NBRI

100 level courses (Compulsory)

Course number	Course content
BIO-NBRI-1-001 (1-0-0-1)	**Biostatistics** Summarization of Data: measures of center, dispersion, skewness Dependence of variables: Correlation, linear regression, logistic regression Basic probability distributions: Binomial, Normal, Chi-squares. Estimation of parameters: method of moments, maximum likelihood Testing of hypotheses: (a) parametric tests: t-test, z-test, chi-squares test, ANOVA (b) non-parametric tests: Mann-Whitney, Kruskal Wallis, Kolmogorov-Smirnov
BIO-NBRI-1-002 (1-0-0-1)	**Computation/bioinformatics** Computers: Introduction, Evolution and Classification of computers. Fundamentals of computing. Bit and Byte, Introduction to types of Hardware and Software. Components of Computer. Introduction to operating systems. Introduction to Computer Viruses. Network: Introduction. Network structure and architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols, transport protocol design. Types of network, Topologies of network, Router, Switch, Data Communication, Concept of Wireless networking, LAN, WAN, MAN, Security of the network, Fire-walls, Network Applications Information Technology: Concepts of client Server Architecture, Concept of search Engine, Database search engines. Introduction to Internet Introduction to Word, Powerpoint and Excel Introduction to Bioinformatics: History of Bioinformatics, Genome sequencing projects, Human Genome Project, Applications of Bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations. Literature Search Databases, Nucleic acid and protein databases, Animal and plant databases, Ensembl Genome project TIGR database, Biotechnological databases, Motifs and Pattern Databases, Databases for species identification and classification, Structural databases. Database Retrieval and deposition systems. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction,

	Phylogenetic Tree, Protein structure prediction and visualization.
BIO-NBRI-1-003 (1-0-0-1)	**Basic Chemistry** Thermodynamics Solutions and Ions Chemical bonding and molecular structure Chemical Kinetics Stereochemistry Introduction to drug discovery (Medicinal chemistry approach) Drug target, discovery and development (forward and reverse approach
BIO-NBRI-1-004 (1-0-0-1)	**Research Methodology, Communication/ethics/safety** Philosophy and structure of scientific thoughts, Objective and Motivation of Research, Meaning of the Research, What constitutes a research topic? How to select a research topic?, Importance of literature review, Selection of appropriate methodology, Collection of data, Interpretation of data, Writing research paper, Paper presentation in scientific conference, Statistical methods, Importance of documentation, Procedure for Hypothesis Testing, Values and Ethical Problems, Criteria of Good Research, Good laboratory practice, Chemical, Radioactive and Biological safety: Possible hazards and precautionary measures; do and don'ts upon exposure Research methodology, communication, ethics, safety Asking the right questions: Originality, Depth, Precision can co-exist Formulating and refining the hypothesis: Those who do not learn from the past are condemned to repeat it Study design: Recognizing and minimizing bias Experiment design: Sometimes less is more and the importance of controls Good lab practices: Record keeping, organizing data, organizing the lab space Data interpretation; objectivity, quantification, double blind studies and necessity of statistics Comunicating your data:writing up your research Comunicating your data: presenting your findings Radiation safety Chemical and Biosafety Intellectual property rights What is ethics, the different interpretations & historical instances of unethical science Case studies: Data fraud/ plagiarism and Human Ethics violation

200 level courses

Course number	Course content
BIO-NBRI-2-001 (1-0-0-1)	**Biotechniques and Instrumentation** (compulsory) Part-I Chromatographic Analysis: GLC, HPLC, HPTLC and Flash chromatography Part- II- Spectroscopic analysis: UV, AAS and Mass spectrometry Part- III – Microscopy Light Microscopy, Confocal Microscopy, SEM and TEM NMR Spectroscopy in Plant Metabolomics: Introduction & Scope of NMR Spectroscopy and Applications of NMR Spectroscopy in Plant Metabolomics Electrophoresis:agarose and polyacrylamide gel (native and denaturing),2-D gel Centrifugation (high speed, ultra and differential centrifugation) Common Molecular Biology Techniques Chromatography: affinity, ion exchange, hydrophobic chromatography, size exclusion and reverse phase chromatography Proteomics- MALDI-MS/MS, LC-ESI-MS/MS Practical Chromatography Techniques Spectroscopy Techniques
BIO-NBRI-2-003 (1-0-0-1)	**Biology of Inheritance** What, why and how of this course Introduction, Scope of the course syllabus, Reading lists and handouts for students, Lottery for Term / Review paper topics In the beginning: Cell, chromosome, gene, hereditary units, hereditary materials, what is heredity? Unit of life – A cell and cellular basis for heredity: Why a cell divides? How it divides? Cell cycle, How does cell division impact heredity? Cell division – rules and parameters Chromosomal basis for heredity: Chromosome structures, its functions, chromosomes in cell division, chromosomes in heredity, Aneuploids, Polyploids Everyone had an opinion about heredity: Assorted theories for inheritance, Darwinism, Neo-Darwinism, Lamarckism Gregor Johann Mendel and his seminal contributions to our understanding of genetics and heredity: Where would we be if Mendel had not made his landmark contributions? Mendelism: Genes, determinants, alleles, Mendel's postulates, Laws of inheritance, their applications in real life, Universality or otherwise of these laws What happens when Mendelian laws are not followed / obeyed? Epigenetics, Transposition, Pleiotropy, Heterosis

	What happens when heredity rules go wrong? Inherited disorders, chromosome errors, single gene mutations, induced mutations Mechanisms of inheritance: Recombination, crossing over, chimerism, gene dosage, dominance and incomplete dominance, linkage and linkage disequilibrium, QTLs Does heredity in individuals differ from or impact on populations and communities? Population genetics, genetic communities, quantitative genetics Molecular genetics: Architecture of a Mendelian locus, its dissection and mapping, linkage, genetic and molecular mapping Why is study of genetics central to: Our understanding of evolution, populations, communities, ecology, recombinant DNA technologies? Students display their learning: Return of term / review papers, Seminars / Round-Table brainstorming How far did we succeed? Evaluation times are here again!!! Students to complete a test (30 min, MCQ with negative markings; 1/3 descriptive question); Students evaluate Faculty (15 min – Predesigned questionnaire); Valedictory and Closure of the Course (15 min)
BIO-NBRI-2-005 (1-0-0-1)	**Genomics: Information flow in Biological Systems** Introduction: From Sequence to function in the Age of genomics, Genome databases of various plants. Genome Organization: Nuclear, Mitochondrial and Chloroplast Genome Genome analysis: Cloning systems used in genomics, Sequencing and analyzing genome, Principles of Gene Annotation and prediction, tools and resources Genomes and transcriptomes of model organisms Small RNAs and their role in regulation of gene expression Functional genomics: Strategies to find important genes in the genome and their functional analysis Differential gene expression profiling methods (differential display, subtractive analysis, Microarrays, comparative transcriptomics) Comparative genomics and synteny (Multiple Sequence Alignments & Phylogenetic analysis) Practical Courses: Demonstration of microarray system Demonstration of 454 whole genome sequencing system Demonstration of *Sequnome* system
BIO-NBRI-2-009 (1-0-0-1)	**Plant-Microbe Interaction** Plant associated soil micro-organisms and microbial diversity Plant responses to PGPRs and pathogens Rhizosphere dynamics, effectors and signaling Plant microbe interaction in stressed conditions Molecular mechanisms of PGPRs and pathogens

	Application of Proteomics in plant microbe interaction Role of mutagenesis in plant microbe interaction Bioinoculants for nutrient and disease management Virus structure and morphology, plant virus diseases and symptomatology Transmission of plant viruses Replication and translocation of viral genomes Genome organization of viruses Practical Techniques for study of PGPRs and pathogens-I Techniques for study of PGPRs and pathogens-II Methodology for assay, detection and diagnosis Modern approaches of virus control
BIO-NBRI-2-010 (1-0-0-1)	**Plant Environment Interaction** Environment and Sustainable Development. Environment Pollution in National and Global Perspectives Sources of Air Pollutants and Plant Responses Sources and Fate of Pollutants in the Aquatic Ecosystems Responses of Plants to Water Pollution Sources and Behavior of Soil Pollutants Responses of Plants to Soil Pollutants Prevention and Mitigation of Air Pollution Prevention and Control of Water pollution Energy Resources and Conservation Plant adaptation to Environmental stress Environmental Degradation and Restoration Biomonitoring of Environmental contaminants Environmental Impact Assessment & Auditing Practical To study improvement in physico-chemical characteristics of waste water after treatment with aquatic plants, Physiological and Biochemical response of plants to toxic metals
BIO-NBRI-2-012 (2-0-0-2)	**Cell Signaling** 1. Cell communication: Inter-organellar communication Nucleus-plastidmitochondrion, Plasmodesmata, signal delivery systems. 2. Membrane receptors, Protein kinases: Ion channels, G-protein-coupled receptors,Wall associated kinases, MAPK kinases, Ca++-calmodulin system. 3. Ethylene signalling: Plant two-component signaling systems Ethylene biosynthesis, ethylene signaling cascade ethylene responses in different tissues.

	4. Auxin signalling: Auxin receptors, Auxin-responsive gene expression, Proteolysis and auxin signalling. 5. ABA signalling: Biosynthesis and Catabolism Pathways, Regulation of ABA synthesis and metabolism, ABA Signaling in seed maturation processes Proteolysis and protein interactions, ABA Signaling in Guard Cells, ABA as Antagonizing Signal to Light in Stomatal Movement. 6. Cytokinins, Gibberellins: Cytokinin metabolism, Cytokinin signal transduction, Gibberellin metabolic pathway, Genes of GA Biosynthesis and regulation, Signal transduction pathway, Downstream transcriptional events induced by Gas, Sites of GA Signaling. 7. Brassinosteroids, strigolactones, Signaling by JA, SA, polyamines: Biosynthesis, metabolism, signal transduction-mode of action 8. Light signalling: Phytochrome-mediated responses-energy dependence, Structure of phytochromes, Phytochromes- mechanism of action, Phytochrome interacting factors, Phytochrome-regulated gene transcription 9. Cross talk between signaling pathways
BIO-NBRI-2-016 (1-0-0-1)	**Developmental Biology-Plants** Root - Architecture and types, cell types, molecular basis of root development, lateral root formation, adventitious roots, root hairs, storage roots, gravitropism, hormonal control, root symbiosis, root apex Shoot - Shoot apical meristem, cell division,differentiation, xylogenesis, phloem, branching, secondary wood, molecular basis of development, hormonal control, cell growth, programmed cell death Leaf - Types, phyllotaxis, size and shape control, cell types, venation, plastid biogenesis, stomatal development, senescence Flower - Types, determinacy, ABC model, architecture, pigmentation, control of flowering time, photoperiod control, senescence, hormonal basis, scent, development of reproductive organs, pollination, apomixes Reproduction – Male and female gametophyte development, Pollination, fertilization, zygote, embryogenesis, Molecular basis, male sterility self incompatibility, somatic embryogenesis Fruit - Development, size control, ripening, parthenocarpy, molecular basis, hormonal control, climacteric fruits, abscission, sex determination Seed - Genetic control of seed development, seed structure, types of storage reserves, molecular basis, oil seeds, dormancy and germination, hormonal control, recalcitrance in seeds, photomorphogenesis, endosperm Secondary growth, cambium, trichomes, fibre, totipotency
BIO-NBRI-2-017 (1-0-0-1)	**Epigenetics and Chromatin Organization** Theory Epigenetics: DNA methylation and concept of epigenetics, Histone modifying enzymes and their role, Chromatin modifying matchinary,Chromatin

	architecture, Histone modifications, Hostone methylation, demethylation etc Transcriptional Gene Regulation: Operon Concept,, Transcription Factors and Classification, Promoters, cis-regulatory elements and enhancers, Pre-initiation complex and RNA Polymerase, transciprtion elongation and termination Gene Silencing: Transcriptional gene silencing, Post transcriptional gene silencing : Small RNA world and mechanism of regulation Post-transcriptional gene regulation: RNA processing, Inron splicing etc., Post-translational modifications of protein and their regulation Practical Nuclear Protein preparation, EMSA, Chromatin Immunoprecipitation and analysis
BIO-NBRI-2-018 (1-0-0-1)	**Homeostasis and feedback in biological systems** Light use and leaf gas exchange: Leaf anatomy, light interception and gas exchange, Chloroplasts and energy capture Carbon dioxide assimilation and respiration: Modes of photosynthesis, Photorespiration, Respiration and energy generation Gaining water and nutrients: root function: Root system architecture, Extracting water and nutrients from soil, Soil–root interface, Absorption of water and nutrients by roots Using water and nutrients: cell growth: Membrane transport and ion balance, Regulation of nutrient ion and Cell enlargement Vascular integration and resource storage: Long-distance transport of water and nutrients and Distribution of photoassimilates within plants, Phloem transport, Phloem loading, Phloem unloading and sink utilization Growth analysis: a quantitative approach: Concepts and techniques, Environmental physiology and Crop growth analysis
BIO-NBRI-2-021 (1-0-0-1)	**Molecular breeding of plants** Breeding strategies of self and cross pollinated crops Mode of reproduction in plants, pure line and mass selection, pedigree and bulk population, backcross, population improvement, Self incompatibility and male sterility and their use in hybrid seed production, recurrent selection Experimental designs in relation to plant breeding Randomized complete block design (RBD); latin square designs; augmented block design, Merits and limitations of different designs, Statistical and biometrical methods in plant breeding Analysis of Variance (ANOVA), Correlation, regression and path analysis, heritability, genetic advance, genetic gain, combining ability, heterosis and inbreeding depression, Tests of significance: Sampling distribution of mean and standard error; z and t-test, Chi- square test for goodness of fit, F test. Mutation and polyploidy breeding Selection of parents, mutagen treatment and handling of treated material,

	development of polyploids and their evaluation, Molecular Markers Overview of markers, Concept, Development methodology of AFLP, SSR, and SNP markers, Merits and demerits of different types of markers Mapping populations and phenotyping Types and developmental strategies (F2, RILs, DH lines), Merits and demerits of various types of mapping populations, Field experimental design and phenotyping Construction of linkage map Linkage map, marker polymorphism, genotyping, Data scoring, softwares and Linkage analysis, Germplasm characterization and Diversity Analysis Selection of markers, Genotyping, Data acquisition, Softwares, statistical methodologies and analysis Quantitative Trait Loci (QTLs) and QTL analysis Principle of QTL analysis,Genotyping, phenotyping, Methods to detect QTLs (Single markers, Simple and composite interval mapping), data acquisition, Softwares and analysis, Association mapping in plants Introduction, Choice of population, Analysis of population structure, Trait evaluation (phenotyping), Identification of marker/sequence polymorphism, Statistics of association mapping-Linkage disequlibrium (LD), measure of LD, factors affecting LD Marker Assisted Selection (MAS) Gene tagging by Bulk segreegent Analysis (BSA) and near isogenic lines (NILs), Gene pyramiding, advanced backcross QTL (AB-QTL) analysis, Breeding by Design, Effectiveness and efficiency of MAS over phenotypic selection, foreground and background selections; marker assisted hybrid (MAH) breeding; important examples of successful MAS. Practical Emasculation, pollination, Genotyping (PAGE and ABI DNA Analyzer), data scoring, polymorphism detection.
BIO-NBRI-2-025 (1-0-0-1)	**Biodiversity** Aims, objectives and dynamics of Plant biodiversity Bio-geographic regions of plant biodiversity in India and world Diversity within different plant groups Assessment of biodiversity through classical taxonomic methods Ecological methods for plant diversity inventorying Drivers of biodiversity loss Role of Biosphere Reserve, National Parks, Wild Life Sanctuaries, Sacred Grooves in biodiversity conservation Species distribution and endemism Biodiversity and its sustainable uses

	Biodiversity and traditional knowledge Development of plant databases and its management Biodiversity legal and policy instruments Biodiversity, ecosystem function and ecosystem processes Ecological niche Impact of climate change on plant biodiversity Practical work: Field visit and ecological methods to study biodiversity
BIO-NBRI-2-486 (1-0-0-1)	**Plant morphogenesis and regeneration** History and scope of plant tissue culture, concept of cellular differentiation Dedifferentiation, re-differentiation, totipotency and media composition. Plant Growth Regulators Auxin, cytokinin, GA, ABA, JA, ethylene signaling pathway Organogenesis and somatic embryogenesis: Fundamental aspects of morphogenesis, somatic embryogenesis and androgenesis, mechanisms, techniques and utility. Culture of different plant parts: Root, stem, leaf, meristem culture, ovary, ovule and nucellus culture, embryo culture, endosperm culture. Production of Haploids: Techniques for development of androgenic haploids, factors affecting anther culture, pollen culture, gynogenesis, applications of haploids. Somatic Hybridization: Protoplast isolation, fusion and culture, hybrid selection and regeneration, possibilities, achievements and limitations of protoplast research Application of Plant Tissue Culture: Clonal propagation, artificial seed production/ encapsulation somaclonal variation, production of secondary metabolites/natural products, automation in plant tissue culture, cryopreservation and germplasm storage Specific gene transfer: Direct and indirect methods, current status and limitations. Practical Laboratory organization and equipments, preparation and sterilization of media. Explant preparation, surface-sterilization, inoculation and subculture. Hardening and field transfer of tissue-raised plants, excised root culture, callus culture, encapsulation of seeds/somatic embryos.

300 level courses

Course number	Course content
BIO-NBRI 3-001 (1-0-0-1)	**Seminar Course (compulsory)**
BIO-NBRI 3-003 (1-0-0-1)	**Cell and tissue engineering** Genetic engineering of plant cells -Transgenic plants Methods of direct and *Agrobacterium* mediated gene transfer (Ti plasmid). Methods for DNA transformation: electroporation, microinjection, particle-gun technology. Strategies for crop improvement with special mention of biotic and abiotic resistant plants and value addition. Recombinase-directed chromosome engineering in plants Cre & lox system FLP& FRT system PhiC31 & aatP-attB system R and RS system/ParA& MRS system Production of pharmaceutically important drugs and therapeutics using genetic engineering Large scale production of secondary metabolites using cell and suspension cultures. Hairy root culture and Ri plasmid, Hairy root cultures as phytochemical factories and process of elicitation. Recombinant therapeutic protein production (medical molecular pharming) in plant cells/tissues. Metabolic Engineering of major metabolic pathways and products. Cloning and characterization of secondary metabolic genes. Bioengineering and other means to develop new plant products. Use of genetic engineering and molecular biology tools for Metabolic Engineering. Plant Cell reactors- type of reactors, comparison of reactor performances, Immobilized plant cell reactors. Practical Experiments Electroporation & particle-gun technology Molecular characterization of transgenic plants Hairy root induction and establishment Demonstration of bioreactor
BIO-NBRI-3-486 (1-0-0-1)	**Climate change and Plants** Sources of Green House Gases (GHGs) and their impact, Mitigation strategies of GHGs, Impact of elevated CO2 and temperature on plants, Plant responses to O3 stress, Drought tolerance mechanism of plants, Crop simulation modeling,

	Carbon sequestration, Green technologies to combat climate change, Climate change and forest ecosystems, Climate change and plant diseases, Climate simulation modeling, Remote Sensing & GIS, FACE technology Practical Ozone monitoring techniques Methane efflux measurement Ambient Air Quality Monitoring
BIO-NBRI-3-487 (1-0-0-1)	**Bioremediation** Bioremediation: Principles and Applications Bacterial Remediation of Metal and Metalloid Contamination Fungal Bioremediation Mycorrhiza and Rhizoremediation Phycoremediation Biodegradation of Recalcitrant Organic Wastes Phytoremediation of Contaminated Water & Constructed Wetlands Phytoremediation of Contaminated Soils Phytoremediation and Role of Nutrient Management Role of Nanotechnology in Bioremediation Scope of Soil Carbon Sequestration in Degraded Soils Limiting Factors in Bioremediation Processes Practical Protocols/ Techniques of Soil Bioremediation using Microbes Protocols/ Techniques of Soil Phytoremediation Protocols/ Techniques of Phytoremediation for Aquatic Ecosystems Use of Soil Enzymology in Monitoring of Bioremediation
BIO-NBRI-3-488 (1-0-0-1)	**Environmental Biochem and Biotech** Advances in Environmental Biotechnology Physiology of toxic metal transport and accumulation by plants I Physiology of toxic metal transport and accumulation by plants II Biochemical basis of metal hyperaccumulation in plants Detoxification mechanisms of toxic organic compounds Transgenic microbes for pollution management Molecules and pathways associated with metal detoxification in plants. Gene mining for metal accumulation and transport Transgenic plants as hyperaccumulators of heavy metals. Transgenic crops for low accumulation of toxic metals. Metagenomics of polluted habitats. GM crops and their impact on Environment. Practical

	Element estimation by AAS, ICPMS Enzyme assays- Antioxidant enzymes. Measurement of non protein thiols/Phytochelatins Gene expression by heavy metals (Microarray/RTPCR).
BIO-NBRI-3-489 (1-0-0-1)	**Taxonomy and speciation** Unit-I: Taxonomy of plants History of plant taxonomy and classification of angiosperms International Code of Botanical Nomenclature Modern trends in Taxonomy: (a) Numerical taxonomy, chemo-taxonomy, cytotaxonomy, and (b) Palynology, embryology, anatomy and palaeo-botany Relevance of Herbaria & Botanical Gardens Systematics of Pteridophytes and Gymnosperms (General characters, classification, important families) Systematics of non-vascular plants Plant descriptors, systematic of some selected families in Dicots & Monocots Methods and techniques in plant taxonomy and herbarium Unit –II: Molecular Systematics and speciation Species concept Speciation in plants Molecular Systematics: Concepts and applications Molecular markers in plant systematics Procedures for collecting and sampling of plant materials Molecular Phylogenetics Phylogenetic Inferences Phylogeography: concepts and case studies in plants
BIO-NBRI-3-490 (1-0-0-1)	**Plant Conservation and Reproductive Biology** Conservation biology: principles and applications Introduction to the science of conservation biology, Threats to plant diversity- Causes and consequences of Habitat fragmentation, destruction, overexploitation, diseases, invasive aliens, pollution, and climate change Vulnerability to extinction Habitats, Species and Populations vulnerable to extinction, Examples and Case Studies Conservation at species and population levels: Population genetics and conservation I Measurement of genetic diversity, Population bottlenecks and maintenance of genetic diversity Population genetics and conservation II Gene flow, Reproductive/mating systems; -inbreeding and out -breeding depression Effective population size and management of genetic diversity

	Conservation biology of rare and endangered plants Concepts and practical approaches, Case studies, Designing framework for new case studies Conservation at Landscape and Ecosystems levels Methods and strategic approaches, Case studies Plant species loss: assessment of extinction risks IUCN Red lists: Criteria and Classification, National Red Lists, Biodiversity Hot spots Plant conservation methods and strategies *In situ* conservation, *Ex situ* conservation, Integrated conservation, Recovery, Reintroduction and Rehabilitation of endangered habitats and species, Case studies; visit to botanic garden, conservatories, gene banks, etc. Introduction to Plant Reproductive Biology Modes and mechanics of reproduction in plants Functional Mechanism of Sex gametes and Reproductive behaviour Ontogeny and development of sex gametes in cryptogams, Ontogeny and development of sex gametes in phaenerogams, Floral biology and phenology Reproductive Progression and Plant Breeding Intra and Inter gametophytic mating and sporophyte development , Nature of breeding system, homozygosity and heterozygosity, Reproductive success and origin of polyploid genotype Pollen and Pollination Biology Structural and developmental pattern of pollen, factors influencing pollen productivity (environment, genetic) and pollen syndrome, Pollination mechanism, plant-pollinator interactions , Pollen and pistil interaction Fertilization and Seed Biology Fertilization mechanism, embryo and endosperm development, Fruit biology, seed formation, dispersion and syndrome, Seed germination and seedling demography Abnormal Reproductive Behaviour in Plants Male sterility and self incompatibility, Polyembryony, parthenogenesis, parthenocarpy, Apogamy, apomixis, apospory Recent Trends in Reproductive Biology In vitro culture of pollen, spores, gametophytes, sporophytes, embryo and tissues, Physiological and molecular aspects of sex gamete expression, differentiation, development and floral induction , Production of androgenic plants and somatic hybridization Reproductive Biology and Threatened Plants Genetic load and reproductive barriers, Physiological and genetic infringement of reproductive barriers, Case study, visit to conservatory, fernery and moss houses etc.
BIO-NBRI-3-491 (1-0-0-1)	**Economic Plants and Pharmacology**
BIO-NBRI-3-492	**Floriculture and Agronomy**

(1-0-0-1)	
BIO-NBRI-3-493 (1-0-0-1)	**PHYLOGENOMICS – An interdisciplinary course:** 1. What is PHYLOGENOMICS? (**1 lecture**) 2. Salient features and aspects of Phylogenomics R&D? How or when or why we need phylogenomics? (**2 lectures**) 3. How phylogenomics interfaces with two disciplines in plant sciences? What kind of experimental skills are required to carry out Phylogenomics R&D (**1 lectures**) 4. Related disciplines that are usually associated with or impact Phylogenomics – Phylogeography, Palaeobotany, Phylogenetics, Cladistics, Neural Networks, Fuzzy Logic and (**3 lectures**) 5. Emerging trends and state-of-the-science in Phylogenomics (**1 lecture**) 6. The applications of phylogenomics in understanding the tree of life (including plants); Chloroplast phylogenomics of different plant groups; Phylogenomics and plant adaptations (**3 lectures**) 7. Specialty studies in phylogenomics – perspectives on co-evolution of insects and adaptation to parasitism in plants (**2 lectures**) 8. Case study / Assignment in Phylogenomics and presentation of these data – Case study topics can be allotted on the first day but the last 3 lecture slots to be used for their presentations: individual seminars if number of students is less; else group discussions / group presentation (**3 lecture hour equivalents**)
BIO-NBRI-3-494 (1-0-0-1)	**Biofuels – An interdisciplinary course:** 1. What are BIOFUELS? What is their importance in terms of geo-political realities and scenarios? (**2 lectures**) 2. What kind of biofuel options are available, known and / or developed at present, in the global and in the Indian context? (**2 lectures**) 3. Biofuel R&D – technology and process development – A state-of-the-art description, industrial and technological aspects (**3 lectures**) 4. Specialty biofuels including BIODIESEL, BIOETHANOL and BIOHYDROGEN (**3 lectures**) 5. Prospects for biological engineering, process and technology development for biofuels (**2 lectures**) 6. Value addition to biofuels programs (**2 lectures**) 7. Experimental simulation, designing and developing process through simulation and or actual practicals (**2 lecture hour equivalents**)
BIO-NBRI-3-495 (1-0-0-1)	**Knowledgebase Research Management and it's utilization:** **1. General Management – 2 lecture** Vision, Mandate of the organization, structure of the organization, budgeting of different component, control & functioning.

	2. Project Management – 2 lecture Technical manpower planning, Financial management, Event management, Project review and control, Media management, Inter & Intra Networking, Motivation, Project feasibility, Phases & Project Management. **3. Development of Business and R&D activities – 2 lecture** • Demand & supply • Product marketing • Concept marketing • Customer satisfaction • Quality • Media Management. • Backup by High end research • Continuous upgradation **4. Technology Management Technology Management – 2 lecture** • Issues in technology development. • Interaction with industry case study/role playing • Agreement Negotiations & Drafting. • Issues in technology transfer. **5. Intellectual property rights management – 2 lecture** • Patents • Other than patents (Copy Right, Geographical Indicator, Trade Mark). **6. Benefits of R&D management – 2 lecture** • Benefits from licensing of technology. • Benefits from royalty. • Benefits from consultancy projects. • Benefit sharing vis-à-vis PPV and FRA, Biodiversity Act. **7. Regulatory authorities and legal misuse – 2 lecture** • Govt. agencies (GEAC, Bio-safety). • Different legal issues. • Biodiversity Act and National Biodiversity Authority. • Plant Protection Varieties and Farmers Right Act. • Material Transfer Agreements (MTA), Memorandum of Understanding (MOU). **8. Excellence in R&D management– 2 lecture** Role of R&D management for excellence. Network of Science & Technology in India, Science Auditing: Performance measure and Indicators, Scientometrics: Concepts and applications