RAMAKRISHNA MISSION VIVEKANANDA EDUCATIONAL & RESEARCH INSTITUTE

(Declared by Government of India under section 3 of UGC Act, 1956)

P.O. Belur Math, District- Howrah, West Bengal: 711202

INTEGRATED RURAL DEVELOPMENT & MANAGEMENT (IRDM) FACULTY CENTRE

at

Ramakrishna Mission Ashrama, Narendrapur, Kolkata: 700 103

Two year M. Sc. in 'Agricultural Biotechnology'

PROPOSED COURSE CONTENT (with effect from academic year 2017-18)

Semester-I

ABT 101: Fundamentals of Crop Production (3+2) credits
ABT 102: Fundamentals of Crop Improvement (3+2) credits
ABT 103: Plant Physiology (1+1) credits
ABT 104: Biostatistics –I (2+1) credits
ABT 105: Molecular Biology (2+0) credits
ABT 106: Plant Tissue Culture (2+2) credits
ABT 107: Spiritual and Cultural Heritage of India-I (2+0) credits
Total: 15+ 8 = 23

Semester-II

ABT 201: Fundamentals of Crop Protection (3+2) credits
ABT 202: Plant Biochemistry (2+1) credits
ABT 203: Biostatistics –II (1+1) credits
ABT 204: Microbiology (3+2) credits
ABT 205: Genetic Engineering (2+0) credits
ABT 206: Agricultural Extension (1+1) credits
ABT 207: Cell Biology (2+1) credits
ABT 208: Spiritual and Cultural Heritage of India-II (2+0) credits
ABT 209: Seminar-I (0+1) credit
Total: 16+ 9 = 25

Semester-III

ABT 301: Immunology (2+0) credits
ABT 302: Bioinformatics (1+1) credits
ABT 303: Molecular Breeding (2+1) credits
ABT 304: Genomics and Proteomics (2+0) credits
ABT 305: Transgenic in Crop improvement (2+0) Credits
ABT 306: Environmental Biotechnology (2+2) credits
ABT 307: Molecular Tools and Techniques (0+2) credits
ABT 308: Organizational/ Industrial Placement (0 + 9) credits
ABT 309: Seminar –II: Proposed Plan of Dissertation Work (0+1) credits
Total: 11+16 = 27

Semester-IV

ABT 401: Seminar-III (0+1) credits
ABT 402: Dissertation work (0+24) credits
Total: 0 + 25 = 25

Optional/ Special Papers

ABT 403: Entrepreneurship Development and Marketing (2+2) credits
ABT 404: Agricultural Extension (1+1) credits
ABT 405: Pharmacognosy and phytochemistry of Medicinal and Aromatic Plants (3+2) credits
ABT 406: Organic Farming: (3+4) credits

Semester-I [Total: 15 (T) + 8 (P) = 23 credits/ 414 hours]

ABT 101: Fundamentals of Crop Production (3+2) credits

Theory: 3 Credits/ 54 hours

1. Agroclimatic zones of West Bengal. **1 hour**
2. Classification of Crops. **1 hour**
3. General principles of Crop production: Climate, soil preparation and Tillage, Seeds sowing and Seed Treatment, Nutrient Management, Water Management, Intercultural Operations, Plant protection measures, Harvesting, Threshing and Stoarge. **8 hours**
4. General principles of Seed Production: Characteristic of good quality seed; quality seed production, Seed certification, Hybrid seed production, Seed storage. **6 hours**
5. Crop rotation, Principles, Advantages and Factors affecting the selection of crop rotation. Crop sequences and system with emphasis on mixed cropping, inter cropping and multiple cropping. **2 hours**
6. Basics of Soil Science: Basic concept of soil, Soil formation, Soil Components, Soil elements, soil texture, structure, Soil organic matter, Soil water, C: N ratio and its importance, Problem soils and reclamation, Plant nutrients, essentiality criteria, role of essential nutrients, Soil testing, Fertilizer and manure. **16 hours**
7. Basics of Horticulture and Medicinal plant: Sub disciplines of horticulture, Techniques for horticultural plant propagation through Cutting, Budding, Grafting. Common medicinal plants, their medicinal uses. Extraction, isolation and purification of bioactive compound of plant origin and general cultivation practices. **12 hours**
8. Organic Farming: Concept, principles and methodology, Quality, certification, Marketability and export of Organic product, Different low cost input like Panchagavya, Amritpani; Preparation of cow dung and cattle urine, concepts of biodynamic agriculture: BD500 and 501. **8 hours**

Practical: 2 credits/ 36 hours

1. Identification of seeds, crops, implements etc. **4 hours**
2. Crop production practices (Conventional and organic farming) throughout the season. **10 hours**
3. Practice of techniques for horticultural plant propagation in different types of plants. **6 hours**
4. Visit to any seed production farm. **6 hours**
5. Seed germination test. **2 hours**
6. Seed viability test. **2 hours**
7. Soil sampling, Soil testing (pH, EC, Org C, N, P, K). **12 hours**
8. Fertilizer calculations. **2 hours**
9. Preparation and use of Panchagavya, Amritpani, Poudh Sanjibani, Homemade pesticides and fungicides etc. Preparation of BD500 and 501. **4 hours**
10. Study of common medicinal plants and their effective parts **4 hours**
11. Methods of extraction of bio-reactive compound of some medicinal plants **6 hours**

ABT 102: Fundamentals of Crop Improvement (3+2) credits

Theory: 3 Credits/ 54 hours

1. Basics of plant genetics: Early concepts of inheritance, Mendelian Genetics, Extra chromosomal inheritance, Chromosome and its structure, Genetic fine structure analysis, Gene interaction, Linkage and crossing over, Polygenic interaction, Chromosomal Aberration, Sex determination, Differentiation and Sex-linkage, Sex-influenced and Sex-limited traits; Mutation and mutagenic agents, Concepts in population genetics, Hardy-Weinberg law; Factors distinguishing Hardy-Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Transposon. **30 hours**

2. Basics of plant breeding: Breeding in Agricultural development, Plant introduction and domestication, Centre of origin, Concept about Germplasm and its conservation, Gene bank (field and seed), role of IBPGR, Reproduction of Flowering plants, Pollination and fertilization, Male sterility & incompatibility. **14 hours**

3. Breeding method for crop improvement: Selection (Mass and Pure line), hybridization and handling of hybrid population in relation to self and cross fertilized crops, Hybrid vigour and heterosis exploitation, Stress (biotic and abiotic) resistance breeding. **10 hours**

Practical: 2 Credits/ 36 hours

1. Study of floral morphology of different crops (Self- and cross pollinated crops). **8 hours**
2. Laboratory exercises in probability and chi-square. **2 hours**
3. Chromosome mapping using three point test cross. **2 hours**
4. Induction of mutation through EMS. **2 hours**
5. Numerical problems on Hardy Weinberg Equilibrium. **2 hours**
6. Analysis of components of genetic variation. **4 hours**
7. Demonstration of hybridization technique. **6 hours**
8. Handling of Statistical package for genetic analysis (Genetic parameters, heritability, genotypic and phenotypic correlation, Path analysis, D^2 analysis). **10 hours**

ABT 103: Plant Physiology (1+1) credits

Theory: 1 Credit/ 18 hours

1. Plant physiology and its significance in agriculture. **2 hours**
2. Plant cell water relation, properties of water- physical and chemical, Transpiration and its mechanism. **2 hours**
3. Outline of plant nutrients relating to its role and deficiency symptoms, Hydroponics and its utility. **2 hours**
4. Photosynthesis- C_3, C_4 and CAM mechanism, Photorespiration. **3 hours**
5. Respiration- Aerobic and anaerobic, salt respiration. **3 hours**
6. Stress physiology related to drought, salinity and metal toxicity. **2 hours**
7. Photoperiodism and vernalization related to flowering. **2 hours**
8. Basic concept of plant growth regulators and its role in agriculture, Growth retardant. **2 hours**

Practical: 1 Credit/ 18 hours

1. Determination of osmotic potential of a plant cell. **1 hour**
2. Determination of rate of transpiration from a given leaf. **2 hours**
3. Determination of stomatal frequency of a given leaf. **2 hours**
4. Role of ABA and Cytokinin on stomatal behavior. **2 hours**
5. Separation of chlorophyll and its estimation by spectrophotometer. **2 hours**
6. Determination of respiration rate by respiroscope. **2 hours**
7. Determination of rate of respiration by the application of respiratory inhibitors. **2 hours**
8. Determination of osmotic potential of potato tuber on wet weight basis. **2 hours**
9. Effect of PEG on seed germination behavior. **2 hours**
10. Effect of NaCl on seed germination behavior. **1 hour**

ABT 104: Biostatistics –I (2+1) credits

Theory: 2 Credits/ 36 hours

1. Agricultural Statistics- Meaning and importance, its Characteristics. Analysis and interpretation of data: Data- Definition, types (Qualitative vs. Quantitative) Presenting quantitative Data-

Graphical presentation (Bar diagram, Histogram, Frequency Polygon, Ogive, Pie chart etc.); Tabular presentation (Simple, Bivariate, Multivariate). **6 hours**

2. Measures of Central Tendency: Mean- definition, properties, advantage and disadvantages, use; Median- Definition, properties, advantage and disadvantages, use; Mode- Definition, properties, advantage and disadvantages, use. Interpretation and Conclusion. **4 hours**

3. Measures of Dispersion: Range, Mean deviation, Quartile deviation, Standard deviation, Variance etc: Deviation and use; Skewness and Kurtosis, Interpretation and Conclusion. **4 hours**

4. Correlation and regression: Definition, Simple correlation coefficients its properties, Rank correlation coefficients, Partial correlation coefficients, multiple correlation coefficients, Regression analysis, concepts of regression line and its utility, interpretation and conclusion. **6 hours**

5. Elementary concept of Normal Distribution, Binomial distribution and Poison distribution. **6 hours**

6. Hypothesis- Definitions, Types, Sources, Utility, and Characteristics of good hypothesis, Z-test, t-test, F-test, $\chi 2$ test: definition and application. **10 hours**

Practical: 1 Credit/ 18 hours

1. Graphical presentation (Bar diagram, Histogram, Frequency Polygon, Ogive, Pie chart etc.); Tabular presentation. **2 hours**

2. Practical on mean, median and mode. **4 hours**

3. Analysis of measures of dispersion and skewness and kurtosis. **4 hours**

4. Analysis of correlation and regression. **3 hours**

5. Study on Z-test, t-test, F-test, $\chi 2$ test. **2 hours**

6. Use of Computer in Research (Concepts only)- entry; Data Presentation and Analysis using appropriate Software: Statistical Packages. **3 hours**

ABT 105: Molecular Biology (2+0) credits

Theory: 2 Credits/ 36 hours

1. Historical development of Molecular Biology. Nucleic acid as genetic material with experimental evidences. **4 hours**

2. Nucleic acids: DNA structure; Watson and Crick model, A, B, Z and Triplex DNA; DNA contents and C-Value paradox, denaturation, renaturation and cot curve. Physical and Chemical properties of DNA. RNA: Structure, types and function. **7 hours**

3. DNA replication in prokaryotes and eukaryotes; Enzymes and accessory proteins and their structure and function; fidelity, proof reading, processivity; replication of single stranded circular DNA, DNA repair: Enzymes, photo reactivation, nucleotide excision repair, mismatch correction, SOS response. **9 hours**

4. Transcription: Prokaryotic transcription, transcription unit, promoters- constitutive and inducible, operators; eukaryotic transcription- RNA polymerases structure, types and function; general transcription factors, Post transcriptional modification; RNA processing (processing of mRNA, tRNA and rRNA), RNA splicing. **6 hours**

5. Translation: Structure and function of ribosome; genetic code, properties of genetic code, Wobble hypothesis, Translational frame shifting and RNA editing; protein synthesis in prokaryotes and eukaryotes (initiation, elongation and termination). Post translational modification and transport of proteins. **6 hours**

6. Regulation of gene expression in prokaryotes and eukaryotes. **4 hours**

ABT 106: Plant Tissue Culture (2+2) credits

Theory: 2 Credits/ 36 hours

1. History of plant cell and tissue culture, Application of tissue culture in crop improvement,

Culture media, Sterilization technique, Totipotency, types of culture, Micro propagation. **10 hours**
2. Organogenesis (direct and indirect), Embryogenesis (direct and indirect), Somaclonal and gametoclonal variation, somatic embryos and artificial seeds- Cryopreservation. **8 hours**
3. Meristem culture vis-à-vis virus elimination, Protoplast culture vis-à-vis wide hybridization, protoplast fusion, somatic hybrids, protoplast viability test, Embryo culture and embryo rescue, Anther culture vis-à-vis dihaploids, Cell suspension culture and secondary metabolites, hardening techniques. **18 hours**

Practical: 2 Credits/ 36 hours

1. Laboratory set up **2 hours**
2. Sterilization of glass goods, plastic wares, media and plant materials **2 hours**
3. Formulation and preparation of media for shoot and root initiation. **4 hours**
4. Fresh Culture for micropropagation **4 hours**
5. Sub culturing **4 hours**
6. Direct organogenesis using suitable explants. **6 hours**
7. Indirect organogenesis using suitable explants **6 hours**
8. Suspension culture development from calli **4 hours**
9. Somatic embryogenesis from calli. **2 hours**
10. Embryo culture, Anther culture **2 hours**

ABT 107: Spiritual and Cultural Heritage of India-I (2+0) credits

Theory: 2 Credits/ 36 hours

1. Shanti Mantras and some selected vedic hymns-Shraddha Suktam, Sangha mantra etc. **2 hours**
2. Swami Vivekananda's Message to the Youth: It is youth who will transform this nation, Take up an ideal and give your whole life to it, Stand on your own feet, Awaken the spirit of 'Rajas' within you, Believe in yourself, Be bold and fearless, Expand your heart, Be open to learning from anyone, Develop a gigantic will. **10 hours**
3. Swami Vivekananda's Message to Reformers: Liberty is the first condition for growth, Affirm; Do not condemn, Don't lead but serve, Act with unselfish motives, create 'sanction' from the people, The Indian Nation will rise only when the self-esteem of the masses is raised, Real social reform will happen when the people learn to help themselves. **12 hours**
4. Swami Vivekananda's message to Educationists: manifest the infinite knowledge within, man-making education, strengthen faith and pride in ourselves as a nation, focus on character-building assimilation of ideas, enable the student to learn, enable individuals to find solutions to the challenges of life, give ideas and culture, develop the power of concentration. The condition necessary for the teacher, the taught and for effective transfer of learning. **12 hours**

Semester-II [Total: 16 (T) + 9 (P) = 25 credits/ 414 hours]

ABT 201: Fundamentals of Crop Protection (3+2) credits

Theory: 3 Credits/ 54 hours

1. Basics of Agricultural Entomology, Acarology, and Nematology: Concepts of pests, type of pests and related group of pesticides. Basic knowledge of insect, life cycle, and metamorphosis, major insect orders and their characteristics. Important insect pests of some important field crops and horticultural crops. Mite: Characteristics, causes of mite pest outbreak, some important species of mite and their damage symptom, predatory mite. Economic importance of nematodes, their damage symptoms and control. IPM with special reference to Chemical control, biological control, Botanical pesticides. Non-insecticidal-chemicals for pest control: Antifeedent, repellant, attractant, hormonal, semio-chemicals, Insect resistance. **31 hours**

2. Basics of Plant Pathology. Fungus: Characteristics of important phyla: Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Oomycota, Hypochytriomycota, Plasmodiophoromycota; mode of action. Important fungal diseases of some important field crops and horticultural crops. Phytopathogenic bacteria: Importance, mode of action, important bacterial diseases of some important field crops and horticultural crops. Virus: Symptomatology of important plant viral diseases, transmission, host virus interaction, virus vector relationship, Plant viral diseases of some important field crops and horticultural crops. Disease management with special reference to chemical control, Biological control, antagonistic fungi and bacteria, Disease resistance. **31 hours**

3. Basics of weed science and their control: Weed biology and ecology, weed classification, crop-weed competition, allelopathy, weed indices. Principles of weed management (preventive, control and eradication). Herbicides: classification based on chemical nature, method and time of application; selectivity; mode and mechanism of action of herbicides. factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures. Weed control through bio-herbicides, mycoherbicides and allelochemicals, herbicide resistance in weeds and crops; herbicide rotation. Weed management in major crops and cropping systems. Parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control Integrated weed management. **18 hours**

Practical: 2 Credits/ 36 hours

1. Dose calculation and application of chemical pesticides. **4 hours**
2. Identification of different types of damage/ symptoms by insect pest/ diseases. **6 hours**
3. Collection of insect pest, natural enemy, damaged plant parts and preservation. **4 hours**
4. Collection and dry preservation of diseased specimens of important crops. **4 hours**
5. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters. **6 hours**
6. Identification of different plants with properties of insecticidal action, Production procedure of botanical pesticides. Testingon target group, and isolation of Azadirechtin. **6 hours**
7. Isolation, mother culture development, production, formulation and testing efficiency in laboratory of antagonistic fungi and Bacteria. **8 hours**
8. Isolation, mother culture development, production, formulation and testing efficiency in laboratory of entomo-pathogenic fungi and Bacteria. **8 hours**
9. Multiplication of parasitoids, Predators and coccinellids etc. **10 hours**
10. Identification of important weeds of agricultural crops and preparation of weed herbarium. **4 hours**

ABT 202: Plant Biochemistry (2+1) credits

Theory: 2 Credits/ 36 hours

1. Scope and importance of biochemistry in agriculture; fundamental principles governing life;

structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waal forces; general introduction to physical techniques for determination of structure of biopolymers. **6 hours**

2. Chemistry, structure, function and metabolism of biomolecules- carbohydrates, amino acids, proteins, lipids and nucleic acid. **15 hours**

3. Enzyme catalysis– general principles of catalysis; Enzyme properties and classification; Mechnaism of enzyme action; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes, isozymes. **10 hours**

4. Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers. **6 hours**

5. Vitamins: Classification, importance and biological function, deficiency symptom. **3 hours**

Practical: 1 Credit/ 18 hours

1. Estimation of reducing Sugar. **2 hours**
2. Estimation of non-reducing sugars. **2 hours**
3. Estimation of protein content. **2 hours**
4. Estimation of oil. **2 hours**
5. Estimation of saponification value and acid value of oil. **2 hours**
6. Practical on chromatographic technique- TLC, Column, HPLC, HPTLC etc. **8 hours**
7. Estimation of enzyme. **2 hours**

ABT 203: Biostatistics –II (1+1) credits

Theory: 1 Credit/ 18 hours

1. Sampling: Meaning and Significance, Types, different Sampling methods, Sampling errors and biases. **6 hours**

2. Design of Experiments: Definition, importance etc., Principles of design of experiments, Concepts of Uniformity trial and contour map. **2 hours**

3. Completely Randomized Design (CRD): Definition, model, Lay out, Analysis of Variance (ANOVA), Advantages and Disadvantages. **2 hours**

4. Randomized Block Design (RBD): Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. **2 hours**

5. Latin Square Design (LSD): Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. **2 hours**

6. Split Plot Design: Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. **3 hours**

7. Factorial Design: Definition, model, Lay out, Analysis of Variance, Advantages and Disadvantages. **3 hours**

Practical: 1 Credit/ 18 hours

1. ANOVA of Completely Randomized Design (CRD). **2 hours**
2. ANOVA of Randomized Block Design (RBD). **2 hours**
3. ANOVA of Latin Square Design (LSD). **2 hours**
4. ANOVA of Split Plot Design. **4 hours**
5. ANOVA of Factorial Design. **4 hours**
6. Analysis of variance using appropriate Software: Statistical Packages. **6 hours**

ABT 204: Microbiology (3+2) credits

Theory: 3 Credits/ 54 hours

1. The History of Microbiology, Microbial classification, Microbes and Agriculture. **4 hours**
2. Microbial cell culture techniques: Laboratory status, Different media for fungi, bacteria, actinomycetes etc; Isolation of target organism from plant parts, soil etc. including surface sterilization, dilution etc; for incubation-moist chambering etc, Sterilization of medium, glass wares etc.; Transfer of culture to media. **8 hours**
3. Microscopic technique in microbial culture, Micrometry, the Dark-field microscope, Phase-contrast microscope, Differential Interference Contrast Microscope, The Fluorescence Microscope. Staining techniques, Electron microscopy, Transmission electron microscopy and Scanning Electron microscopy, Scanning Probe Microscopy. **12 hours**
4. Microbial Nutrition- The Common Nutrient Requirements; Requirements for Carbon, Hydrogen, and Oxygen; Nutritional Types of Microorganisms, Requirements for Nitrogen, Phosphorus, and Sulfur, Growth Factors, Uptake of Nutrients by the Cell, Culture Media, Isolation of Pure Cultures, Colony Morphology and Growth, Chemotaxis, Bacterial Endospore. **8 hours**
5. Microbial growth, Measurement of Microbial Growth, The Chemostat, The Turbidiostat, Influence of Environmental Factors on Growth, Quorum Sensing and Microbial Populations-Control of Microorganisms by Physical and Chemical Agents. **8 hours**
6. Soil microbiology: Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil, Siderophores, Soil microbial biomass; Soil enzymes; Plant growth promoting rhizobacteria. **10 hours**
7. Mushroom: Importance of mushroom as food, edible, non-edible mushroom species; spawn production, culture of mushroom, processing of mushroom. **10 hours**

Practical: 2 Credits/ 36 hours

1. Sterilization and preparation of media, Enumeration of bacteria and fungi from environmental samples – soil and plant parts (moist chambering). **6 hours**
2. Techniques for pure culture-streaking, pour plate and spread plate. **6 hours**
3. Differential, Negative, and Spore Staining techniques. **6 hours**
4. Micrometry. **4 hours**
5. Determination of ammonification. **4 hours**
6. Determination of Nitrification. **4 hours**
7. Determination of microbial denitrification. **2 hours**
8. Practice of mushroom production technology, spawn production and processing. **8 hours**

ABT 205: Genetic Engineering (2+0) credits

Theory: 2 Credits/ 36 hours

1. Host restriction and modification system, Restriction enzymes and cutting of DNA. DNA ligase and ligation of DNA molecules, DNA modifying enzymes: Kinase, Alkaline phosphatase, Terminal transferase etc., Linkers and Adapters. **8 hours**
2. Gene cloning: cloning vector, Salient features and uses of most commonly used vector i.e.; Plasmid, Bacteriophage, Phagemid, Cosmid, BAC,YAC, PAC and cloning stratigies, Shuttle vector, Expresson vectors, Chromosome walking, Probe preparation and labeling, radio labeling and non radio labeling. Gene libray: Genomic library and cDNA library, Identification of desired cloned gene by Colony hybridization, plaque hybridization and Immunological assay. **10 hours**
3. DNA estimation, Electrophoresis- Agarose electrophoresis, Sodium dodecyl sulphate gel electrophoresis (SDS-PAGE). Polymerase Chain Reaction (PCR), DNA sequencing. Blotting technique: Southern, Northern and Western blotting. **14 hours**

4. Gene transfer: Agrobacterium mediated gene transfer; Ti plasmid, Ri plasmid and T DNA, Cointegrate vector and binary vector, Transformationtechnique, Marker gene, Reporter gene, Virus mediated gene transfer, Direct gene transfer: Electroporation, Particle Bombardment, Microinjection, Macroinjection, Chemical method. **8 hours**

ABT 206: Agricultural Extension (1+1) credits

Theory: 1 Credit/ 18 hours

1. The Concept of Agricultural Extension and its scope **2 hours**
2. Fundamentals of Rural Society and Rural Organizations: Features of rural society, characteristic of rural people, structure of rural society; Culture: Concept, Function, relation to Extension; Groups: Concept, Typology, Importance in Extension; PRI system 7 **hours**
3. Technology Transfer in Agriculture: The Concept of Technology, Typology, Stages of Technology Transfer, Technology Assessment and Refinement **2 hours**
4. Extension Methods: Communication *vis-a-vis* Agricultural Extension; Extension Methods and Audio-visual Aids; Adoption and Diffusion of Agricultural Innovations **5 hours**
5. System of Extension in India: First Line Extension, Public Extension, Private Extension: voluntary sector and corporate houses; ATMA system **2 hours**

Practical: 1 Credit/ 18 hours

1. Conducting a Village Survey and Report Preparation (including interaction with farmers and visit to farmers' field) **6 hours**
2. Preparation and application of extension teaching methods/A-V aids **[Assignment]**
3. Visit to an Agricultural Extension organization/office (ADA Office/KVK/NGO) **6 hours**
4. Visit to agricultural input retailers' shop and interaction with farmers **6 hours**

ABT 207: Cell Biology (2+1) credits

Theory: 2 Credits/ 36 hours

1. Prokaryotic and eukaryotic cell architecture. **2 hours**
2. Membrane structure and function: Structural models; composition and dynamics; Transport of ions and macromolecules; pumps, carriers and channels; Endo and Exocytosis; membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata. **6 hours**
3. Cell organelles: Nucleus- structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Cell cycle and control mechanisms; Mitochondria- Structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution. Structure and function of Golgi apparatus, ER, Peroxisomes, Glyoxisomes, Vacuoles. **10 hours**
4. Cell division: Mitosis and Meiosis, Cell cycle checkpoint. **6 hours**
5. Plant Meristem Organisation and Differentiation: Organization of Shoot Apical Meristem (SAM); organization of Root Apical Meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Embryo and Endosperm development; growth and differentiation. **8 hours**
6. Cell signaling and cell transduction: The basic elements, Extracellular messengers and their receptors, Protein coupled receptors and second messenger, Calcium as an intracellular messenger, Apoptosis. **8 hours**

Practical: 1 Credit/ 18 hours

1. Preparation and use of fixatives. **2 hours**
2. Preparation of stain for chromosome study. **2 hours**

3. Pretreatment in cytology. **1 hour**
4. Mounting media. **1 hour**
5. Permanent slide preparation. **2 hours**
6. Pyronin-Methyl green staining. **2 hours**
7. Feulgen- Light green solution. **2 hours**
8. Observation of mitotic cell division. **4 hours**
9. Observation of meiotic cell division. **4 hours**

ABT 208: Spiritual and Cultural Heritage of India-II (2+0) credits

Theory: 2 Credits/ 36 hours

1. Selected vedic hymns: Medha Suktam, Durga Suktam, Acharyopadesha etc. **2 hour**
2. Swami Vivekananda's message on women's empowerment: the ideal of woman as mother, womanhood personified in Sita, as warrior, eligibility for the highest knowledge, common humanity grounds, respecting the women, all round education of women, develop their own solutions. **12 hours**
3. Swami Vivekananda's message on the uplift of the masses: Dedicate yourself, develop faith in equality and oneness of man, educate the masses, solution to the caste problem. **13 hours**
4. Swami Vivekananda's message on restoring our national glory: India's ideal is spirituality, India's mission is spiritual regeneration of the world, India's solution to life's challenges, India must share the spiritual knowledge with the West and gain material knowledge from them, India is readying for its time under the sun. **13 hours**

Semester-III [Total: 11 (T) + 16 (P) = 27 credits/ 414 hours]

ABT 301: Immunology (2+0) credits

Theory: 2 Credits/ 36 hours

1. Overview on immune system: innate and acquired immunity, Organ and cells of immune system- Primary and secondary lymphoid organs. Humoral immune response and cell mediated response, ADCC; Cytokines– Properties, structure and uses. Interferons, Immunoglobulin– Basic structure, Class and subclass. Molecular organization of immunoglobulin, Immunoglobulin super family. **8 hours**

2. Major Histocompatibily complex: MHC genes, types, MHC and immune responsiveness and disease susceptibility, HLA typing. Cellular distribution of MHC expression. T cell receptor; structure, function overview on TCR mediated Signalling. **8 hours**

3. Antigen processing and presentation; Antigen presenting cells and their role. Exogenous antibody and endogenous antibody, Antigen-antibody interaction-precipitation and agglutination reaction, immunodiffusion test, Immunoelectrophoresis, and fluorescent antibody test. B cell maturation, activation and differentiation. B cell receptor. T cell maturation, activation and differentiation. Signal transduction with T cell activation. **8 hours**

4. Vaccines: role and properties of adjuvants, recombinant DNA and protein based vaccine, chimeric and hybrid monoclonal antiboby and its application. **4 hours**

5. Introduction to the basic principle of molecular technology and techniques used in pathogen detection. Method of diagnosis: principle of ELISA and its role in viral detection, microarray based detection, hybridization based detection and detection through PCR, Complement system. Restriction hybridoma technique and production of monoclonal antibodies. **8 hours**

ABT 302: Bioinformatics (1+1) credits

Theory: 1 Credit/ 18 hours

1. Introduction to Bioinformatics: What is Bioinformatics? Functions of Bioinformatics. What does Informatics mean to Biologists? What Questions can Bioinformatics answer? Database and NCBI Data Model: Public Biological Databases, NCBI Data Model, NCBI function, Types of Database, Some common terms used in the Gene Bank flat file, Authors, Locus Name, Accession Number, gi Number, Patents. **6 hours**

2. Structure Database: The Notion of Three-dimensional Molecular Structure Data. PDB: Protein Data Bank at the research Collaboratory for Structural Bioinformatics (RCSB), Database Searching, PDB File Retrieval, mmCIF File Retrieval, and links. MMDB: Molecular Modeling Database, Structure File Formats. Database Structure Viewers, MMDB Viewer: Cn3D Mage, CAD and VRML, Structure Similarity Searching, Nucleic Acid Structure Polymorphism, Genome Sequencing/ Comparative Genomics. **6 hours**

3. Bioinformatics Tools- Internet: Data Mining & Retrieve, Entrez, Locus Link, BLAST, Motifs, Gene prediction & phylogeny, Phylogenetic tree, Role of bioinformatics in genomics, Genome mapping and Mapping Database and Proteomics, Concept on Micro arrays. **8 hours**

Practical: 1 Credit/ 18 hours

1. Introduction to major databases **6 hours**
(i) Nucleotide Database
(ii) Protein Database
(iii) Structure Database

2. Use of FASTA format, Blast tool **4 hours**

3. Use of Bioinformatics tools- RasMol, RasTop, Cn3D **4 hours**

4. Use of EMBOSS Tools **4 hours**
5. Case study on Rice **2 hours**

ABT 303: Molecular Breeding (2+1) credits

Theory: 2 Credits/ 36 hours

1. DNA marker: Definition, importance, types: RAPD, ISSR, SSR, RFLP, AFLP etc, advantages and limitation, identification of linked marker. **10 hours**
2. Marker Assisted Selection (MAS): Concept, procedure, advantages, Practical achievements, merits and demerits. **8 hours**
3. Breeding of Transgenic crop: Concepts, main features; transgenic breeding vs conventional breeding, procedure, merits and demerits. **8 hours**
4. Quantitative trait loci: Concepts, importance; concepts of RILS and NILS, Procedure of QTL development, practical achievement. **10 hours**

Practical: 1 Credit/ 18 hours

1. Study of RAPD marker, ISSR marker, SSR marker. **8 hours**
2. Phylogenetic relationship study based on molecular marker. **4 hours**
3. Linkage and associationship analysis. **6 hours**

ABT 304: Genomics and Proteomics (2+0) credits

Theory: 2 Credits/ 36 hours

1. Structural genomics: Classical ways of genome analysis, large fragment genomic libraries, physical mapping of genomes, genome sequencing– principles and translation to large scale projects; recognition of coding and non-coding sequences and gene annotation; comparative genomics. **8 hours**
2. Identification and classification using molecular markers- 16S rRNA typing/ sequencing, EST's and SNP's. **2 hours**
3. Functional genomics: DNA chips and microarray technology and their use in transcriptome analysis; mutants and RNA in functional genomics; metabolomics and ionomics for elucidating metabolic pathways etc. **8 hours**
4. Proteomics: Protein structure, function and purification. Protein analysis (includes measurement of concentration, amino acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; microscale solution isoelectric focusing; peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and differential display proteomics, protein-protein interaction, Yeast two hybrid system. **10 hours**
5. Pharmacogenetics: High throughput screening in genome for drug discovery- identification of gene targets, pharmacogenetics and drug development, Application of genomics and proteomics in agriculture, human health and industry. **8 hours**

ABT 305: Transgenic in Crop improvement (2+0) Credits

Theory: 2 Credits/ 36 hours

1. Concepts, principles and scope of transgenic technique vis-à-vis Biotechnology. Commercial status of transgenic plant, regulatory procedure for commercial approval of transgenic crop, biosafety concern of transgenic crops. **8 hours**
2. Herbicide resistance; Glyphosate, sulphonyl urea, phosphinothricin, atrazine etc. **4 hours**
3. Insect resistance: Bt toxin, synthetic Bt toxin, protease inhibitor, lectins etc. Antisense RNA

technology vis-a-vis Delay of fruit ripening. **8 hours**

4. Disease resistance: Pathogenesis, related proteins, anti-microbial protein, phytoalexin, manipulation of disease resistance gene. Virus resistance: Coat protein mediated cross protection, non-structural protein mediated resistance, satellite RNA protection, defecting inferring RNAs. Resistance to abiotic stress. **10 hours**

5. Transgenic for quality like improved storage, male sterility, golden rice. Production of antibiotics and pharmaceuticals in plants, Transgenic plants as bioreactor. **6 hours**

ABT 306: Environmental Biotechnology (2+2) credits

Theory: 2 Credits/ 36 hours

1. Environmental Biotechnology: Concept and scope; Bio-monitoring & Biodegradation: Concept, factors, methods. **4 hours**

2. Bioremediation- *In-situ* and *ex-situ*, advantages and disadvantages; Bioremediation of contaminated ground water and phytoremediation of soil metals, microbiology of degradation of xenobiotics, applications of biosensors in environmental pollution, Treatment strategies for pesticides, oil, toxic pollutants, heavy metal pollution, contaminated soil. **4 hours**

3. Application of Biotechnology in solid waste management: Composting; Vermiculture; Effective micro-organism technology, Biogas, sanitary landfill technology. **6 hours**

4. Biological treatment of waste water: primary, secondary and tertiary treatment (stabilization of pond, aerated lagoon, activated sludge process, trickling filter, anaerobic treatment etc), biofilms, role of microphyte and macrophytes in water treatment, Root-zone treatment. **4 hours**

5. Bioenergy: Biofuel, bioethanol, biohydrogen production. **4 hours**

6. Biodegradation of agricultural chemicals and use of biofertilizer [free living, symbiotic (rhizobial, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria, taxonomic classification, nodule formation, competitiveness and quantification of N_2-fixing, phosphate solubilizing bacteria and fungi, including mycorrhiza]; Xenobiotics and bioaccumulation, Microbial transformation/ degradation of pesticides, eutrophication control. **8 hours**

7. Bioreactors, Biodegradable Plastics, Biosurfactants, bioscrubbers. **2 hours**

8. Conservation of biodiversity through biotechnology. **4 hours**

Practical: 2 Credits/ 36 hours

1. Biogas processes **2 hours**
2. Application of bioremediation **4 hours**
3. Compost and vermicompost production **8 hours**
4. Study of bioreactor and its use in sewage treatment **2 hours**
5. Isolation and production of N_2-fixing biofertilizers **10 hours**
6. Isolation and production of PSB **4 hours**
7. Production of Azolla **2 hours**
8. Production of VAM **2 hours**
9. Production of BGA **2 hours**

ABT 307: Molecular Tools and Techniques (0+2) credits

Practical: 2 Credits/ 36 hours

1. Handling of laboratory instruments. **4 hours**
2. Isolation of plant genomic DNA. **2 hours**
3. Isolation of bacterial genomic DNA. **2 hours**
4. Isolation of fungal genomic DNA. **2 hours**
5. Isolation of plasmid DNA– mini preparation. **4 hours**

6. Estimation of DNA using Spectrophotometer. **2 hours**
7. Agarose gel electrophoresis. **2 hours**
8. Sodium Dodecyl Sulphate gel electrophoresis (SDS-PAGE). **4 hours**
9. Purification of DNA from Agarose gel. **2 hours**
10. Restriction digestion of DNA and DNA ligation. **4 hours**
11. Preparation of competent cell. **2 hours**
12. Cloning of DNA. **6 hours**

ABT 308: Organizational/ Industrial Placement (0 + 9) credits

ABT 309: Seminar –II: Proposed Plan of Dissertation Work (0+1) credits

Semester-IV [Total: 0 (T) + 25 (P) = 25 credits]

ABT 401: Seminar-III (0+1) credits

ABT 402: Dissertation work (0+24) credits (NC)