mechanism of mutation.

DNA sequencing, recombinant DNA technology, vectors, isolation of genes, recombinants vector, selection of recombinants, PCR; general features of replication, transcription, site directed mutagenesis and translation in eukaryotes.

Practical

Isolation and purification of DNA and RNA from different sources, check of purity of isolated DNA and RNA, restriction fragmentation and separation of oligos by agarose electrophoresis,RAPD analysis of DNA, cDNA synthesis using PCR, Southern and Northern blotting experiments.

BCH 508 Pesticide Biochemistry (2+0)

Entry and distribution of different classes of pesticides in plants and animals.

Pesticide metabolism – microsomal oxidation, cytochrome P450 interaction, extramicrosomal metabolism, enzymatic conjugation.

Metabolism of different classes of pesticides involving different enzyme systems.

Biochemistry of toxic action of pesticides.

BCH 509 Basics of Immunology (2+1)

Theory

History and scope of immunology, antigens, adjuvants, immune system, organs, tissues and cells, immunoglobulins, molecular organization of Immunoglobulin.

Classes of antibodies, Antibody diversity, theories of generation of antibody diversity, Vaccine, Monoclonal antibodies, polyclonal antibodies, Hybridoma, Recombinant antibodies, complement system – classical and alternate.

Cellular interactions in the immune response, major histocompatibility complex, cell mediated immune response, cytokines.

Immunoregulation, immunological tolerance, hypersensitivity, mechanisms of immunity, innate resistance and specific immunity. Current immunological techniques – ELISA, RIA.

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, agglutination, direct and indirect haemagglutination, Immunoelectrophoresis, Complement fixation, Quantitation of immunoglobulins by zinc sulphate turbidity and single radial immunodiffusion.

BCH 510 Food and Nutritional Biochemistry (2+0)

Theory

Fundamentals of humam nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains (including cereals, pulses and oilseeds), fruits and vegetables. Physico-chemical, functional and nutritional characteristics of carbohydrates, proteins and fats and their interactions (emulsions, gelation, browning etc.).

Biochemical and nutritional aspects of vitamins, minerals, nutraceuticals, antinutritional factors, biochemistry of post harvest storage.

Effect of cooking, processing and preservation of different food products on nutrients, biochemical aspects of food spoilage, role of lipase and lipoxygenase, oxidative rancidity and antioxidants.

Enzymes in food industry, food additives (coloring agents, preservatives etc.), biogenesis of food flavours and aroma, nutritional quality of plant, dairy, poultry and marine products.

BCH 601 Advanced Enzymology (2+0)

Theory

Theory of enzymatic catalysis, specificity, concept of active site and enzyme substrate complex, active site mapping, acid-base and covalent catalysis, factors associated with catalytic efficiency, proximity and orientation, distortion and strain, induced fit hypothesis, Mechanism of enzyme reactions.

Effect of different factors affecting enzyme activity, transition state theory, Arrhenius equation, Determination of energy of activation, kinetics of pH and temperature and determination of pKa and ΔH of active site amino acids.

Kinetics of bisubstrate reactions, mechanism determination by radioisotope exchange, kinetics of mixed inhibitions, substrate and product inhibition.

Role of enzymes in regulation of metabolism, allosteric enzymes and their kinetics, enzyme engineering, Bifunctional enzymes, enzyme engineering.

BCH 602 Metabolic Pathways II (2+0)

Theory

Pathways of carbohydrate biosynthesis - gluconeogenesis, pentose phosphate pathway, glyoxylate pathway.

Biosynthesis of amino acids, amino acids as biosynthetic precursors.

Fatty acids and lipid biosynthesis, regulation and their metabolic disorders.

Biosynthesis of purine and pyrimidine ribonucleotides, formation of deoxyribonucleotides and their regulation.

BCH 603 Transport Biochemistry (2+0)

Theory

Biomembranes and their classification based on cellular organelles; physico-chemical properties of different biological membranes.

Membrane components – lipids, their distribution and organization; proteins, intrinsic and extrinsic, their arrangement; carbohydrates, their function.

Various membrane movements; transport of biomolecules across membrane.

Role of membrane in cellular metabolism, cell recognition and cell-to-cell interaction; signal transduction.

Biochemistry of transmission of nerve impulse through nervous system.

BCH 604 Advanced Molecular Biology (2+0)

Theory

Organization of prokaryotic genome, nuclear and organelle genes, concept of genome mapping, molecular evolution, cell development and differentiation.

Prokaryotic and eukaryotic gene regulation, RNA editing, molecular biology of viruses.

Methods of gene isolation and transfer in plants and animals, application of genetic engineering in different fields.

Site directed mutagenesis, gene targeting and gene therapy, bioethics and biosafety guidelines and IPR in recombinant DNA research.

BCH 605 Advanced Techniques in Biochemistry (0+2)

Practical

Isolation and purification of protein from microbial/plant/animal source. Electrophoretic separation of protein. Determination of molecular weight of protein using PAGE/ gel filtration method.

Experiments on DNA: Isolation, agarose gel electrophoresis and restriction analysis of DNA.

Isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation.

Isolation and purification of enzymes, isozymic analysis and enzyme immobilization.

BCH 606 Plant Biochemistry II (2+0)

Theory

Phytohormones and their mode of action, signal transduction. Biochemistry of seed development and germination, Biochemistry of fruit ripening.

Biochemistry and significance of secondary metabolites – cyanogenic glycosides, glucosinolates, phenolic compounds, steroids and terpenoids, alkaloids; their role in plant defense system.

Plant defense response, antimicrobial molecules; genes for resistance, hypersensitive response and cell death; systemic and acquired resistance.

Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation.

Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

BCH 607 Current Topics in Biochemistry (1+0)

Theory

Advanced topics related to Nutrition and metabolism.

Advanced topics related to enzymology and industrial biochemistry.

Advanced topics related to molecular biochemistry and immunology.

Advanced topics related to metabolic engineering and bioprospecting.

BCH 608 Functional Genomics and Metabolomics (2+0)

Theory

Protein and nucleic acid sequencing: Various methods of sequencing including automated sequencing and microarrays, whole genome sequence analysis.

Comparative genomics, functional genomics, transcriptomics, gene identification, gene annotation, pairwise and multiple alignments, application of genomics, Quantitative PCR, SAGE, MPSS, microarray.

Proteome technology: 2D-PAGE, MSMS, MALDI-TOF, protein microarray, comparative proteomics and structural proteomics.

Metabolic pathway engineering, vitamin A engineering in cereals, microarray analysis, role of bioinformatics in functional genomics.

BCH 609 Environmental Biochemistry (2+0)

Theory

Environmental pollutants, their classification, sources and impact on living beings.

Effect of various pollutants on animal, plant and microbial metabolism; their detoxification mechanism in animals, plants and microbes. Biochemical basis of pollutant tolerance.

Soil enzymes, their source and role in environment.

PG Agricultural Chemicals Syllabus

BCH 521 Basic Chemistry I (2+1)

Theory:

Structure of atom, electronic theory of valency. Dipole moments, electron displacements (inductive, electromeric, mesomeric effects). Hydrogen-bonding, atomic and molecular orbitals. Types of organic reactions, carbocations, carbanions and free radicals.

Nomenclature, general methods of preparation, properties and uses of alcohols, aldehydes, ketones and mechanisms of associated reactions.

Nomenclature, preparation and properties of alicyclic compounds, Diels-Alder reaction. Theories of aromaticity, substitution in benzene ring, orientation for further substitution. Preparation, properties and uses of substituted aromatic compounds (halogenated, nitro, amino compounds, diazonium salts, phenols and aromatic acids) and mechanisms of associated reactions. Bicyclic – naphthalene and naphthaquinone.

Heterocyclic compounds: nomenclature of furan, thiophene, pyrrole, indole, pyrazole, imidazole, oxazole, thiazole, pyridine, piperidine, quinnoline, isoquinnoline, pyran, diazine etc. and their properties.

Introduction to natural products: chemistry of steroids and terpenoids, alkaloids and flavonoids.

Practical

General aspects, detection of functional groups and preparation of their derivatives. Separation and identification of organic compounds in binary mixtures. Identifying tests of natural products.

BCH 522 Chemistry of Insecticides and Acaricides-I (2+1)

Theory

Introduction and classification of synthetic insecticides, chemistry of conventional organochlorine insecticides: DDT, HCH, Lindane; uses, mode of action. Cyclodiene insecticides: nomenclature, uses, synthesis and mode of action of aldrin, dieldrin and endosulfan.

Organophosphorus insecticides: chemistry, classification and mode of action. Important reactions namely Michaelis-Arbuzov reaction, Perkow reaction, Thiono-thiolo rearrangement. Preparation, properties and uses of eidfenphos, fenthion, DDVP, monocrotophos, phosphamidon, chlorfenvinfos, malathion, ethyl parathion, fenitrothion, quinalphos, diazinon, chlorpyrifos, disulfoton, dimethoate, ethion, methamidophos, acephate, azinphos-methyl.

Chemistry of carbamate insecticides: classification, synthesis, uses and mode of action of carbofuran, carbaryl, aldicarb, methomyl and propoxur.

Synthetic pyrethroids: Chemistry, classification, mode of action, history and evolution from natural pyrethrins. Preparation, synthesis, uses and properties of cypermethrin,

deltamethrin, fenvalerate, fluvalinate, cyfluthrin, trifenthrin; non-ester pyrethroid – ethofenprox.

Neonicotinoids: Chemistry, classification, mode of action and uses. Preparation, properties and uses of imidacloprid, acetamiprid, thiocloprid.

General introduction and mode of action of ecdysones and ecdysoids. Inhibitors of chitin synthesis, chemosterilants.

Acaricides: Chemistry, classification, mode of action etc. Properties: 2,4-dinitrophenols and esters, benzoic acid esters, dicofol, spinomeisifen.

Practical

Preparation and characterization of DDT, DDE, and Methoxychlor, Preparation of organophosphorus insecticide: Part A – phosphorodichloridite and Part B – phosphonate, Preparation and characterization of oxime ether, Preparation of DDVP. Estimation of different insecticides.

BCH 523 Basic Laboratory Techniques (1+2)

Theory

Laboratory hygiene and safety, laboratory accidents and their management. Human safety and protection, handling and storage of flammable, volatile, health hazardous and corrosive chemicals, glassware safety, emergency response. Precautions and safety while carrying out reactions and handling reaction wastes.

Different types of glassware and their use. Laboratory notebook upkeep, maintenance and importance. Melting and boiling points, their determination, apparatus used and allied information. Distillation, fractional distillation, crystallization. Vacuum filtration.

Purification and drying of solvents. Solvent removal by distillation, evaporation, reduced pressure evaporation and rotary evaporation (Buchi type). Vacuum pumps, water aspirators etc. and their use.

Steam distillation, supercritical fluid extraction, extraction of volatiles by Clevenger apparatus and solid phase extraction.

Chromatography - principle and practice, types etc. Partition and adsorption chromatography with examples (TLC, Paper, GLC, HPLC, Gel, HPTLC etc.). Spot visualization, chromogenic reagents etc. Column chromatography, Introduction to GC and HPLC.

Practical

Introduction to Laboratory equipment and cleaning of glassware, assembling of different apparatus. Purification of solvents, crystallization and sublimation. Chromatography: Paper, Column, TLC, Preparative TLC, HPTLC, Steam Distillation, Elemental Analysis, Use of stirrer, pump and presentations.

BCH 524 Pesticide Residue Analysis (1+1)

Theory

Pesticide residue – concept, types, source, steps of analysis: sampling, extraction, clean up and estimation; significance and safety considerations: risk assessment and management, hazard identification etc. Definitions with examples: aged residue, immobilized residue, dislodgable residue, exposure, adverse effect, bioaccumulation, food chain, acceptable daily intake, theoretical daily intake, estimated daily intake, estimated maximum daily intake, biomagnification, zero tolerance, persistence, dissipation, predicted no effect concentration, raw agricultural commodity. Monitoring of pesticide residue in agricultural produce and environment.

Planning and layout of experiments. Application of analytical techniques for residue analysis such as spectrophotometry, chromatography including GC, HPLC, GC-MS, LC-MS and ELISA.

Qualitative and quantitative analysis. Accuracy and precision. Standardization of extraction and clean up conditions to achieve maximum recovery. Limit of quantification, limit of detection, limit of determination, multi-residue analysis by quick, easy, cheap, effective, rapid and safe (QuEChERS) method and GC/LC-MSMS method. Radiotracer techniques in residue analysis.

Method validation and performance verification. Documentation and audit of laboratory data. Laboratory proficiency testing, Codex Alimentarius Commission and its functions, Calculation of MRL. Introduction to ISO 17025. GLP principles, quality control and assurance in pesticide residue laboratories, system suitability test. Biosensors.

Basic statistics and experimental design. Residue data and legal implications.

Practical

Identification of Organochlorine insecticides in water by TLC, Identification of Carbamate insecticides in water by TLC, Estimation of carbamate insecticide residues in vegetable by visible spectroscopic method, Estimation of Organophosphorus insecticide residues in soil by visible spectroscopic method. Recovery tests of pesticide residues in soil and plant systems.

BCH 525 Chemistry of Fungicides and Nematicides (2+0)

Theory

Historical development of fungicides. Classification based on chemical nature and mode of action. Sulphur, copper, mercury, tin, arsenic and dithiocarbamate fungicides.

Benzene derivatives, phenol, quinone, polyhalogen, alkane sulfenyl group, carboxamide and dicarboximide group of fungicides.

Organophosphorus fungicides (examples, heterocyclic fungicides: Imidazole, benzimidazole, triazole, oxazole, thiazole, pyridine, pyrimidine, quinoline, quinoxaline, morpholine etc).

Fungicides of formamide group, alkane, alkane carboxylic acid and other miscellaneous groups. Strobilurin fungicides and antibiotics.

Historical development of nematicides. Preparation, properties and uses of aliphatic halogen compounds. Methyl isocyanate liberators, organophosphates and carbamates.

BCH 526 Chemistry of Herbicides and PGRs (2+1)

Theory

Classification of herbicides based on time of application, mode of action and selectivity; chemistry of phenoxy acid herbicides: 2,4-D, MCPA, Dichlorprop, Mecoprop, Fenoprop, Phenoxy butyric acid. Urea derivatives: Linuron, Monuron, Metoxuron, Isoproturon, their synthesis and mode of action; chemistry of bipyridylium herbicides - Diquat, Paraquat; and organophosphates.

Aliphatic and benzoic acid herbicides: Dalapon, Dicamba, Amiben; 2,4-Dinitro phenols, Dintro-orthocresol, Chemistry of carbamates and thiocarbamates: Isopropyl N-phenyl carbamate, Isopropyl-N-(3-chlorophenyl) carbamate, Methyl-N-(3,4-dichlorophenyl) carbamate, S-Ethyl N,N-dipropyl thiocarbamate, Diallate, Molinate, Oxime carbamates, Sulfonyl carbamates, Biscarbamates; Chemistry of amides and anilides: Propanil, Pentanochlor, Allidochlor, Butachlor, Metolachlor.

Triazines: Simazine, Atrazine, Metribuzin, Atratone, Ametryne, Prometryne; Dinitroanilines: Trifluralin, Fluchloralin, Pendimethalin; Pyridines: Pyrichlor, Picloram, Triclopyr. Pyridazines: Pyrazones, Metflurazon, Norflurazon. Pyrimidines: Terbacil, Bromacil; Oxadiazoles: Thiazole and Triazole herbicides.

Diphenyl ethers: Flurodifen, Acifluorfen, Oxyfluorfen; Phenoxy-phenoxy acid herbicides: Fluazifop, Fenoxaprop, Clodinafop, Quizalofop; Sulfonylureas: Chlorsulfuron, Metsulfuron methyl, Sulfosulfuron, Pyrazosulfuron ethyl, mode of action, selectivity; Imidazolinones: Imazethapyr, Imazaquin, Imazapyr.

Herbicide uptake, translocation and selectivity, Herbicide safeners – Naphthalic anhydride, Phthalic anhydride, N,N-diallyl Chloroacetamide (Allidochlor), Dichloroacetamides, Cyometrinil, Flurazole, Fenchlorozole ethyl, Cloquinocet mexyl; Relative potency, Prosafeners, Safeners.

Plant Growth Regulators, Auxins, Gibberallin - synthesis, properties. Biosynthesis of Auxins and Gibberallin, Wain's three-point attachment theory, Cytokinins, Brassionosteroids.

Practical

Synthesis of 2,4-D, its m.p, TLC, UV-VIS, IR, GC-MS, NMR study; Preparation of nitrosomethyl urea, Preparation of diazomethane and derivatization of 2,4-D, GC of methyl derivative, Synthesis of propionyl chloride and its distillation, its TLC, UV-VIS, IR, GC-MS, NMR study, Synthesis of Propanil, m.p, its TLC, UV-VIS, IR, GC-MS, NMR study, Synthesis of Maleic hydrazide, m.p, its TLC, UV-VIS, IR, GC-MS, NMR study, Educational Tour to some Agrochemical Factory/ Laboratory, if any.

BCH 527 Chemistry of Botanicals and Biopesticides (2+0)

Theory

Conventional natural insect control agents such as pyrethrins, rotenones, nicotine, ryanodine, isobutylamides, drimane sesquiterpenoids, withanolides, clerodanes, quassinoids and limonoids - sources, isolation, characterization, synthesis, application and mode of action.

Insect behaviour modifying chemicals (Semiochemicals) – pheromones. Allelochemicals: allomones, kairomones, synomones, apneumones. Insect hormones: JH, Anti-JH, JH-mimics, feeding deterrents and repellents – both natural and synthetic: sources, chemistry, mode of action etc.

Phytoalexins, stress metabolites: Sources such as Leguminosae, Solanaceae etc. Acetylene and polyacetylene phytoalexins. Chemistry, use and mode of action natural fungicides, nematicides including photo-activated pesticides like α-terthieyl.

Pesticides of microbial origin: Sources, chemistry and mode of action of tetranactin, avermectins, milbimycins and spinosad. Herbicides like biolaphos and phosphonothricin. Phytotoxins like *Alternaria alternata* toxin, tentoxin, cornexistin, hydantoxidin. Other microbials such as NPV based insecticides.

Allelochemicals and chemical ecology. Application of biotechnology in pest management.

BCH 528 Analytical Techniques in Pesticide Chemistry (2+1)

Theory

Absorption spectroscopy: UV-VIS and IR spectrophotometry, their theory, principle, instrumentation and application in structure elucidation of organic compounds and analysis.

Separation science and technology: Paper, column, thin-layer, ion exchange and flash chromatography: principle, adsorbents, their preparation, properties, mechanism of retention and application in isolation of organic compounds. GC, LC and HPTLC: principle, instrumentation and application for separation of organic compounds.

Theory, principle, instrumentation and application of NMR and mass spectroscopy in structure elucidation of organic compounds.

Theory and practice of recent techniques in NMR: C13 and 2D for structure elucidation of organic compounds. Tandem techniques such as GC-MS, LC-MS for validation of results of analysis by GC, LC, GPC and HPTLC.

Practical

UV-VIS spectroscopy, IR spectroscopy, Mass spectrometry, NMR spectrometry. Conventional chromatography, advances in chromatography. Structure elucidation of organic compounds using tandem techniques.

BCH 529 Basic Chemistry II (2+0)

Theory

Stereochemistry: Isomers, chiral molecules, optical isomerism. Symmetry elements, asymmetry, chirality, conventions describing configurations: D-L and R-S system. Stereoiso-merism resulting from more than one centre (diastereoisomers). Geometrical isomerism, E-Z system of nomenclature. Conformations of acyclic and cyclic systems.

Chemical thermodynamics - reversible and irreversible processes, first law and its application to ideal and non-ideal gases, second law, entropy and free energy.

Kinetic theory of gases, Maxwell-Boltzmann distribution law. Surface chemistry - chemical and ionic equilibria, law of mass action, pH and buffer solutions. Phase rule and its application, colligative properties.

Chemical analysis – principles and classification, volumetric, gravimetric and potentiometric analyses.

Chemical kinetics – reactions of various order, Arrhenius equation, Collision theory, theory of absolute reaction rate; Chain reactions, normal and branched chain reactions.

Introduction to Photochemistry: theories and types of photochemical reactions, direct and indirect photolysis, photosensitizers, quenchers, light filters, quantum yield. Pericyclic reactions, sigma-tropic rearrangements.

BCH 530 Pesticide Formulations (2+1)

Theory

General aspects: definition, objectives, process, product spectrum, classification, formulation codes etc. Solid and liquid formulations including the latest developments: preparation, properties, specifications, use etc.

Formulants: carriers/ diluents, surfactants, synergists, safeners, encapsulants, antioxidants, stabilizers etc. highlighting chemistry, classification, properties, use etc., formulant-toxicant interactions, pesticide mixtures.

Machinery and equipment, packaging and labeling. Packaging standards, requirement, materials, disposal, decontamination etc. Labeling: content, specifications, needs for low literacy regions, etc.

Application: principles, distribution and coverage, recent developments. Precautions in use of pesticides.

Bio-efficacy: basic considerations and applied aspects, physico-chemical basis, pesticide antidotes.

Practical

Equipment used in formulation research, Determination of acidity of a pesticide, Determination of alkalinity of a pesticide, Preparation of controlled release formulation, Release of active ingredient from CR formulation in soil and water, Preparation of toxicant based creams, Study of solid carriers: Determination of (i) Surface acidity by volumetric method, (ii) Surface area, study of solid carriers, (iii) Sorptivity and (iv) Particle size. Preparation of dust, wettable powder and granules, Determination of wettability and suspensibilty of wettable powder, Study of liquid carriers (i) Flash point

and specific gravity, Study of liquid carriers (ii) Determination of viscosity. Study of surfactants: Micelle formation, Preparation of liquid formulations, Determination of emulsion stability of an emulsifiable concentrate, Application technology: Sprayers.

BCH 531 Movement, Degradation and Metabolism of Pesticides (2+0)

Theory

Movement and fate of pesticides in the environment: Drift, volatilization, adsorption, desorption, leaching, runoff etc. Soil pesticide interactions. Movement in plant, animal and other living systems: Penetration, translocation, excretion etc. (role of physico-chemical parameters).

Persistence – factors affecting (physical, chemical, biochemical etc.), primary and secondary metabolites in plants and animals with examples. Biotic and abiotic transformations. Biochemical transformations in living systems.

Photochemical transformation of pesticides: Phototransformation products and their significance. Other abiotic factors transforming xenobiotics.

Chemical transformation of xenobiotics – effect of pH, moisture, environmental gases etc.

Food chain in environment – significance and implications.

BCH 621 Regulations and Quality Control of Pesticides (2+0)

Theory

Current status of plant protection agrochemicals, The Insecticides Act, laws, acts and regulations for the social security and welfare of industrial labour. Acts relating to protection of air, water and the general environment.

Quality, quality control, role of industry, government etc. Imitation and adulteration in the developing world. Establishment of a quality control laboratory in pesticide formulation as per BIS specifications.

Interaction with industry for practical knowledge on the above topics.

BCH 622 Advances in Insecticide Chemistry (2+0)

Theory

Recent advances in insecticide development, new generation insecticides with novel mode of action. Safer insecticides, endocrine-based, nervous system based, different metabolic pathways based insecticides; pro-insecticides.

Natural products from plants, animals and microorganisms; virus and bacteria as source of insecticide, spider toxins as lead structure for novel pesticides.

BCH 623 Advances in Fungicide and Herbicide Chemistry (2+0)

Theory

Recent advances in fungicides and herbicides development. New generation fungicides and herbicides with novel mode of action. Recent developments in botanicals and bio-pesticides with reference to fungicides and herbicides.

BCH 624 Practicals in Pesticide Chemistry (0+1)
(Based on BCH 622 and BCH 623)

Practical

Identification and estimation of modern insecticides, fungicides and herbicides. Extraction of active ingredient from formulations and their purification. UV-VIS, IR, HPLC and GC-MS analysis of some insecticides, fungicides and herbicides. Preparation of metabolites, Photodegradation of pesticides, Leaching of pesticides.

BCH 625 Special Topics in Agrochemicals (1+0)

Theory
The teacher will give a topic relevant to the area of specialization of the student as a Term Paper to develop proficiency in his field of research.

BCH 626 Principles of Pesticide Chemistry (2+0)

Theory

Mode of action of different classes of insecticides, fungicides and herbicides including mew generation molecules.

Structure-activity relationship of different classes of insecticides, fungicides and herbicides including mew generation molecules.

BCH 627 Pesticides and Environmental Risk Assessment (2+0)

Theory

Source and movement of pesticides in environmental components like soil, air, water, flora and fauna, and other non-target organisms. Fate and adverse effects of pesticides on them.

Decontamination of pesticides through physical, chemical, photochemical, microbial, enzymatic and biotechnological techniques. Ground water decontamination. Different methods of pesticide disposal (physical, chemical, incineration and soil treatment). Disposal of industrial effluents and related xenobiotics.

Registration and legalisation of pesticide residue data. Role of pesticide residue analysis in monitoring and decision making of pesticide use. GLP in pesticide residue analysis.

WHO and FAO code of conduct for pesticide residue in environmental components.